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# POWER AND THE ENGINEER

DEVOTED TO THE GENERATION AND
TRANSMISSION OF POWER

ISSUED WEEKLY

VOLUME XXXI

July 1 to December 31, 1909

109385
24/4/11

Hill Publishing Co.,
505 PEARL STREET,
NEW YORK.

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v.31

# POWER AND THE ENGINEER

## INDEX FOR VOLUME XXXI 1909,

### JULY 1 TO DECEMBER 31.

### Explanatory Note.

Illustrated articles are marked with an asterisk (*). Book notices are marked with a dagger (†). Cross references to a particular initial word may refer to any cognate word beginning in the same way. Thus, a reference from "Oil" to "Lubricant" would apply equally to "Lubricating," "Lubrication" or "Lubricator." The cross references condense the matter and assist the reader, but are not to be regarded as conclusive. So, if there were a reference from "Boiler" to "Furnace" and if the searcher failed to find the required article under the latter entry, he should not regard it as useless to turn back and look through all the "Boiler" entries, or others that the topic may suggest, as he would have done had there been no cross reference. Letters are indexed under title or subject, general articles under writer's name as well. Not all articles relating to a given topic necessarily appear under the same entries.

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# The Low-Pressure Steam Turbine

## Efficiency and Use of the Low-pressure Steam Turbine, Utilizing Live Steam in Periods of Shortage, and the Regenerative Heat Accumulator

BY R. M. NEILSON

In view of present-day knowledge, it may seem strange that, after the first Parsons commercial steam turbine was built in 1885 by Clarke, Chapman, Parsons & Co., and was found to be, generally speaking, a success (it was used for several years generating current for incandescent electric-lamp manufacture), about six years elapsed before a condensing steam turbine was built. This latter machine, constructed in 1891 by C. A. Parsons & Co. for the Cambridge Electrical Supply Company, confirmed the opinions of its designers, that a turbine could deal effectively with low-pressure steam; and the success of the steam turbine used in conjunction with a condenser was henceforth insured.

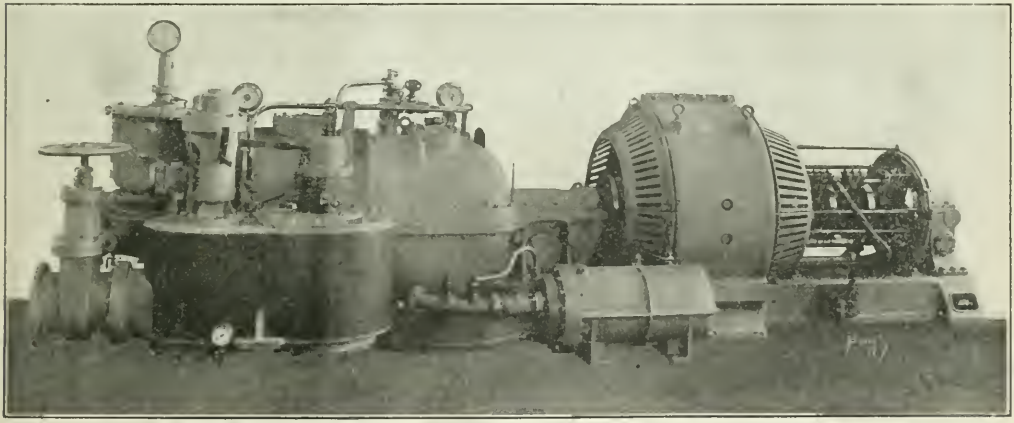


FIG. 1. PARSONS LOW-PRESSURE TURBINE IN SHEFFIELD WORKS OF JOHN BROWN & CO.

It is now well known that for utilizing the energy in steam at and below atmospheric pressure a turbine is much more efficient and, when its speed of rotation is not an objection, generally more convenient than a piston engine. The reason for the greater efficiency of the turbine has already been many times explained. Suffice it here to say that it is due not so much to any virtue of the latter, as a turbine is not really an efficient machine for usefully expanding an elastic fluid, but to the impracticability of constructing a piston engine having a sufficiently large cylinder capacity to expand the steam to the large volume which corresponds to a high vacuum, not to mention the condensation and mechanical friction losses produced in a piston engine with even a moderate steam expansion. The fact is not so familiar to engineers as it ought to be, that at a pressure corresponding to a vacuum of 28.5 inches of mercury, with the barometer at 30 inches, a single pound of steam occupies a volume of 440 cubic feet.

### Gain in Utilizing Low-pressure Turbines

The great amount of available energy in low-pressure steam has been shown in the February 2 number of POWER AND THE ENGINEER and in the chart published with the March 16 number. Suppose, for example, that steam is supplied by the boilers at a pressure of 155 pounds per square inch above the atmosphere, that is, about 170 pounds absolute. If this steam is utilized in a noncondensing engine and expanded down to 15 pounds per square inch absolute, it will be seen from the chart referred to that 136,000 foot pounds of work is obtainable under ideal conditions; the actual work obtained is, of course, less. If the exhaust steam from the noncondensing engine is utilized in a low-pressure engine exhausting at a pressure of one pound per square inch absolute, or about 28 inches of vacuum with the barometer at 30 inches, 114,000 foot-pounds of work is obtainable, this figure being the difference between the 250,000 foot-pounds obtainable from the whole expansion from 170 to 1, as given on the chart, and the 136,000 foot-pounds obtainable from the expansion to atmospheric pressure. A low-pressure reciprocating engine has, as aforesaid, a very low efficiency, but a low-pressure turbine, excluding very small sizes, could give out a large proportion of the 136,000 foot-pounds available, and may, in fact, develop a brake horsepower more than the high-pressure engine which supplies it with exhaust steam. The great gain to be derived by employing a low-pressure turbine to utilize the energy in exhaust steam will therefore be obvious.

For example, several small reciprocating engines employed in a factory and aggregating 400 indicated horsepower may have a steam consumption of 35 pounds per indicated horsepower per hour, the total steam consumption being, therefore, 14,000 pounds per hour. A low pressure turbine utilizing their exhaust steam might easily develop 400 brake horsepower, which is more than the aggregate brake horsepower of the reciprocating engines. Of course, a turbine may very effectively utilize all the energy in the steam from the boiler to the condenser, but in many cases a reciprocating noncondensing engine is already installed or is preferred to a turbine.

The proposal to combine a high-pressure reciprocating engine with a low-pressure steam turbine dates back at least as far as 1837, when a British patent was granted to James Caleb Anderson for such a combination. Anderson proposed to employ a turbine of the Hero type which would receive the steam exhausting from the reciprocating engine and drive onto the shaft of the latter by a belt. The combination was suggested by Mr. Parsons in the early days of the Parsons turbine, but it is only recently that the idea has been put into practice both on land and at sea.

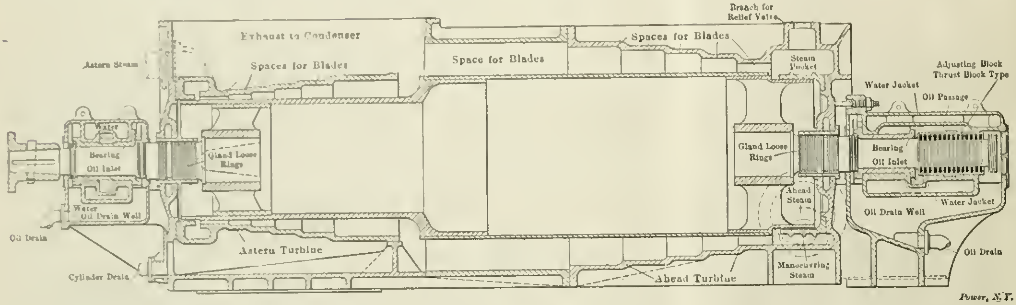


FIG. 2. SECTIONAL ELEVATION OF A PARSONS MARINE STEAM TURBINE (LOW-PRESSURE AND ASTERN TURBINES IN ONE CASING)

### WHERE TO USE A LOW-PRESSURE TURBINE

A low-pressure turbine may with advantage be combined with a piston engine in two sets of cases:

1—In a new installation when it is thought desirable on account of economy or for other reasons to employ a piston engine for the first portion of the expansion of the steam, and when the conditions of working allow of a turbine being employed to complete the expansion.

2—When noncondensing piston engines have already been installed and it is desired to make use of their exhaust steam.

Examples of the first set are the propelling machinery of the British torpedo-boat destroyer "Velox" and of the merchant steamer "Otaki" built by William Denny & Bros. In the "Velox" there are two high-pressure and two low-pressure steam turbines and two sets of triple-expansion reciprocating engines. At full power the reciprocating engines are not used, the live steam being divided between the high-pressure turbines and exhausting from each of these into a low-pressure turbine. At cruising speeds, however, the steam is first supplied to the reciprocating engines, then to the high-pressure turbines and then to the low-pressure machines, the less ratio of expansion in the turbines in this case allowing of lower blade velocities and hence of lower propeller speeds. The reciprocating engines drive onto shafts which are in line with, and are coupled to, two of the turbine shafts at cruising speeds, being uncoupled at high speeds.

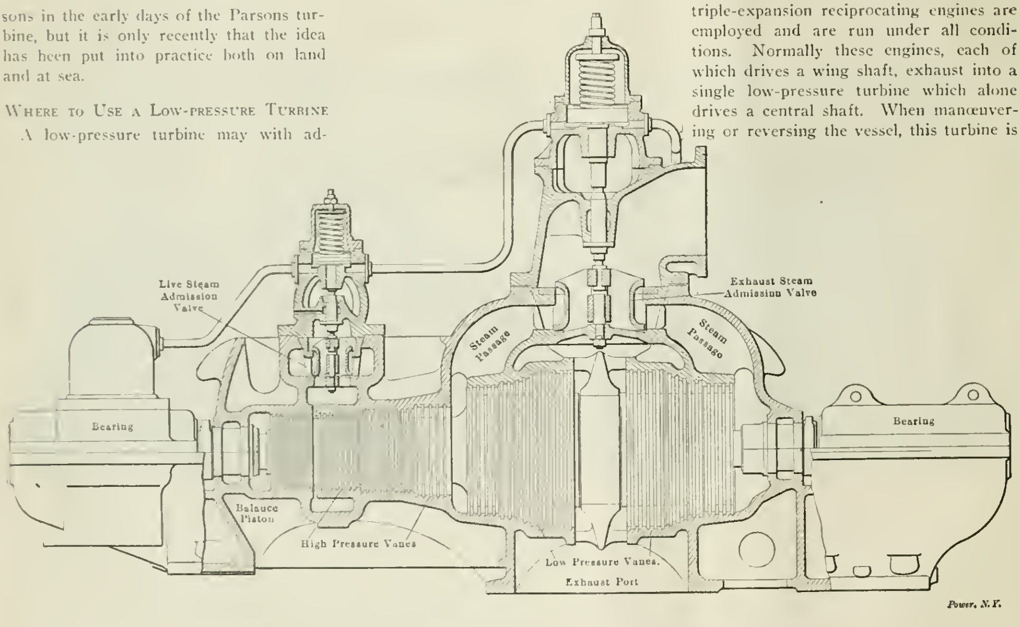


FIG. 3. SECTIONAL ELEVATION OF BROWN-BOVERI MIXED-PRESSURE STEAM TURBINE

In the "Otaki," in which the maximum speed is only about 15 knots, two sets of triple-expansion reciprocating engines are employed and are run under all conditions. Normally these engines, each of which drives a wing shaft, exhaust into a single low-pressure turbine which alone drives a central shaft. When manœuvering or reversing the vessel, this turbine is cut out and the reciprocating engines exhaust direct to the condenser. The trials of the vessel, conducted at the end of October and beginning of November of last year, showed that the arrangement was conducive to economy; and similar installations will probably be repeated on other vessels intended to make long voyages at moderate speed with one filling of the bunkers. The ratio of the importance of economy to weight of machinery varies, of course, in vessels of different classes and reaches its maximum in the class above mentioned.

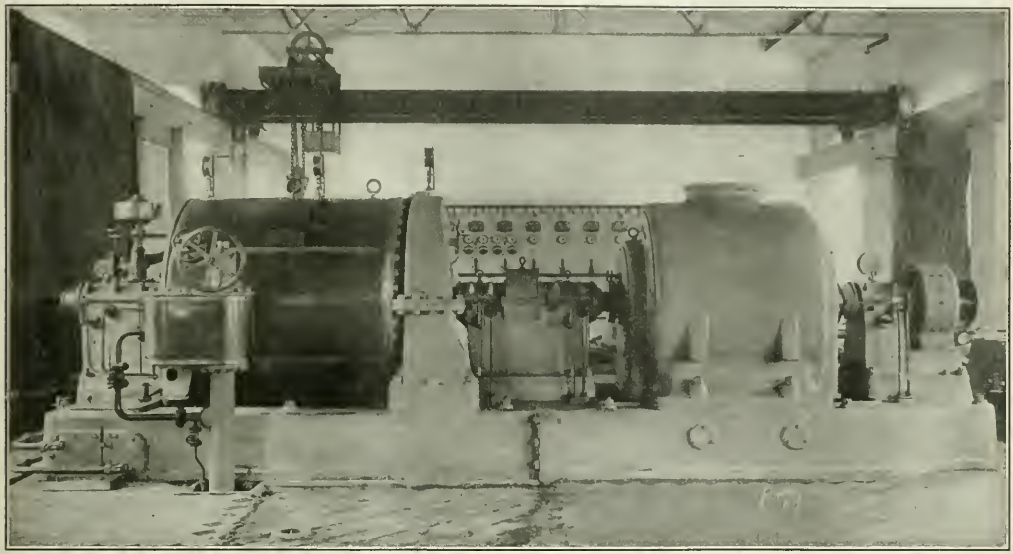
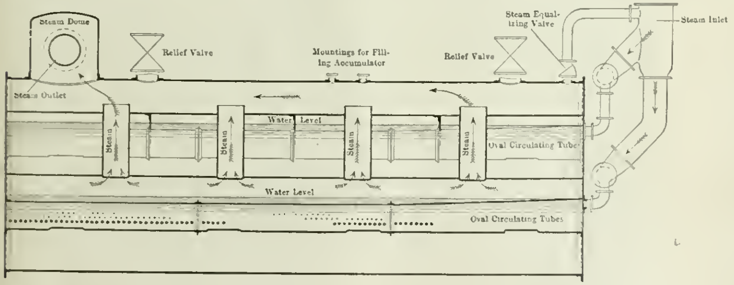
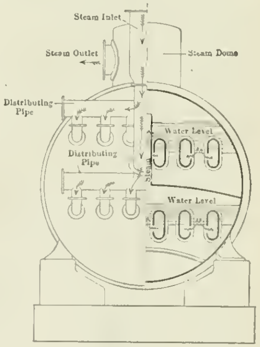


FIG. 4. 1000-KILOWATT MIXED-PRESSURE TURBINE AT BOLCKOW, VAUGHAN & CO., STEEL WORKS, SOUTH BANK, MIDDLESBORO





Power, N. Y.

FIG. 5 RATEAU HEAT ACCUMULATOR, DOUBLE COMPARTMENT, WATER TYPE FIG. 6

The writer is not aware of any land installations in which high-pressure piston engines and low-pressure turbines have been put down at the same time to work in conjunction with each other, but such installations will probably be fairly common in a few years, especially in cases where a reciprocating engine has, or is considered to have, advantages over a turbine other than in economy, say, for example, in the driving of rolling mills at steel works or for winding purposes at collieries.

As previously stated, the second case where low-pressure turbines are employed is with piston engines which have already been working noncondensing and it has been decided at a later date to make use of their exhaust steam in a turbine instead of wasting it or using it for heating purposes. A considerable number of low-pressure turbines have been laid down during the last few years for this purpose chiefly at collieries and steel works, the turbines, as a rule, being employed to drive electric generators and the electric energy utilized for lighting or power purposes. The great amount of exhaust steam now being wasted gives promise of the present number of low-pressure turbines being increased tenfold in a very short time. In collieries alone there is a great field for the employment of these machines, and from the remarks gleaned by the writer from colliery managers and engineers during a recent visit to several of the Fifeshire collieries, there would appear to be no difficulty in advantageously utilizing the electric energy obtained from supplying the whole or greater part of the steam now exhausted from noncondensing engines to a low-pressure turbine. In many cases the exhaust steam is utilized at present to a certain extent for various purposes, but the total value obtained from it is small.

Low-pressure turbines are also being installed in electric-power stations which have heretofore been run noncondensing, but where the advantage of utilizing the exhaust steam to drive low-pressure turbines has been appreciated and where the installation and running of such machines with the necessary condensing plant has been practicable. For example, at the McDonald road power station of the corporation of Edinburgh, Scotland, steam turbines have recently been installed to receive and usefully employ the steam exhausting from reciprocating engines and the same thing has been done at the Grove road station of the Central Electric Supply Company, London. In Edinburgh the difficulty of getting condensing water has been satisfactorily overcome by using city sewage water, although not without some trouble as regards the surface condensers.

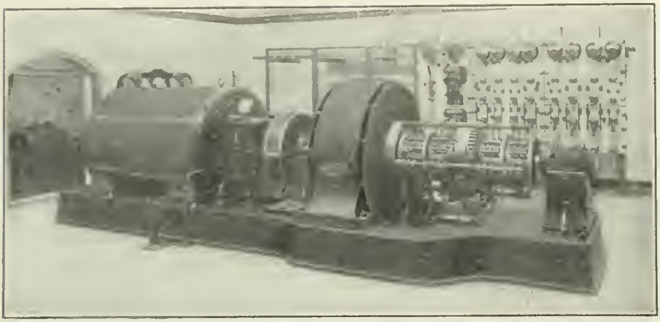


FIG. 7. 500-KILOWATT LOW-PRESSURE TURBINE AT STEEL COMPANY OF SCOTLAND'S HILLSIDE WORKS

Fig. 1 shows an exhaust-steam turbine built by C. A. Parsons & Co., Newcastle-on-Tyne, England, for John Brown & Co.'s Sheffield works. The turbine is fed by steam from a blowing engine in an adjoining building, and drives a continuous-current dynamo of 316 kilowatts capacity at 220 volts. The makers give the steam consumption on test as 40.83 pounds per kilowatt hour, the steam being supplied at atmospheric pressure, and the vacuum, corrected for a 30-inch barometer, being 27.36 inches.

### Intermittent Supply of Exhaust Steam

It often occurs that the supply of exhaust steam to a low-pressure turbine may fail while the services of the latter machine are required. For example, the reciprocating engine or engines supplying the exhaust steam may be stopped at meal hours, while the load on the turbine may be unchanged or only reduced at these times; or the reciprocating engines may be employed on intermittent work, as in the driving of rolling mills in steel works; or the exhaust steam may be obtained from hammers or other machines irregularly employed, and the turbine be utilized to drive an electric generator supplying current for purposes quite irrespective of the source of exhaust steam.

As this problem of keeping going when there is no exhaust steam occurs in the majority of cases when exhaust-steam turbines can advantageously be installed to take steam from existing engines, it is desirable to give some considerable attention to the point. The simplest means of solving the problem consists in running a live-steam pipe to the turbine and supplying the latter with live steam reduced in pressure by a reducing valve to atmospheric or whatever other pressure the turbine is built for. If a suitable reducing valve is employed, this plan is satisfactory when economy of steam is of little importance, and economy will be of comparatively little moment if the intervals of stoppage or insufficiency of the exhaust-steam supply aggregate to only a small yearly amount. There will usually, but not always, be no difficulty in obtaining sufficient live steam for the turbine at these times as the engines normally taking steam and exhausting to the turbine will either not be running at all or else running at less than normal power. When, however, the periods of shortage of exhaust steam aggregate a considerable yearly duration, or generally when economy is of importance, this live-steam-at-reduced-pressure scheme is not to be recommended.

It may be interesting to investigate this loss of economy, not only for the benefit of the academician, but in order that the practical man may have a sufficiently clear idea on the subject in order to be able to decide in any case as to whether this simple means of solving the problem can be tolerated.

### Loss of Available Energy in Passing Steam Through Reducing Valve

When steam expands without doing work, its intrinsic energy must remain constant. This is really a truism—if the steam gives up no energy, its store of energy must be unaltered. The purpose of a reducing valve being to reduce the pressure of the steam without allowing the latter to do work—although no reducing valve is quite perfect in this respect—it follows that the total heat of dry-saturated steam when passed through a reducing valve should remain constant, although the pressure falls. Consequently at the lower or final pressure the steam is superheated. For example, take the case of saturated steam at 150 pounds per square inch gage pressure reduced to atmospheric pressure; the total heat of saturated steam at 150 pounds is 1194 B.t.u. reckoned from water at 32 degrees Fahrenheit. The total heat of the reduced steam should be the same; and, as saturated steam at

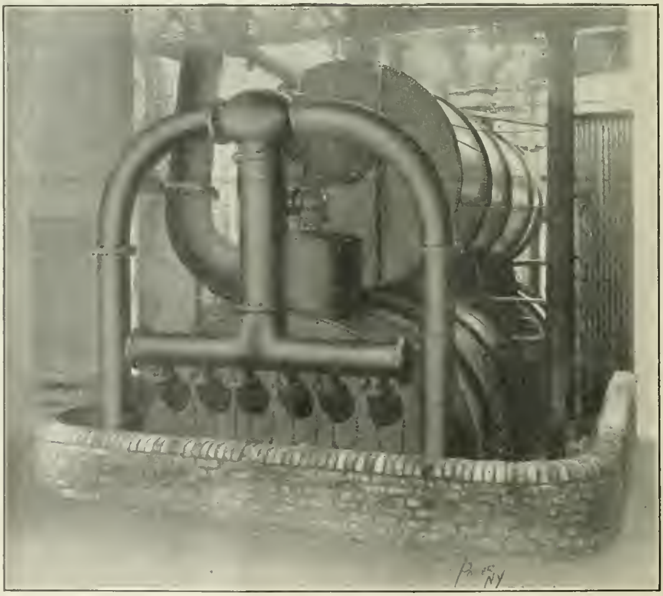


FIG. 8. ACCUMULATOR AT THE HILLSIDE WORKS OF THE STEEL COMPANY OF SCOTLAND

atmospheric pressure has a total heat of 1147 B.t.u., the additional heat energy, viz., 47 B.t.u., must be accounted for by superheat.

Taking the value of the specific heat at atmospheric pressure and between the limits of temperature in question as 0.47 (it is greater than this at higher pressures) the superheat must be 47 ÷ 0.47 = 100 degrees Fahrenheit, the temperature of the reduced steam being, therefore, 212 + 100 = 312 degrees Fahrenheit, as against a temperature of 360 in the case of the original saturated steam. The steam at the lower pressure has, due to this superheat, the same intrinsic energy as it initially possessed; and, if expanded, doing work and without receiving or giving up heat as heat, down to zero pressure, would perform exactly the same amount of work as could be obtained from it in its initial state. It is, however, impossible to expand to zero pressure in any engine whatever, and with expansion to any practical pressure, say even to one-half pound per square inch absolute, the work obtained from the low-pressure superheated steam is less than that obtained from the high-pressure saturated steam. This can be seen in an entropy temperature diagram; it can also be seen by drawing ideal indicator diagrams for the two cases and measuring and comparing the areas.

An example of the loss of available energy by passing the steam through a reducing valve may be instructive. It was stated toward the beginning of this article and can be seen in the energy charts before referred to, that the available energy in saturated steam expanding from 170 pounds per square inch absolute to one pound per square inch absolute is 250,000 foot-pounds. If the steam is first reduced to atmospheric pressure in a reducing valve, its available energy is very much less. Saturated steam at atmospheric pressure, say 15 pounds absolute, would have an available energy of 131,500 foot-pounds; and the additional available energy due to the superheat can be calculated to be 7200 foot-pounds, taking the same value for the specific heat of steam as before, viz., 0.47. Hence the total available energy in the superheated low-pressure steam would be 131,500 + 7200 = 138,700 foot-pounds, which is only about 55 per cent. of the available energy in the high-pressure saturated steam. Although the vacuum at which the turbine exhausts can exercise no influence on the action of the reducing valve, the available energy in the reduced steam depends on the vacuum, and hence the poorer the vacuum the greater will be the loss of available energy in the reducing valve, until, with a zero vacuum, there would be no available energy in the low-pressure steam. Moreover, the greater the initial steam pressure, the greater will be the loss of available energy by the pressure-reducing process.

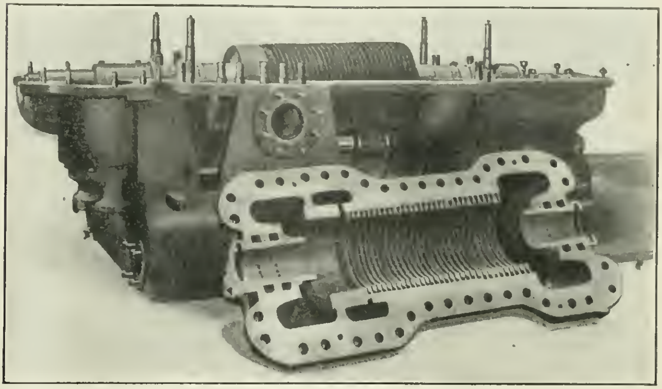


FIG. 9. REACTION TURBINE, WITH COVER REMOVED

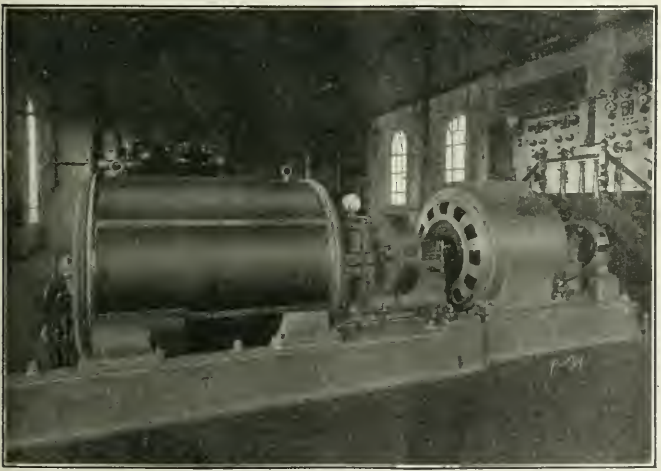


FIG. 10. RATEAU TURBINE AND ALTERNATOR AT BARBER, WALKER & CO.'S BENTLEY COLLIERY

It should be noted that, if the steam is wet when it reaches the reducing valve, some of the heat which would otherwise be used to superheat the steam will be expended in drying it or, what comes to the same thing, the steam after being superheated by the drop in pressure will lose some of its superheat in evaporating the water. The result will be that the steam will be less superheated than would otherwise be the case, but there will be more steam. Enough has been said to show the wastefulness of employing high-pressure steam in a low-pressure turbine and enough also to enable it to be determined when such a course of action is justifiable.

## High-pressure Turbine Preferable to Reducing Valve

To allow high-pressure steam to be economically employed when the exhaust-steam supply fails or is insufficient, it is now common practice to provide an auxiliary high-pressure turbine which receives the live steam (no reducing valve being employed) and, after expanding it to about atmospheric pressure, according to the conditions of the case, exhausts to the low-pressure turbine. It is usual to place this high-pressure turbine in axial alinement with the low-pressure machine and either in the same casing or in a separate casing and to allow it to rotate idly, driven by the low-pressure machine when no high-pressure steam is being used. There is a small amount of frictional drag due to this idle running, but the arrangement is simple, convenient and not costly. Such an arrangement is often called a mixed-pressure turbine. The auxiliary high-pressure machine, although of some-

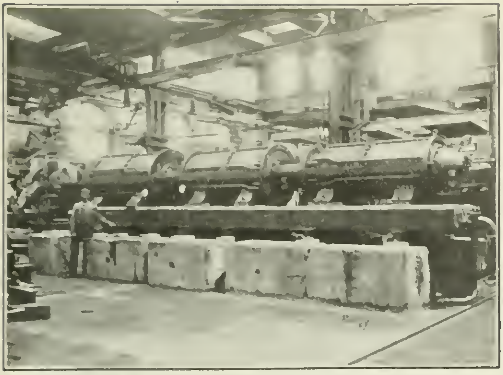


FIG. 11. LENZ 740-HORSEPOWER EXHAUST-STEAM TURBINE

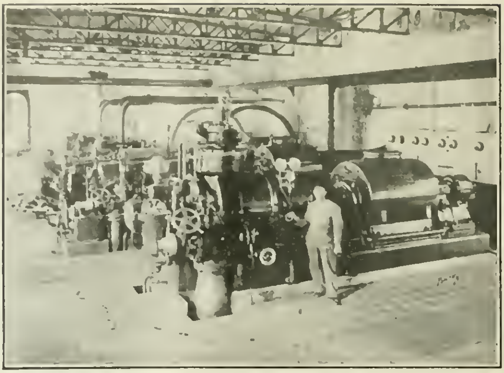


FIG. 12. HERNE 450-HORSEPOWER EXHAUST-STEAM TURBINE

where about half the power of the low-pressure machine so that in conjunction with the latter it can give full power with live steam only, can be made of much less than half the size of the low-pressure turbine, not only on account of the less specific volume of the steam at the higher pressure, but because of the fact that to produce a given power with high-pressure steam will require only about half the weight of steam that will be called for if low-pressure steam is employed. The increase in cost of a mixed-pressure turbine over a simple-pressure turbine is in Europe about 15 to 25 per cent.

### MIXED-PRESSURE TURBINES

Fig. 3 shows the Brown Boveri arrangement of low-pressure turbine with auxiliary high-pressure end. High-pressure live steam when required is admitted by the automatic valve shown at the left of the figure and, after expanding in the high-pressure buckets to about atmospheric pressure, proceeds to the low pressure part of the machine which is arranged on the double-flow principle, the steam passing from both ends toward the center.

The exhaust steam gains admission to the machine by way of a balanced valve, similar to that which admits the live steam, and proceeds along the passages shown to the two ends of the low-pressure turbine; these passages also serve to conduct the exhaust from the high-pressure machine to the remote end of the low-pressure turbine. The high- and low-pressure admission valves are controlled by a joint automatic oil-operated control mechanism. The high-pressure turbine being of the single-flow type requires a balance piston of dummy rings, but the double-flow low-pressure blades are self-balancing.

Fig. 4 shows a 1000-kilowatt Rateau mixed-pressure turbine direct-coupled to an electric generator. This, the writer believes, was the first mixed-pressure turbine to be put to work in Great Britain. It is installed at the steel works of Bolckow, Vaughan & Co., near Middlesboro. It will be seen that there is only one comparatively short cylindrical casing which includes both the high- and the low-pressure blades. This is according to standard practice with Rateau turbines, and makes a very compact machine.

### THE REGENERATIVE HEAT ACCUMULATOR

It frequently happens that the hourly supply of exhaust steam is equal to the hourly consumption of a low-pressure turbine to give the power required, but that the exhaust steam supply is irregular, owing either to the intermittent running of the high-pressure engine or engines supplying the steam or to the engine being of a very slow-running nature such as is sometimes employed for pumping purposes; or it may be desired to utilize this irregular supply of exhaust steam to the best advantage, but not to expend live steam except on infrequent occasions; or it may be advantageous to steady the exhaust steam supply even if live steam is frequently used as an auxiliary. Especially is this the case with winding engines at mines and rolling-mill engines at steel works, where the stoppages in the supply of exhaust steam are frequent but short.

To steady the supply of exhaust steam and enable an approximately constant

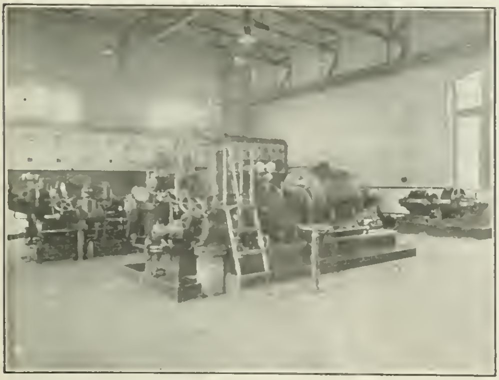


FIG. 13. GOETTELBORN 525-HORSEPOWER EXHAUST-STEAM TURBINE

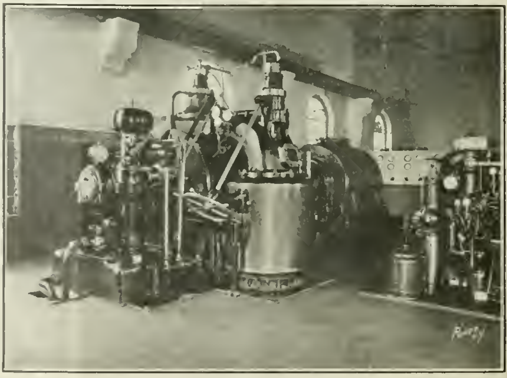


FIG. 14. HERNE 1650-HORSEPOWER EXHAUST-STEAM TURBINE

stream to be obtained even if the supply completely stops for short intervals of time, Professor Rateau several years ago brought out a regenerative heat accumulator which consists in a heat-storage reservoir in which the exhaust steam, when in excess of the demand, is condensed and in which the water is re-evaporated when the exhaust-steam supply fails or is insufficient.

The two essentials of such an accumulator are that it shall contain a sufficient mass of some material to store the required amount of heat, and that there shall be a sufficient water surface or sufficient circulation to allow of the necessary rate of evaporation being obtained when required without an undue fall in temperature. Water is usually the most suitable accumulator of heat, and the accumulators generally employed consist of steel cylinders containing water. Several modifications are in use. A satisfactory arrangement of Rateau accumulator is that shown in Figs. 5 and 6. The exhaust steam enters the apparatus by the steam inlet shown, which divides into two branches which respectively feed the two distributing pipes, which in turn supply the steam each to a row of oval circulating tubes. The accumulator is divided into two chambers, each of which contains six of these oval circulating tubes. Each tube is perforated along one side, and the steam escapes through the perforations and blows up through the water in the chamber, thus acting to circulate the water. Each chamber contains both steam and water, the normal water level being just above the top of the oval tubes. The steam space in the lower chamber communicates with that in the upper chamber by four vertical ducts, which serve for the discharge of the steam from the lower chamber. The steam outlet for both chambers is by way of the dome shown at the left hand of Fig. 5.

These accumulators work automatically. When there is an excess of exhaust steam, that is, when more steam is entering the accumulator than is being taken by the turbine, the pressure rises. The boiling point, being dependent on the pressure, must rise also, and consequently water can exist in the accumulator at a higher temperature. The water already in the accumulator forming the storage material absorbs heat from the steam, which the latter gives up by in part condensing on the surface of the water, as, due to the rise in the pressure of the steam, the water is a few degrees colder. The uncondensed steam passes on to the low-pressure turbine.

When the steam supply stops or is insufficient, the pressure in the accumulator falls, owing to the constant demands of the turbine, and, the boiling point falling in consequence, the water in the accumulator in part evaporates.

The exhaust-steam water is used as the storage material, but the amount of water deposited in the accumulator during a period of excess is only a small percentage of the average amount in the accumulator. This is necessarily the case as each pound of water evaporated takes about 1000 B.t.u. from the remaining water in the accumulator, and the temperature of the latter cannot be allowed to vary more than a few degrees or there would be an inconvenient amount of variation in the pressure of the steam supplied to the turbine. For example, a fall in temperature from 213 to 206 degrees Fahrenheit means a fall in pressure from 15 pounds to 13 pounds per square inch absolute.

Of late years these steam accumulators have been installed in considerable numbers in Europe, and it has come to be considered standard practice to provide a steam accumulator whenever a low-pressure turbine is installed to use the steam exhausting from one or more noncondensing engines which are irregular in their running or in their steam consumption.

### Limitations of Accumulators

These accumulators are, however, suitable only for smoothing out inequalities of steam supply of short duration. They are very suitable in the case of a noncondensing engine which runs for a minute or part of a minute and stops for an equal period, but they would not be suitable in the case of a stoppage or serious diminution of steam supply of several minutes. This is on account of the great size that would be required to store heat for anything more than a short period. This will be appreciated when it is noted that to evaporate one pound of water at atmospheric pressure requires 966 B.t.u., which means lowering the temperature of 966 pounds of water in the accumulator 1 degree Fahrenheit. To evaporate 10 pounds of water per second, which is about the consumption of a 1000-kilowatt turbine (the exact figure depending on the vacuum, type of machine, etc.), therefore, requires the lowering of the temperature of 9660 pounds of water one degree or 96,600 pounds one-tenth of a degree. This is the drop in temperature in one second and is at the rate of 6 degrees per minute. It will thus be seen that an accumulator holding nearly 100,000 pounds of water cannot sustain the demands of a 1000-kilowatt turbine for long without a serious fall in temperature and hence fall in pressure of the steam.

To give an idea of the size of accumulators actually in use it may be said that the accumulator at the Hallside works (at Newton, Lanarkshire) of the Steel Company of Scotland consists of a cylinder 34 feet long and 11 feet 6 inches in diameter. It is shown in Fig. 8 and is of the type illustrated in Figs. 5 and 6. The accumulator acts in conjunction with two low-pressure Rateau turbines each of about 600 brake horsepower.

Three accumulators of a slightly different design, but acting in substantially the same manner are installed at the Auckland Park colliery, Bishop Auckland, County Durham, England, and are each about 7 feet in diameter and 30 feet in length. These accumulators draw steam from a considerable number of noncondensing engines and were designed to supply during engine stops of small duration sufficient steam to generate 1000 kilowatts.

### Cost of Accumulator and Low-pressure Turbine

The cost of accumulators varies considerably according to the length of period to be bridged over and other conditions; they can be obtained for a less price now, for the same capacity, than was the case a few years ago. To give an idea of cost, an accumulator suitable for a 500-kilowatt low-pressure turbine and able to bridge over periods of total stoppage of exhaust steam of one minute to 1½ minutes would probably cost in Great Britain about $5000 to $7500. Low-pressure turbines cost about $15 to $20 per kilowatt, and mixed-pressure turbines about 15 to 25 per cent. more.

To show how much attention is now being given in Europe to the utilizing of low-pressure steam for power purposes, it may be mentioned that one firm of turbine manufacturers in Great Britain, and not the first on the field in exhaust-steam utilization, has already delivered or has on order 11 mixed pressure and an equal number of low-pressure turbines, the whole aggregating 9300 kilowatts; and one large firm on the continent of Europe at the end of 1908 had already built or had on order 11 mixed-pressure or low-pressure machines aggregating 9700 horsepower. These do not include turbines for ship propulsion.

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The Santa Fe Railway Company proposes to electrify the line over Raton Pass, thirty-eight miles, between Trinidad, Colo., and Raton, N. M., in which event 15,000 electric horsepower will be required for twenty-four hours' consumption in hauling freight and passenger trains through the Rocky Mountains. The change from steam to electricity will involve an expenditure of about $1,500,000, and J. J. Henry, president of the Southern Colorado Power and Railroad Company, of Trinidad, will figure with the Santa Fe officials on a contract to do the work.

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Harriman engineers are stated to be considering the advisability of electrifying the Central Pacific, Oregon Short Line and San Pedro.

# Experimenting with Fuel Oil

By R. Renton Hind

The Hawaiian Electric Company, Honolulu, H. T., is effecting a saving of nearly 10 per cent. in fuel consumption as a result of consistent experimenting with fuel oil under water-tube boilers. The boiler plant consists of two 300-horsepower Stirling boilers and three Heine boilers of the same unit capacity arranged in separate batteries. The former were installed about eight years ago and the latter in 1896. Both sets burned coal up to four years ago, at which time change was made to oil.

The Stirling people recommended no particular change in the setting beyond the laying of a few bricks on the grates, but it soon became evident, from the unsatisfactory results that were obtained at the outset, that some change was necessary. The first step in the experimental stage was to remove the arch from over the bars and the result was so encouraging that further changes were made both in the feeding of the oil and in the admission of air to the furnace. The burner (Witt's "Little Giant") was inclined at an angle of about 45 degrees and air was admitted at the base of the flame, *A*, Fig. 1, and at *B*. After these changes were made there was a marked decrease in fuel consumption and perfect combustion was obtained.

In a number of oil-burning plants the writer has noticed puffs of densely black smoke emitted at intervals from the stack and this undesirable condition is due, among other causes, to the condition of the oil upon entering the burners. This appears to be in line with experience of the Hawiian Electric Company, for a change in the method of heating the oil previous to its entering the burners aided the combustion.

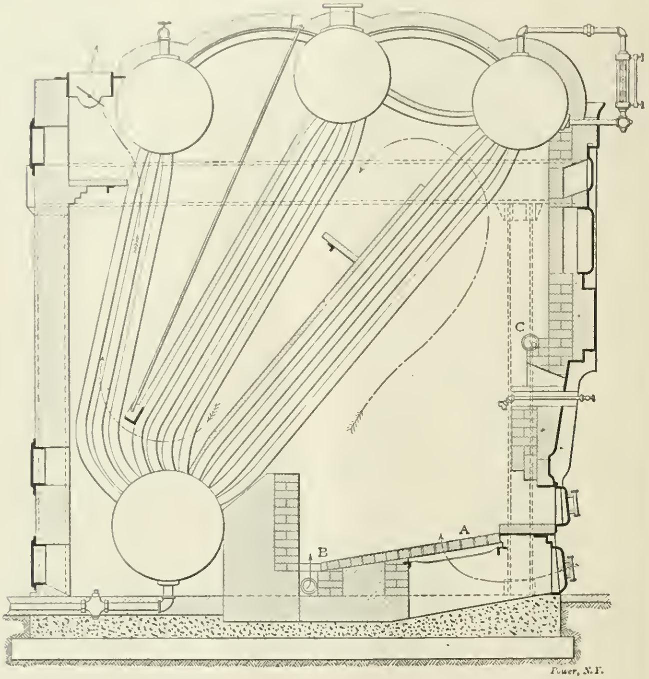

FIG. 1.

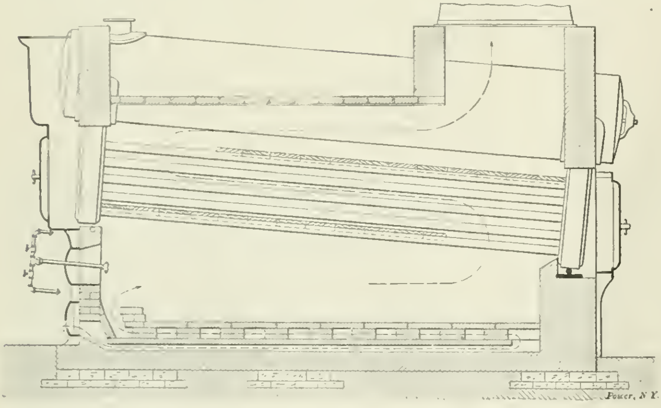

FIG. 2.

The standard oil burning plant contains an oil pump, usually a duplex, set upon a stand and connected in duplicate with another of the same size, the latter to be used in case of emergency, the exhaust connections of both being led into a small oil heater fastened to the under side of the stand. A pump governor completes the outfit. In lieu of a gravity feed system, which the insurance companies will not allow, the pump maintains the oil under a pressure at the burners and at a temperature of about 100 degrees Fahrenheit. This company, while using the pump system, does not make use of the exhaust heating apparatus previous to the entering of the oil into the furnaces, for it appears that the gradual heating of the oil in mass in the heater tank results in the reaction of a gas which causes the oil to be delivered from the burners in a series of puffs, forming a detriment to good combustion. Instead, the oil is delivered to the burners cold and is here met by a jet of superheated steam. At *C*, Fig. 1, this steam pipe is shown in cross-section, having been led around the furnace under the direct action of the flames.

### Changing the Settings

While the Stirling boilers offered no especial difficulties in the attempt at improvement in their steaming qualities, the Heine battery presented no small problem to those who had charge of the work of making changes. While this type of boiler setting gave admirable results with coal as a fuel, the combustion chamber proved to be too small for the proper burning of oil. Acting upon the experience gained from changes made in the Stirling, the first step was to cover the grate bars with loose brick as before. Then the bridgewall was removed, resulting in a slight improvement in efficiency. The grate bars were next lowered and, as in the case of the Stirling, a secondary admission of air was made where the bridgewall had been located. This change was unsatisfactory, for the flames had a tendency to roll around in the combustion chamber. Next, the furnace floor was lowered to that of the ashpit in order to get more combustion room, the grates were removed and air admitted at the front of the furnace. Considerable improvement was effected by this change, but it was thought better to preheat the air before its admission to the furnace. To this end the furnace floor was constructed as shown in Fig. 2, the air passing from the front of the furnace to the rear and back again. Further improvement was noted, but the side walls were soon burned out and to remedy this the cold air was led through a passageway through the side walls to the rear of the boilers and thence back under the floor, as before, to the furnace.

As a rule there is a roaring noise common to most oil-burning furnaces but in this plant combustion is effected without this objectionable feature and instead of a white, blinding flame one is surprised to see the flames a bright red, moving slowly through the tiers of tubes.

### Flue-damper Regulation

Flue-damper regulation is used entirely, rather than the more common system of air regulation by means of the ashpit doors, and this seems to be reasonable enough when it is considered that fuel oil creates its own draft and the opening or closing of the flue dampers merely serves the purpose of accelerating or retarding the speed of the flames in their passage from combustion chamber to flue.

As the two batteries draw their oil supply from the same source no attempt has been made to test the relative merits of the two types of boiler in use but the following figures, taken from the "log," give one an idea of what is being done under actual conditions: On December 16 of last year, 425,936 pounds of water was evaporated, at the expenditure of 98 barrels (32,928 pounds) of Coalinga (Monterey county, Cal.) oil. The calorific value of this oil is about 18,500 B.t.u. per pound and at this figure the efficiency of the boilers is a little over 70 per cent.

Summing up, therefore, it would seem that the experiments brought out the following facts:

Secondary air admission is only permissible where the combustion chamber is of ample proportions.

As in the case of coal, preheated air is an aid to more complete combustion.

Stack-damper regulation is preferable to air regulation.

The quieter the fire the more complete the combustion.

The heating of the oil at the moment of its emmision from the burner by the use of superheated steam is preferable to the heating of the oil before its entrance to the furnaces.

The writer is indebted to O. R. Williams, chief engineer of the Hawaiian Electric Company, for the facts given herewith and to the management for permission to publish them.

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## The Problem of a Vacuum Bottle

By C. M. Ripley

How many of us read the advertisements, "Keeps Liquids Hot for One Day and Cold for Three Days" that are appearing in the street cars and in our magazines? How many of us ever stop to think what law governs this difference? I recently called at the sales office of one of these vacuum-bottle companies, and think that the conversation that follows should be made part of contemporaneous "engineering" literature.

Inquisitive Caller: Why is it your bottle doesn't keep liquids hot as long as it will keep them cold?

Vacuum "Expert:" Why that's easy. Heat travels faster than cold.

Inq. Caller: You mean the heat will travel *outwardly* from the bottle more rapidly than the cold will travel *outwardly?*

Vac. Expert: Exactly sir. Exactly.

Inq. Caller: But cold is simply the absence of heat. It seems to me that they would both travel at the same speed.

Vac. Expert: Oh no. Heat waves are always more rapid than cold waves.

Inq. Caller: Now let's see if I understand you. Say we have a bottle of your vacuum type, filled with ice water. You say that this will stay cold for three days. In order for it to get warm, the heat from the air must travel *inwardly* to the ice water. This you say takes three days.

Vac. Expert: Yes that's right.

Inq. Caller: Now if we had hot liquid in one of your bottles, the cold must travel inwardly in order to cool it off. This you say takes one day. Is that right?

Vac. Expert: That's the idea, old man.

Inq. Caller: Well then, if the *cold* can do in *one* day what it takes *three* days for the *heat* to do, it seems to me that cold must travel three times as fast as heat, although you say that heat travels faster than cold.

Vac. Expert: Well, er, that is, you see, heat travels *out* faster than it travels *in*, but cold travels *in* faster than it travels *out*.

Inq. Caller: Ummmmm. That's queer, isn't it? And yet it seems to me that as the heat travels *out* the cold must travel *in* at exactly the same speed, just as when the sun rises, the dark travels away just as fast as the light travels toward us. I always thought that heat and cold were to each other exactly what light and darkness are to each other.

Vac. Expert: Well, my friend, I'm sorry I can't make you see this. But it's a fact just the same that heat will travel faster than cold.

Inq. Caller: Which way, inwardly or outwardly?

Vac. Expert (with a bored expression): Why anyway, either way. That is a fixed law among the scientists.

Inq. Caller: But if the cold will get into the bottle in one day, and it takes three days for the heat to get in, I can't quite understand.

Vac. Expert (very much annoyed): That was just a slip of the tongue; cold does travel faster than heat. That's one on me.

Inq. Caller: But the heat will travel *out* of the bottle in one day and it takes three days for the cold to travel out of the bottle. So when you think about it that way it seems that after all the heat travels faster than the cold.

Vac. Expert (very much annoyed): Well you see it depends. Now, really, I've only been in this business for four days, and I'll call in our shop superintendent who is really the father of the vacuum bottle. (Presses a button. Mr. Buzz enters.) Now Mr. Buzz will you please explain to this gentleman the real scientific reason for the fact that our wonderful bottle will keep a liquid cold three times as long as it will keep it hot?

Mr. Buzz: Ahh! Um! I should be glad to, sir. You see in 1873 when I first brought out this wonderful invention, I was confronted with a very difficult problem in thermodynamics. That minute margin of sealed contact between the inner bottle and the outer bottle, besides the tiny platinum contact to the bottom, the radiation from which is practically negligible, coupled with the peculiar effect which light brings to bear upon the question of heat radiation, led me to a most exhaustive study of molecular action and a practical application of Dewar's flask. You see, my dear sir,— —

Inq. Caller (interrupting): But why does it stay cold longer than it stays hot? I want to know *why*, if you can tell me.

Mr. Buzz: Well, in the first place, we will start with the fixed and fundamental law that heat travels faster than cold—

Inq. Caller: Gentlemen, thank you. Good afternoon.

### Chapter 2

In my room that evening, I got out my pencil and paper and figured what the normal temperature would be, and how far from the normal a hot liquid would be in winter as compared with a cold liquid in summer. In using the Fahrenheit scale, I could see no reason for the great variation in the length of time. In using the Centigrade scale, I came nearer being able to explain the phenomenon. But I am still almost as unsatisfied with my attempts as I was with the elaborate and involved explanations of the patient, "vacuum expert" and the bombastic Mr Bu[illegible]

It might be a good advertising scheme for some vacuum bottle manufacturer to offer a prize bottle to each competitor in a "guessing contest." I am hoping some of the readers of this paper will be able to enlighten me better than either the "father of the vacuum bottle" or his four-day old "vacuum expert," as he first termed himself

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## Graphite for Lubrication

The advantages possessed by graphite for lubrication are well recognized. Used either with oil or by itself, loose or in various alloys and compositions, it has proved its usefulness and efficiency in too many places to need to have its advantages further questioned or urged.

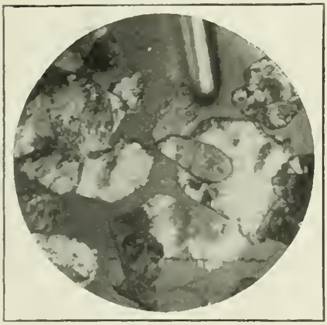


FIG. 1

But there are two kinds of graphite upon the market, the flake and the finely powdered, or amorphous, and there is a continual argument as to which is the better. The advocates of the fine, floury, amorphous sort argue that friction, being due to the interlocking or engagement of the minute rugosities of the surfaces, will be best reduced by the use of the finest material which, on account of its fineness, can pack itself into the minute cavities of the bearing and reduce it all to one level, slippery plane. They show that graphite in this form is adhesive, that when a pinch of it is rubbed between the fingers it covers them with a glossy coating which requires washing or even scrubbing for its removal, while the flaky variety can be blown off from the finger with which it has been in contact, leaving it scarcely soiled.

On the other hand, it is claimed for the flake variety that the flakes are of such microscopic thinness that they work themselves into the bearing and coat it much as would minute particles of gold leaf, that if crushing and grinding is necessary the graphite gets it in the bearing. Certainly a bearing which has been treated for any considerable length of time with either form of graphite presents a firm, smooth uniform, lustrous, slippery surface, which must materially reduce friction and wear.

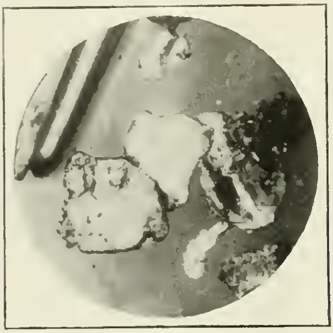


FIG. 2

In order to present the matter intelligibly to our readers we have had prepared the accompanying microphotographs of samples of both kinds of graphite magnified forty diameters. Figs. 1 and 2 show the flake and 3 and 4 the amorphous variety. The large object projecting into the field is the point of a fine cambric needle. In Fig. 1 the instrument is focused so as to bring out the scratches upon the glass slide upon which the sample was spread. The needle point is so thick that although it rested upon the glass it is considerably out of focus, but the graphite flakes are so thin that even when packed upon each other they are still within the focal plane, showing that they are much thinner than a needle point, and the manner in which they would cover up and plate over any irregularities of the surface is shown by their relation to the scratches in the glass.

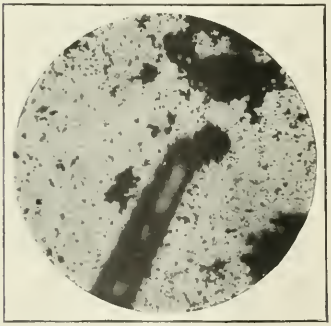


FIG. 3.

It is impossible to get the amorphous or powdery variety evenly distributed over the field so as to show its extreme fineness. Fig. 3 is an attempt at this, with the instrument focused upon the finer particles distributed all over the field, but it was impossible to clear the field of the black masses where the fine powder stuck together. Fig. 4 is the same view with the focus upon the masses in the middle of the field. These masses, it should be understood, are not lumps, but simply aggregations of the powder lightly held together, splitting up readily at the touch of the needle, but adhering to the needle and to other grains, as shown. The difference in this adhesive characteristic is very prettily brought out in the photographs where, in Figs. 1 and 2, the needle with which the grains have been stirred and arranged is perfectly bare, while in Figs. 3 and 4 the tendency of the amorphous variety to cling to its surface is very apparent. The extreme fineness may be realized by comparing the size of the particles scattered about the field with the needle point, remembering that the larger spots are composed of masses of powder probably as fine as the detached particles shown.

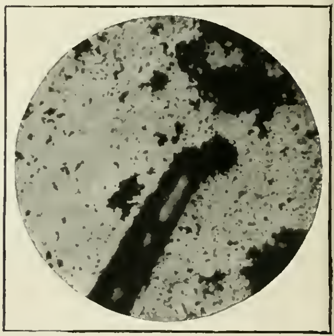


FIG. 4.

Is there any difference in lubricating quality due to these physical differences of size and adhesiveness? As we started by saying, both kinds have demonstrated their value and each has its partizans We present these views that our readers may get an intelligent idea of relativ sizes, etc., and should be glad to hav from them discussion as to whether i makes any difference whether the surfac is graphite-coated by filling up the in terstices or by bridging them over, and i so, which plan is the better and why.

# Types of Check Valve and Their Operation

## Some Observations by an Operating Engineer on the Operation and Construction of the Various Types of Check Valve Used in Practice

### BY W. H. WAKEMAN

How many engineers make a practice of testing every check valve that they install in order to know whether it leaks or is tight? Is it not common practice to screw or bolt on a valve (according to the style of connection), assume that it is perfect and give it no farther attention until something happens to show that it is defective? The writer's attention was called to this matter by the following incident: A 6x4x6-inch duplex boiler-feed pump delivered hot water into a vertical pipe as illustrated in Fig. 1. A pet cock is located in the right-hand upper part of the water box, in accordance with common practice, also an outlet in the delivery pipe, which is represented by another pet cock in the ell shown. Above this a swing check valve is placed, and higher up a gate valve is provided. This water box was warm one morning when it ought to have been cold, thus showing that water had found its way back from the boilers. Investigation showed that the fireman had left the gate valve open, as he thought that the check valve would hold the water, but it did not. A test of the matter showed that with the supply shut off from the pump and the gate valve open, water would run out of the pet cock on the water box to its full capacity, and it continued to discharge at this rate so long as the gate valve was left open, but the stream ceased to flow when this valve was shut.

When the cap was removed, the cause of excessive leakage was easily discovered, and reference to Fig. 2 will make it plain. The pin *A* carries the hanger *B*, and this holds the clapper *C* in place, but allows it to open and close by swinging on the pin *A*. The seat of this valve is not level, but is inclined at an angle of about 45 degrees, hence as the parts become worn by long service and hard usage the clapper *C* slides down as low as possible, leaving a space in the form of a new moon at the highest point where the port is not completely covered by the clapper. Consequently the valve leaks, and that is what had taken place in this case.

This valve might have been repaired by providing a larger pin and boring out the bearing at each end, also the hanger to reduce the lost motion to a minimum. The clapper was too loose in the hanger, hence the hole at this point required boring and bushing until a better fit was secured, although all of these joints must work easily in order to prevent them from failing to operate when wanted. The clapper required refacing in a lathe, and the seat should have been treated with a valve file. The cost of this work is almost always sufficient to warrant the purchase of a new valve, hence it was decided to send for one at once.

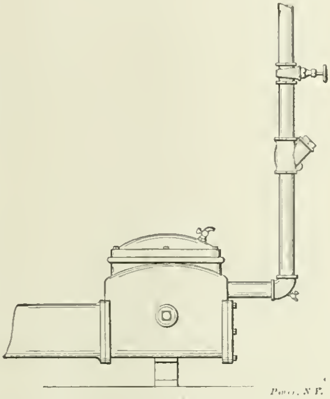


FIG. 1. WATER CONNECTION OF BOILER-FEED PUMP

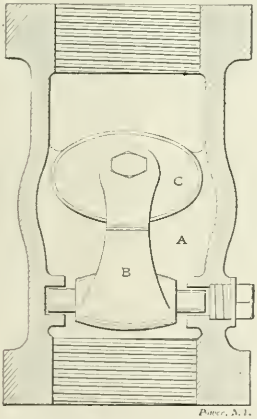


FIG. 2. SECTION OF LEAKY CHECK VALVE

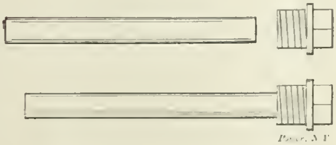


FIG. 3. PIN ON WHICH HANGER SWINGS

It arrived in due time, was installed at once, tested by means of the gate valve and the pet cock as before, and found to be leaking as badly as the old one did before it was removed. Careful examination of the clapper showed that it covered the port, and was apparently a good fit on the seat. The cover was replaced and another trial made which showed that the valve was now tight. The pump was run for a time, then shut down and the valve tested again, showing that it leaked freely as before, but while watching the stream coming out of the pet cock, something snapped and the flow of water ceased. This gave a clue to the cause of trouble, and when the cap was again removed and the parts examined, the defect was discovered.

Again referring to Fig. 2, there is much lost motion at each end of the hanger where it swings on the pin, hence it was possible to move the clapper *C* sidewise until one edge of it was held off from the seat, causing a bad leak. Opening the pet cock reduced the pressure slightly at this point, and boiler pressure acting on the upper surface of the clapper forced it down suddenly, causing the snap previously mentioned and stopping the return of water. As long as the hanger remained nearly in a central position the valve worked properly, but it could not be depended upon to do this, as it would shift frequently and render the valve worthless for the service required. It would be possible to make a small collar to go on each side of the hanger and thus prevent this side motion, but all such makeshifts are to be avoided as far as possible. They would answer the purpose in this case while in position, but if it became necessary to remove the hanger at some future time, these collars would probably be lost and cause trouble, so that a new hanger was made which was wide enough to leave but little lost motion at this point, and the valve leaked no more.

Fig. 3 illustrates the pin on which the hanger swings, and the side plug which holds it in place in the body of the valve. Originally they were made in two separate pieces, as shown by the upper sketch, but new parts were made to replace these and both were combined in one piece of brass, as illustrated by the lower pin. When made separate the side plug could easily be removed, but the pin was left in place without any provision for removing it, hence when it was necessary to take out the clapper for adjustment or repairs, it was an annoying and exasperating job to remove the pin, partly because this unhandy form of construction is unnecessary. The lower pin in Fig. 3 comes out when the side plug is unscrewed, and both are replaced when repairs are completed without the slightest inconvenience.

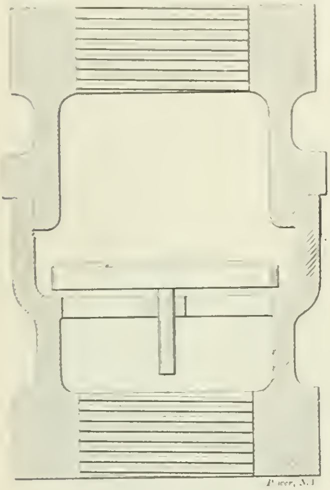


FIG. 4. VERTICAL CHECK VALVE WITH SCREWED ENDS

where the pressure is high and the service hard.

Fig. 6 shows an angle check valve on the exhaust pipe of a duplex pump, which was installed for the following reason: Exhaust steam from this pump is discharged into a heating system, and when steam is shut off from the coils at night and at other convenient seasons, water runs down and fills this exhaust pipe and the cylinders below it. To overcome this objection the angle check valve was used, but it proved to be noisy, and as the sound telephoned along the heating pipes it proved objectionable to people in several rooms in the large building above it. An attempt was made to abate the nuisance by unscrewing the cap, taking out the disk holder and putting a spiral spring into its hollow stem, as shown in Fig. 7.

If such a spring is not at hand when wanted, it is an easy matter to make one, provided a lathe is available and some brass wire is at hand. Fig. 8 is a plan of a lathe in use for this purpose. An arbor is placed on the centers, with a dog on the end nearest the headstock for the double purpose of causing the arbor to turn with the face plate and holding the wire in place. While the lathe operator holds the brass wire a helper puts an iron hook over the arbor from the opposite side of the lathe. The spindle is started and while the operator allows the wire to slip through his hands as wanted, the helper slides the hook along the arbor, thus keeping the coils far enough apart to make a suitable spring.

When using a spring for this purpose precautions must be observed as follows: When put in the hollow stem of the disk holder it must project above it as shown in Fig. 7, but the coils must be far enough apart to allow the whole to be compressed into the hollow stem, in order to know that the disk can rise as high after the spring is inserted as it did before. The spring should be stiff enough to do the required work, but if made too stiff it will create unnecessary friction.

Before a new check valve is put into service care should be taken to know that the disk can lift high enough to give full capacity. In this case proceed to determine this point as follows: Unscrew the cap, raise the stem of the disk holder as high as possible and measure the distance from the disk to the bearing of the cap as in Fig. 9. It is $3\frac{1}{4}$ inches, and measuring from the seat to the top of the body, as illustrated in Fig. 10, the distance is more than $3\frac{3}{4}$ inches. The difference is full $\frac{1}{2}$ inch, which represents the possible lift of the valve. If the disk of a valve lifts one-quarter of its diameter it is sufficient to give full capacity of the valve, provided the passage is not obstructed by wings or guides. It is a good idea to remove the cap of a screwed check valve before it is put into service. If it is screwed down just enough to prevent a leak at this point when it is put on, it is possible to remove it without serious disfigurements later on, but if left as it comes from the manufacturers, it will stick fast, and the corners will be spoiled in the process.

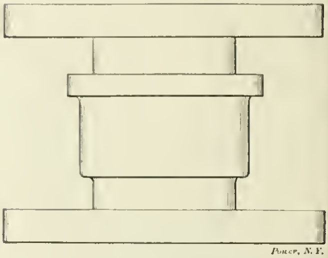


FIG. 5. FLANGED VERTICAL CHECK VALVE

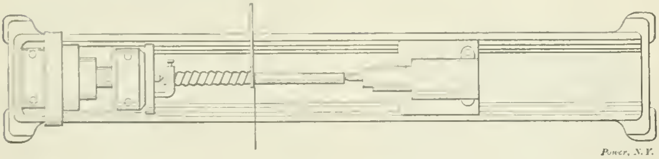
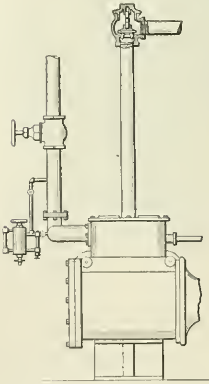


FIG. 8 MAKING SPIRAL SPRING ON LATHE



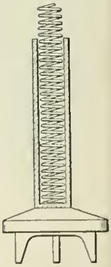


FIG. 6. ANGLE CHECK ON EXHAUST PIPE

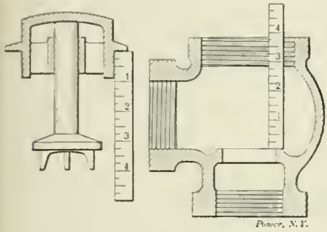
FIG. 7. ENLARGED VIEW OF DISK AND SPRING

Fig. 4 is a vertical check valve with screwed ends. When connected in a line of pipe in the position for which it was designed, it is much superior to the swing check valve shown in Fig. 1, both in appearance and durability. The disadvantage of this valve is found in the fact that its internal parts are not readily accessible for inspection and repairs. Wherever it is used a union ought to be located just above it, thus providing a way for disconnecting the pipe without breaking a pipe joint. When this valve is taken apart at a point just above the center line, the disk can be taken out at pleasure.

Fig. 5 is a flanged vertical check valve which is made to meet the requirements of engineers who prefer this style of joint,

Fig. 11 is a combination stop and check valve of the angle type, which may be used in an exhaust pipe if required. One advantage of it is that the lift may be regulated at pleasure, for although the disk holder slides on the spindle, they are not fastened together. Steam or water passing upward and outward through this valve, lifts the disk, but if anything attempts to pass in the opposite direction the disk quickly falls and shuts the port. If for any reason it is necessary to keep the valve shut, the spindle may be turned down the same as if it was a regular globe valve. The name of every special valve of this kind ought to be cast on the body to prevent engineers who are not familiar with such appliances from misusing them through ignorance of their design and construction.

Angle check valves are usually designed to be attached to a vertical pipe which forms the inlet, while the discharge is into a horizontal pipe, as indicated by the arrows in Fig. 11, but Fig. 12 illustrates a combination valve in which the side opening constitutes the inlet, and the outlet is downward. This refers to the operation when the valve stem is in a vertical position, but when it is located horizontally it operates the same as the valve in Fig. 11.



Power, N.Y.

FIGS. 9 AND 10. VALVE MEASUREMENTS

Fig. 13 is an angle check valve of the extra-heavy pattern, suitable for a working pressure of 250 pounds to the square inch. A good feature of this valve is that the cap is fastened on with bolts instead of being screwed into place. The writer's experience with 4-inch valves containing this feature is that a cap can be removed from one of them with less labor, and less danger of straining the pipe line in the process, than is necessary with a much smaller valve containing a screwed cap. Another good feature of this design is that if the bolts are weakened by corrosion, it is not difficult to ascertain their condition and renew them at small expense, but with a screwed cap it becomes necessary to renew the entire valve if the threads become worn, or the body is expanded by frequent removals of the cap to clean and repair the internal parts.

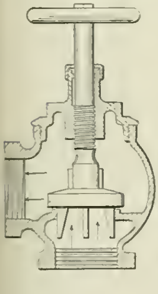


FIG. 11. ANGLE TYPE OF CHECK AND STOP VALVE

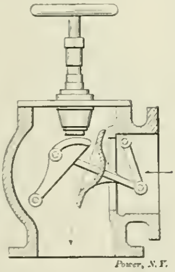

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FIG. 12. ANGLE VALVE DISCHARGING DOWNWARD

Fig. 14 illustrates an angle check valve with a flanged inlet and a screwed outlet. They are also made with a flange on the outlet and female threads on the inlet if required for special cases. Male threads will be supplied for either inlet or outlet if so ordered, and any style of flange including American or English standard, Navy type, grooved and tongued, etc., can be secured. Radial flanges are also available, which is equivalent to using a 45-degree ell in the line. The caps are screwed, but the larger sizes are fitted with slots for convenience in removing them. A bar of iron or steel that will fit into a slot is nearly always available in a steam plant, but a large monkey wrench, or a solid wrench of exactly the right size may not be on the premises.

Where a check valve is located on the feed-pipe line of a boiler, or is used in any similar service in connection with a single-acting pump, it wears rapidly, because it opens and closes many times per hour. Some of the manufacturers of these valves seem to think that this result is due to heavy moving parts, hence have proceeded to make them lighter. This is certainly a mistake, for although it must be admitted that the weight of these parts is a factor in the problem, it is so small that it may be neglected entirely without making any material difference in the results secured in everyday practice.

To illustrate this point, suppose that water is delivered to a boiler carrying 150 pounds pressure, through a 2-inch feed pipe, and an ordinary single direct-acting steam pump is used as a boiler feeder which is large enough to supply the demand when running at a slow speed. A stroke of this pump raises the check valve, and when the piston stops, pressure acting on the top of the disk forces it downward until it strikes the seat. The area of this disk is 3 square inches, therefore the total pressure acting on it is 450 pounds. There is probably what might be called a heavy back pressure in this case, which may be assumed to be one-half of the forward pressure, and this acts as a cushion to let the disk down easily. There is still 225 pounds acting on the disk, which is sufficient to account for the pounding action and its results in practice.

Suppose that the moving parts of a certain check valve are made heavy enough to be durable and satisfactory, but it is possible to remove one-half pound of metal from each of them without causing an immediate collapse. What effect can this have on the pounding action above mentioned, and what per cent. of the force of each blow is eliminated by the removal of this small amount of metal? The strength of the parts may be reduced 25 per cent. by the process, while the gain made by the change is too small to be mentioned, as far as the user is concerned, but where 1000 of them are manufactured, it saves 500 pounds of good metal, which is an important item.

Fig. 15 is an angle check valve with both inlet and outlet flanged. One advantage of this design is that it is easily connected, and may be disconnected without disturbing the pipes. When ordering such a valve for a given size of pipe, it is only necessary to specify the valve, stating that it is to be fitted with flanged ends, also that one pair of companies flanges is wanted. The flanges should be drilled to the standard given for the pressure to be carried, then when a valve is secured to the end of each connecting pipe, the pipe flange can be turned to match the holes in the flange, and the bolts will go in without trouble or delay.

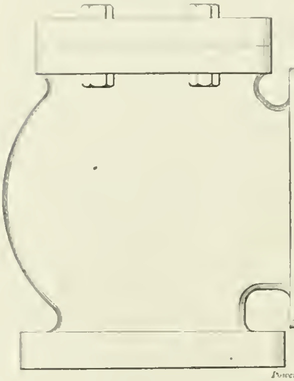
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FIG. 13. ANGLE CHECK VALVE WITH BOLTED CAP

However, if a flanged gate or globe valve is to be connected to the flanged check valve, it becomes necessary to have a standard templet for drilling the holes in order to avoid mistakes. Recognizing the necessity for this, the manufacturers of such goods have adopted a standard for all sizes of pipe and fittings, and Fig. 16 illustrates this templet as applied to a 4½-inch valve. The diameter of the flange is 9¼ inches, and the holes are

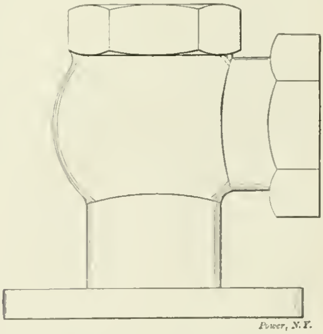
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FIG. 14. FLANGED INLET AND SCREWED OUTLET

drilled on a circle 7½ inches in diameter. They are spaced equally on either side of a vertical line drawn through the center, therefore this valve can be connected with the stem in a vertical or a horizontal position, or at an angle between these positions, at pleasure.

Fig. 17 illustrates what is commonly called a dead weight safety valve, but for some purposes it is useful for a check valve. For illustration, in a certain small plant it was necessary to blow steam into a tank containing a rather thick, pulpy mass of material very early in the morning, which made it necessary for the engineer, who was also the fireman, to get out of bed much sooner than was agreeable. One night he filled the boiler with water to the top of the gage glass, and left the steam valve open about one-eighth of a turn. This plan permitted him to sleep about two hours longer the next morning, but on examining his boiler he found that all pressure was off and as a partial vacuum had formed during the night, atmospheric pressure acting on the surface of the tank had forced the material up into the steam pipe and some of it had gone into the boiler.

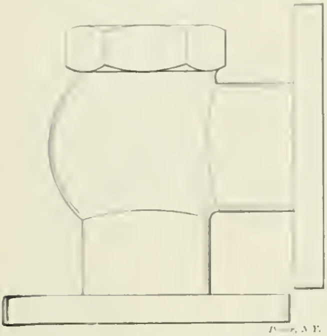
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FIG. 15. FLANGED INLET AND OUTLET

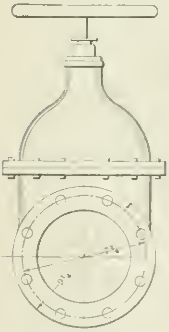
FIG. 16. STANDARD TEMPLET OF 4½-INCH VALVE

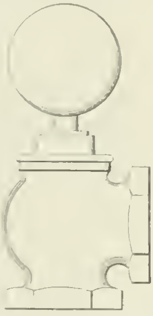
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FIG. 17. DEAD-WEIGHT SAFETY VALVE

An ordinary check valve will prevent the return of anything through the supply pipe, but the weight can be used to close the valve at any desired low pressure. If it is weighted to close at 10 pounds, steam can be allowed to escape until the pressure is reduced to the desired point, when this check valve will close, preventing any more steam from escaping, and at the same time closing the return passage. The plan of leaving a boiler without attendance will not be considered advisable by some engineers, and it is not recommended here without qualification, but it can do no harm if there is no fire on the grate, and in many plants new fires are built every morning.

Fig. 18 illustrates a balanced check valve. A globe check valve is preferable on some accounts, but it does not open as easily as the swing type. With this small lever and weight attachment in use it is practicable to counterbalance the weight of the internal moving parts until the valve will open very easily. In a certain large building there are many pipe radiators, and the drip pipe of each is supplied with a check valve to prevent steam from backing up into the pipes. It is necessary for these valves to open easily, because the steam pressure is practically balanced, therefore the only unbalanced force available to lift the disks is the column of water which collects above each, and the hight of this must be limited in order to keep water out of the lower pipes where it is not wanted. The balancing device shown in Fig. 18 would be valuable for such cases, and on the other hand, if for any reason it is desired to prevent the disk from leaving its seat too easily, the lever can be moved to the position indicated by the dotted lines. In this case the leverage of the outside weight is added to the weight of the internal parts, so that more force is required to open the valve, and it will close quicker than before. The cap of this valve is fitted with a square top, giving the engineer a better chance to remove it without disfiguring the corners.

Fig. 19 shows the internal design and construction of an all-brass swing check valve for a horizontal pipe. The objections mentioned in connection with the use of a swing check valve in a vertical pipe, apply to this case with equal force. As these are only faults of construction and not of the design, careful inspection before connecting them to the pipe line will secure the rejection of those that are unfit for use. The illustration shows a plug directly opposite the clapper, which can be removed for the purpose of inserting a screwdriver. The clapper is fitted with a slotted nut to receive the screwdriver and when a carpenter's brace is fitted to the top of it and turned rapidly, the disk and seat will soon be ground to a perfect contact at all points, thus securing a tight valve. However, this is a rather tedious job which can be avoided by using check valves containing hard rubber or composition disks, which can be easily removed and replaced at slight cost.

Finding it necessary to use a small check valve a short time ago, the writer selected one similar to Fig. 19, but several tests showed that it was tight for a part of the time and leaked the remainder, proving very unsatisfactory. It was removed and another substituted, which was practically of the same construction except that it was fitted with a disk made of hard rubber. It operated exactly like the other, and it would appear that if the manufacturers of these valves would adopt and maintain a more rigid system of inspection, they would not allow so many imperfect valves to leave their factories.

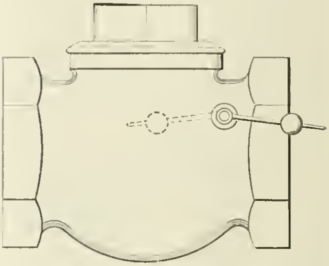
Power, N.Y.

FIG. 18. BALANCED CHECK VALVE

The valve illustrated in Fig. 20 was finally purchased, and it is always tight when closed. One good feature of this valve is that there are no wings nor guides to reduce the size of the passage through it, or to prevent it from closing promptly by being too large or too rough to work easily. It is held in place by a rigid stem that moves easily in a smooth hole, and the pressure on this stem is equalized by means of the small hole cast in the guide near the top, as shown. This allows some of the liquid to pass into the space above the stem when it falls, and as the stem rises this liquid is forced out again. The disk holder contains a disk that can easily be renewed when worn out by long service or broken by accident.

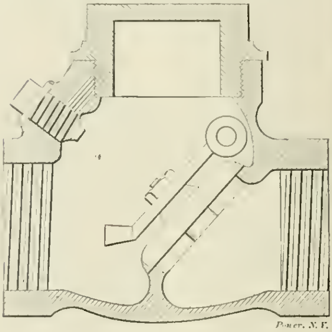
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FIG. 19. ALL-BRASS SWING CHECK VALVE

Fig. 21 represents a valve that is used in many plants, but the passage through it is really much smaller than it is supposed to be. This area ought to at least equal the cross-section of the pipe on which it is used, and if larger will do no harm. The shape of the valve results in excessive friction when water is forced through it, as one valve is equal to many yards of clean pipe in this respect. In a certain case to which my attention has been called, a direct-acting steam pump that was used for feeding a pair of tubular boilers, would not run fast with the steam valve wide open. There was apparently good reason for condemning the pump as imperfect, but the engineer remembered that he had a globe check valve like Fig. 21 near the heater. He purchased another one of the same kind, but one size larger, screwed a bushing into each end of it, and connected the combination in place. When steam was again turned into the pump the piston moved much faster.

The philosophy of the incident is that with a check valve corresponding to the pipe, the passage was much too small, but by using a valve one size larger the capacity was increased and the friction greatly reduced. Examination of the nearest valve of this kind at hand shows that the circular hole through it equals the size of the pipe for which it was designed, but the wings occupy about 40 per cent. of the space, which accounts for the friction. This valve was made by a reputable firm which is not ashamed to place its name prominently on it, but in other cases valves may be found without a name on them in which the hole is less in diameter than the pipe, and the wings occupy about 50 per cent. of that. Consequently, the actual capacity is much less than it ought to be. In this way Fig. 20 is a superior type of globe check valve, because there is nothing below the disk to reduce the capacity for delivering water.

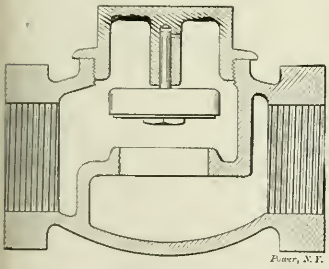
Power, N. Y.

FIG. 20. VALVE WITH VERTICAL GUIDE STEM

The boilers in my plant are fed by two duplex pumps, while heaters are available, and by injectors at other times. One single steam pump is kept in reserve for emergencies. While I was writing the above description my assistant started this pump for the purpose of keeping it in working order. While the duplex pumps only are in operation, the check valves are silent, but with the single pump running, they can be heard plainly. This is due to the different ways in which pumps deliver water, but the point here is that if one kind of a check valve lasts longer in one plant than another kind does elsewhere, the difference may not be due to superior valves, but to the kind of pump used.

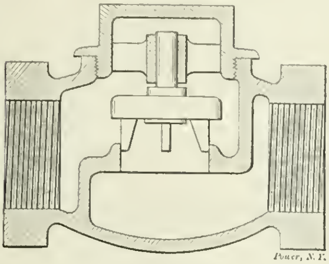
Power, N. Y.

FIG. 21. VALVE PASSAGE OBSTRUCTED BY WINGS

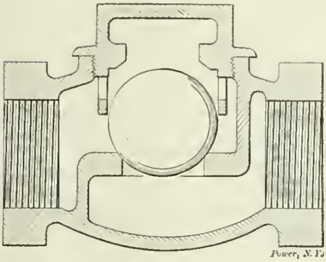
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FIG. 22. BALL CHECK VALVE

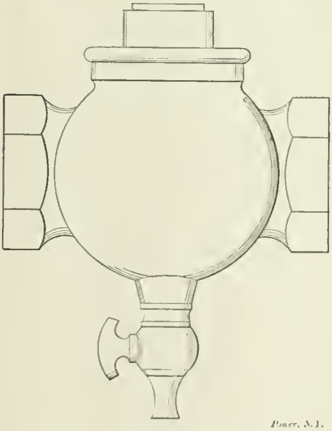
Power, N. Y.

FIG. 23. GLOBE CHECK VALVE WITH DRAIN

Fig. 22 represents a peculiar kind of check valve, as it contains a ball instead of a clapper or a disk. As this ball is designed to be perfectly round and it is frequently turned while in use by the action of water passing around it, a large wearing surface is presented and it ought to prove durable in service.

Fig. 23 illustrates a globe check valve with a pet cock in the bottom for the purpose of allowing all of the water to drain out when the piping is not in use. This is a valuable feature for places that are exposed to low temperatures, as it is difficult to get all of the water out of such a valve without a special device for the purpose, and a valve will also be ruined if allowed to stand more than one-half full of water where it can freeze.

Fig. 24 is a globe check valve with one end flanged and the other screwed. The principal advantage of this design is that it is easily installed, even in a pipe line that is already in place, by cutting one length of pipe in two and removing both pieces from the line. One piece is then threaded, the check valve screwed on the old thread and the new thread put into the fitting from whence the old one was removed. A flange is then screwed on the old thread on the other piece, and enough cut off from the opposite end to compensate for the check valve. This end is then threaded and put into the fitting from which the pipe was removed. When the two flanges are packed and bolted together the job is finished, and only one length of pipe has been disturbed. If these directions are followed, the result will be more satisfactory than if attempts are made to return old threads to their former places.

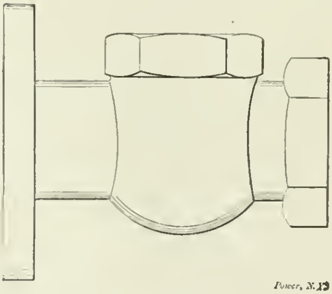
Power, N. Y.

FIG. 24. HORIZONTAL SCREW AND FLANGE CHECK VALVE

Fig. 25 shows a globe check valve with both ends flanged. The body appears to be longer than is necessary to the casual observer, but engineers who have to use and keep them in repair will not think so, because it is necessary to put a wrench on the cap to remove it, and if only a monkey wrench is available for this purpose it causes much trouble unless there is sufficient space in which to adjust and turn it.

Fig. 26 illustrates an extra-heavy globe check valve with both ends and the cap flanged. On a valve of the right size for a 2½-inch pipe on which 150 pounds pressure is carried, there are four bolts in each flange, and it would appear as if there was not enough material used to secure sufficient strength for the pressure. These bolts are ¾ inch in diameter, but cutting

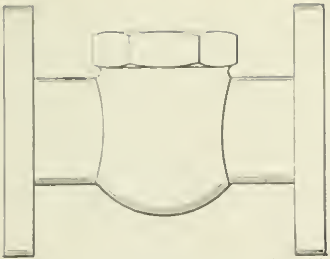
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FIG. 25. CHECK VALVE FLANGED AT BOTH ENDS

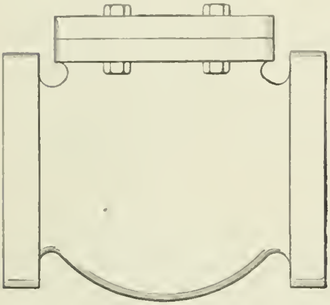
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FIG. 26. GLOBE CHECK VALVE WITH BOTH ENDS AND CAP FLANGED

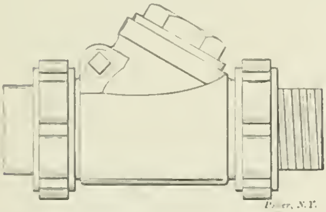
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FIG. 27. CHECK VALVE WITH MALE AND FEMALE THREADS

the threads on them reduces the effective diameter to about 9/16 inch, the cross-section of which contains 0.25 square inch, or 1 square inch sectional area for the four. Many of the bolts used on such work are made of inferior iron, the tensile strength of which is an uncertain quantity, but assuming it to be 30,000 pounds with 6 as a factor of safety, gives 5000 pounds as the safe load for these bolts.

The area of a 2½-inch circle is 4.9 square inches, so that with a pressure of 150 pounds to the square inch the total load due to pressure is

$$4.9 \times 150 = 735 \textit{ pounds},$$

or only about one-seventh of the safe load. A 3-inch heavy flange is equipped with eight bolts 5/8 inch in diameter, and after allowing for the reduction due to cutting threads on them, the effective diameter is about 7/16 inch and the area 0.15 square inch, or 1.2 square inches for the eight bolts on which the safe load equals,

$$1.2 \times 5000 = 6000 \textit{ pounds}.$$

The area of a 3-inch circle is 7 square inches, giving a total load of

$$7 \times 150 = 1050 \textit{ pounds},$$

or only about one sixth of the safe load. This comparison is presented for the purpose of showing that although a 3-inch flange contains twice as many bolts as a 2½-inch flange, the load per square inch of sectional area is nearly the same. Shocks and jars due to the action of water, strains caused by the expansion of metal, and the effect of leverages of the pipes reduce this margin, but it is still large and this fact accounts for the freedom from failure of bolts in this service.

While it is necessary to provide metal enough in the bolts to hold the total strain that must come upon them, there is another factor to be included in the calculation. This refers to the fact that the bolts must be near enough to each other to prevent the packing between them from blowing out under pressure. An inflexible rule for this purpose cannot be laid down, because much depends on the thickness of the flanges and the pressure carried, also on the kind of packing used. There is a chance here for the display of good common sense, and as a general rule the flanges that were designed for modern service show by their appearance that they can be depended on to withstand high pressures and severe service.

Fig. 27 is a swing check valve of superior design and neat appearance. The illustration shows a male thread on the right and a female thread on the left end, but any other combination can be secured. The male thread is screwed into a coupling, and the female thread is turned onto a piece of pipe by means of a flat iron bar inserted in the end, where it engages two projecting lugs. This enables the engineer to make tight joints without disfiguring the external finished surfaces. A spanner wrench is used to tighten the union nuts.

Fig. 28 is a combination check and stop valve designed similar to Fig. 12 except that this is a globe instead of an angle valve, and can therefore be used in a straight line of pipe.

Fig. 29 is a check valve for a steam-pipe line, although it is called a nonreturn valve. It is designed for a stop valve on a boiler that will allow steam to come out freely, but if reduction of pressure from any cause starts a return movement of the steam, this valve closes instantly and prevents farther action. If a tube bursts or collapses in one boiler of a battery, this valve will prevent steam in the other boilers from blowing back through the disabled boiler, which it might not be possible to prevent if only a common globe valve was used for this service.

In a certain large plant fitted with a score of boilers, it was formerly the custom for boiler tenders to clean one or more at stated times, fill them with cold water and then turn steam from the main header directly into the cold boilers. As such a barbarous practice has prevailed in the past, and may in the future, it is a good idea to supply every boiler with one of these valves to guard against such ignorance and stupidity. An indicator

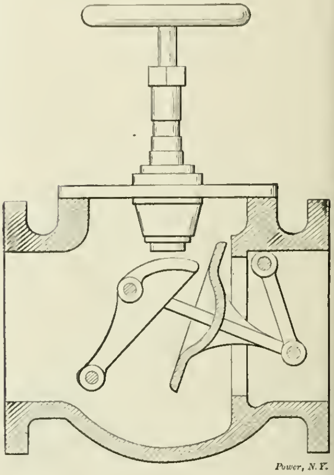
Power, N.Y.

FIG. 28. COMBINATION CHECK AND STOP VALVE

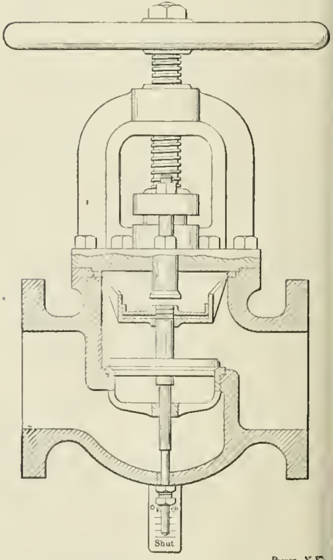

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FIG. 29. NONRETURN VALVE WITH INDICATOR

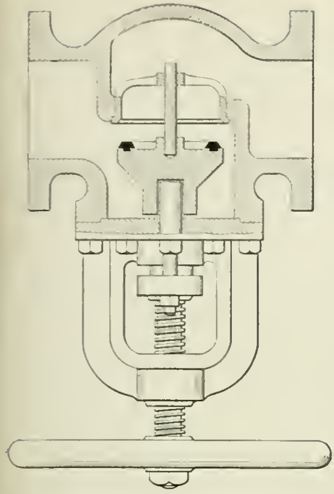

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FIG. 30. NONRETURN VALVE OF INVERTED TYPE

below the globe shows the position of the disk, as it cannot be determined by the stem, except that when the stem is screwed down as far as possible the valve is known to be shut, and it cannot open automatically until the wheel is turned backward and the stem raised.

Fig. 30 is similar to the preceding except that the wheel must be below the pipe, as illustrated, instead of above it. Both of these valves are cushioned to prevent damage by rapid opening and closing automatically under pressure.

## The Capacity of Refrigerating Machines

By F. E. Matthews

How can one determine, as nearly as possible, the amount of refrigeration produced by an ice machine by simply noting the temperatures of the brine, the high and low pressures, the size of cylinders, the stroke and the revolutions per minute?

The above question suggests two possible answers based on the two general possible methods of arriving at the amount of refrigeration produced by refrigerating machines. The first method is to measure the *results* actually produced in a known amount of brine or amount of cooling effect in degrees produced as a known amount of brine or other media having known heat-absorbing capacities per degree rise in temperature. From this knowledge the number of heat units extracted per minute, hour, or day may be calculated; and from this, as explained hereinafter, the capacity in pounds or tons of equivalent ice-melting capacity may be readily computed by simply dividing the number representing the heat extracted expressed in B.t.u., or other convenient units, by the number of such units necessarily extracted per minute, hour or day, as the case may be, to produce refrigeration at the rate of one pound or one ton per day.

The second method is actually to weigh or compute the number of pounds of the refrigerating fluid, assumed in this case to be ammonia, passing through the cycle of operations per unit of time and, by knowledge of the amount of refrigerating effect that a pound of the refrigerating fluid is capable of producing under the observed conditions of back pressure and liquid temperature (determined approximately from the head pressure), finally arrive at a more or less accurate estimate of the amount of cooling effect being produced. The units in which refrigerating duty is usually expressed among English-speaking people are as follows:

(1) *British Thermal Unit (B.t.u.)*—Equivalent to the latent heat of water, or the amount of heat required to raise the temperature of a pound of water through one degree Fahrenheit at its temperature of maximum density at 39 degrees Fahrenheit.

(2) *Pound of Refrigeration*—Equivalent to the expenditure of negative heat (absorption of heat) at the rate of 144 B.t.u. per twenty-four hours; 144 B.t.u. being the latent heat of ice, or the amount of heat required to melt a pound of ice "from and at" 32 degrees Fahrenheit (ice at 32 degrees melting into water at the same temperature).

(3) *Ton of Refrigeration*—Equivalent to the expenditure of negative heat (absorption of heat) at the rate of $2000 \times 144$ B.t.u., or 288,000 B.t.u. per twenty-four hours; 288,000 B.t.u. being the amount of heat required to melt a ton of ice "from and at" 32 degrees Fahrenheit.

From the foregoing it is apparent that the capacity of a refrigerating means which extracts heat at the rate of 288,000 B.t.u. per twenty-four hours is one ton. The above rate is equivalent to $288{,}000 \div 24 = 12{,}000$ B.t.u. per hour, or $288{,}000 \div 24 \div 60 = 200$ B.t.u. per minute.

To absorb heat at this rate certain definite quantities of the primary refrigerating fluid must be evaporated per minute, hour or day, in addition to which if a secondary refrigerating medium, such as brine, is employed, a certain amount of fluid must be cooled through a sufficient range of temperature to supply the amount of heat required to evaporate the ammonia.

It has been proposed to employ as standard pressures 185 pounds head pressure, under which pressure condensed anhydrous ammonia leaves the condenser at about 90 degrees Fahrenheit, and 15.67 pounds back pressure, corresponding to an evaporating temperature in the cooler of 0 degree Fahrenheit. Under these standard conditions, viz., where the anhydrous ammonia enters the refrigerator at 90 degrees Fahrenheit and evaporates at 0 degrees Fahrenheit, from 27 to 28 pounds of liquid must be evaporated per hour per ton of refrigerating effect produced. This means that the ammonia compressor must have effective displacement capacity of about 4 cubic feet per minute per ton.

Refrigerating capacity of evaporating refrigerants depends not on the volume of gas evolved, except as volume depends on weights. The volume of gas varies widely with the pressures, but aside from the cooling effect that must be expended on the liquid to cool it from the condenser temperature down to the cooler temperature, the weight of refrigerant per unit of cooling capacity produced is practically constant under all conditions of temperature and pressure.[*]

At 10 pounds back pressure, for example, corresponding to an evaporating temperature of about 8 degrees below zero, the volume of the gas evolved is 10.8 cubic feet per pound. At 32 pounds back pressure, corresponding to an evaporating temperature of about 19 degrees, the value is about 6 cubic feet. This means that operating at 10 pounds back pressure a compressor must pass approximately 66 per cent. more volume of gas per unit of capacity than when operating at 32 pounds pressure.

The method of arriving at the size of compressor required for the performance of a given refrigerating duty per twenty-four hours is as follows: The latent heat, or the amount of heat expressed in B.t.u., required to evaporate a pound of anhydrous ammonia at 10 pounds back pressure is about 560. If, for example, 150 pounds condenser pressure is carried, the liquid ammonia will pass to the refrigerator at about 84 degrees. The evaporating temperature corresponding to 10 pounds back pressure is —8 degrees, making a difference of temperature of 92 degrees through which the liquid must be cooled before it can produce any useful cooling effect in the refrigerator. For approximations, the latent heat of the ammonia liquid may be taken to be the same as that of water, i.e., unity, in which case the expenditure of 92 B.t.u. will be necessary to cool the liquid from the temperature of the condenser to that of the refrigerator. Subtracting this amount from the latent heat, 560 B.t.u., we have 468 B.t.u. remaining for the performance of useful work in the refrigerator.

The latent heat of ice, taken as the unit pound capacity of refrigeration, is 144. The evaporation of one pound of anhydrous ammonia under the foregoing conditions will produce $468 \div 144 = 3.25$

---

[*] This ignores the small amount of cooling effect available in the superheating of the return gas.

pounds of refrigeration, this regardless of the time in which the evaporation takes place

The evaporation of one pound of anhydrous ammonia per minute under these conditions would produce refrigeration at the rate of 468 ÷ 200 = 2.34 tons per twenty-four hours. At the rate of one pound per hour the tonnage rate per twenty-four hours would be 468 ÷ 12,000 = 0.039.

At 10 pounds back pressure each pound of anhydrous ammonia evaporated has a volume of about 10.8 cubic feet. A compressor displacing this volume of gas per minute will have a capacity of 2.34 tons, or a ton capacity for every 10.8 ÷ 2.34 = 4.6 cubic feet of piston displacement per minute.*

The method of computing the capacity of a refrigerating machine of a given size when operating at a given number of revolutions, from the apparent displacement in cubic feet per minute, involves two other very important factors: First, the back pressure at which the compressor is operated; second, displacement efficiency of the particular compressor in question when operating at the back pressure in question.

The amount of refrigeration produced is directly dependent on the number of pounds of the refrigerating fluid evaporated, due allowance being made for the range of temperature through which the liquid must be cooled before it can do useful cooling work in the refrigerator, and the cooling effect available from superheating of the gas.

When the compressor itself is employed as a meter, i.e., when the amount of the refrigerating medium is computed from the number of cubic feet of volume swept out per minute by the piston, it is necessary to assume or determine the compressor displacement efficiency in order to arrive at the *actual* displacement from the *apparent* displacement indicated by the volume swept out. The weight of a refrigerating medium vapor is directly proportional to its absolute pressure. For a given back pressure the weight of the gas per cubic foot can be determined directly from published tables of the properties of the refrigerating medium in question.

The displacement efficiency of compressors, or the ratio of their apparent to their actual cubical displacement, is not easy to determine, and it is the exception rather than the rule that the builders of compressors can themselves give the efficiency of their various machines when operated under stated head and back pressures. As a matter of fact, the only exact means of determining such efficiencies is by the rather laborious method of checking the amount of refrigerating fluid apparently passing the compressor, with the amount, determined by weight, actually passing the expansion valve. Even this method has a serious shortcoming in the case of "wet" compression machines in that a considerable amount of unevaporated liquid may pass through the compressor and this liquid appearing in the weights of liquid passing the expansion valve indicates a higher displacement efficiency than the compressor deserves.

### EXAMPLE

To compute the refrigerating capacity of an ammonia compressor of the assumed cylinder dimensions of 19x38, operating at 45 revolutions per minute:

Area of 19-inch piston =

$$\pi\, y^2 = 3.1416 \times 9.5 \times 9.5 = 283.53\ \textit{sq. in.}$$

Volume of 19x38 cylinder =

$$\frac{\pi\, y^2\, l}{1728} = \frac{283.53 \times 38}{1728} = 6.235\ \textit{cu. ft.}$$

Apparent displacement in cubic feet per minute =

$$\textit{cu. ft.} = \frac{2\, \pi\, y^2\, l\, n}{1728} = 6.235 \times 2 \times 45 = 561.15. \qquad (1)$$

A somewhat more simple expression for the cubic feet of apparent displacement per minute of a double-acting compressor of *d* inches diameter and *l* inches stroke, operating at *n* revolutions per minute, is:

Cubic feet per minute =

$$d^2\, l\, n\ 0.00090903,$$

or since $2\, l\, n \div 12 = l\, n \div 6$ is the piston speed ($P\,S$) in feet per minute, cubic feet per minute

$$d^2\, P\, S\ 0.00545418.$$

Substituting in these two expressions we have:

$$d^2\, l\, n\ 0.00090903 = 19 \times 19 \times 38 \times 45 \times 0.00090903 = 561.15\ \textit{cubic feet}$$

and

$$d^2\, P\,S\ 0.00545418 = 19 \times 19 \times 285 \times 0.00545418 = 561.15\ \textit{cubic feet.}$$

Under standard conditions of 90 degrees liquid at the expansion valve and 0 degree gas in the refrigerator, the pounds of ammonia evaporated per minute per ton = 27; the cubic feet of ammonia displaced per minute per ton = 4.026; and the apparent cubic feet displacement of an 80 per cent. efficiency compressor per minute per ton = 5.

On the basis of 5 cubic feet apparent displacement per minute per ton the expression for the tonnage capacity of a compressor of diameter *d*, stroke *l* and revolutions per minute = *n*,

$$\textit{Tons} = d^2\, l\, n\ 0.000181806.$$

and

$$\textit{Tons} = d^2\, P\, S\ 0.000100081. \qquad (2)$$

Substituting the values for *d*, *l*, *n* and *PS* as in the foregoing example, we get as the tonnage capacity per twenty-four hours, in each case, 112.23 tons.

A method which avoids opportunity for error in determining the compressor displacement efficiency assumed, but at the same time introduces another difficulty in the form of brine-tank insulation losses, which fortunately can usually be more or less accurately determined and corrected for, is to check the apparent performance of the compressor by the actual performance of the refrigerating system as a whole, as determined by direct measurement of the cooling effect produced on brine, where it is regularly employed in the plant, or on brine, water, or some other fluid of known specific heat where a secondary medium has to be introduced for the purpose of test. If, in the latter case, the refrigerating effect cannot be put to useful work, it may be neutralized by steam or some other source of artificial heat.

For very accurate determinations the amount of secondary refrigeration medium cooled should be determined preferably by weighing and the specific heat of the medium determined by some competent expert familiar with this class of work. Thermometers used in taking the temperatures of the secondary medium before and after cooling, as well as all other apparatus, should be carefully calibrated, both before and after the test.

For ordinary accuracy 25 "heat gallons" is considered equivalent to a ton of cooling effect, a "heat gallon" being the cooling effect required to reduce the temperature of 5 gallons of calcium chloride brine, of 1.2 specific gravity, through a range of 5 degrees Fahrenheit per minute.

Since there are 288,000 B.t.u. in a ton of cooling effect and 1440 minutes in a day, we arrive at 200 as the number of B.t.u. per minute equivalent to the rate of a ton per twenty-four hours, and the amount of heat carried away by the brine per minute divided by 200 will give the rate of cooling in tons per twenty-four hours.

The amount of heat carried away by the brine is determined from the weight in pounds *W* circulated per minute, its specific heat *S* and the range of temperature $(t - t_1)$ through which it is cooled. If we know the value of all of these factors the rate of cooling in tons per twenty-four hours will be readily determined from the equation

$$\textit{tons} = \frac{W\, S\, (t - t_1)}{200}. \qquad (3)$$

---

*According to the standards adopted by the Ice Machine Builders in 1903, the evaporation of 27.7 pounds of ammonia under the "standard" conditions of 185 pounds head pressure (90 degrees Fahrenheit) and 15.67 pounds back pressure (0 degrees Fahrenheit) constituted a ton capacity. On this basis, approximately 5 cubic feet of displacement would be allowed per ton per twenty-four hours, in a compressor of 80 per cent. displacement efficiency.

The volume of the brine circulated per minute can be calculated from the dimensions and strokes per minute of the pump, due allowance being made for slippage, and this can be readily converted into weight of brine circulated per minute by multiplying the number of cubic feet per minute by the weight of brine per cubic foot as given in the accompanying table.

EXAMPLE

It is found by test that the brine pump of a brine-circulating system discharges 1000 gallons of brine per minute, the temperature of the warm return brine being 7 degrees Fahrenheit higher than the outgoing cold brine. One thousand gallons and 7 degrees spread is equivalent to 7000 heat gallons, which, divided by 25, the approximate number of heat gallons per ton, gives 280 as the approximate tonnage capacity at which the system is operating.

| CALCIUM CHLORIDE (CaCl) BRINE. | | | | SODIUM CHLORIDE (NaCl) BRINE. | | | |
|---|---|---|---|---|---|---|---|
| Degrees Salinometer at 60° Fahr. | Specific Gravity at 60° Fahr. | Specific Heat. | Weight Pounds Per Cubic Foot. | Degrees Salinometer at 60° Fahr. | Specific Gravity at 60° Fahr. | Specific Heat. | Weight Pounds Per Cubic Foot. |
| 12 | 1.024 | 0.980 | 63.923 | 4 | 1.007 | 0.992 | 62.862 |
| 27 | 1.041 | 0.964 | 65.082 | 8 | 1.015 | 0.984 | 63.361 |
| 36 | 1.058 | 0.936 | 66.066 | 10 | 1.019 | 0.980 | 63.611 |
| 40 | 1.076 | 0.911 | 67.169 | 12 | 1.023 | 0.976 | 63.860 |
| 44 | 1.085 | 0.896 | 67.931 | 14 | 1.026 | 0.972 | 64.048 |
| 52 | 1.103 | 0.884 | 68.755 | 16 | 1.030 | 0.968 | 64.297 |
| 62 | 1.121 | 0.868 | 69.979 | 20 | 1.037 | 0.960 | 64.734 |
| 80 | 1.159 | 0.844 | 72.456 | 24 | 1.045 | 0.946 | 65.234 |
| 88 | 1.179 | 0.834 | 73.599 | 28 | 1.053 | 0.932 | 65.733 |
| 95 | 1.199 | 0.817 | 74.847 | 32 | 1.061 | 0.919 | 66.173 |
| 104 | 1.219 | 0.799 | 76.096 | 36 | 1.068 | 0.905 | 66.669 |
| 112 | 1.240 | 0.778 | 77.407 | 40 | 1.076 | 0.892 | 67.159 |
| 120 | 1.305 | 0.767 | 81.464 | 48 | 1.091 | 0.874 | 68.105 |
| | | | | 60 | 1.115 | 0.855 | 69.603 |
| | | | | 80 | 1.155 | 0.829 | 72.101 |
| | | | | 100 | 1.196 | 0.783 | 74.660 |

The specific gravity of a substance is the ratio of the weight of that substance to the weight of the same volume of pure water at its temperature of maximum density at 39 degrees Fahrenheit, at which temperature it weighs 62.425 pounds per cubic foot. The weight per cubic foot of brine given in the table is determined by multiplying 62.425 by the specific gravity as determined by a salinometer, or other similar hydrometric instrument.

If we have the more specific information that the brine—calcium chloride—is of a density of 120 degrees salinometer, corresponding to a specific gravity of 1.305, weighing 1.305 × 62.425 = 81.464, and that the specific heat of brine of this density is 0.767, we can calculate the refrigerating duty more exactly by means of the formula given:

$$Tons = \frac{W\ S\ (t - t_1)}{200}.$$

Since there are 7.48 United States gallons in a cubic foot, the weight of the brine per gallon is

$$1.305 \times 62.425 \div 7.48 = 10.89$$

pounds, and since 1000 gallons is circulated per minute the weight *W* to be substituted in the foregoing expression is 10.890. From the table we find that the specific heat of brine of 1.305 specific gravity is 0.767 and since the range through which the brine is cooled is 7 degrees Fahrenheit, we have from equation (3):

$$Tons = \frac{10{,}890 \times 0.767 \times 7}{200} = 292.34\ tons.$$

EXAMPLE

By test it is found that the refrigerating machine cited in the first example, when operating at 23 revolutions per minute, cooled 134.5 barrels of wort from a temperature of 81.82 to 48.10 degrees Fahrenheit in 100 minutes. What is the rate of cooling in tons per twenty four hours and what is the capacity of the machine when operating at 50 revolutions per minute?

At 39 degrees Fahrenheit the temperature of maximum density of water, at which temperature the weight of pure water is taken as a standard with which to compare the weights of other substances of the same volume in order to determine their specific gravities, is 62.425 pounds per cubic foot or 8.345 pounds per gallon.

At from 13 to 15 strength of extract the specific gravity of wort is 1.05 (compend.) and the specific heat is 0.9. A barrel of beer contains 31 gallons.

From the foregoing, then,

$$W = 134.5 \times 31 \times 8.345 \times 1.05 = 36{,}534.2\ pounds.$$

and the formula then becomes:

$$Tons = \frac{36{,}534.2 \times 0.9 \times 33.72}{200 \times 100} = 55.43,$$

55.43 being the tonnage capacity of the machine when operating at 23 revolutions per minute.

The capacity of the machine in tons per twenty-four hours when operating at 45 revolutions per minute as computed in the first example would be

$$\frac{45 \times 55.43}{23} = 108.45\ tons.$$

In the test of cooling beer the machine which, according to computations made in the first example would be expected to produce 112.23 tons, actually did produce only 108.45 tons, or 96 per cent. of the former; which, assuming that the test was made under standard pressures, indicates that the compressor displacement efficiency is not as high as assumed by 4 per cent. In other words, this efficiency is 0.96 × 80 = 76.8 per cent., and the apparent cubical displacement per actual ton of refrigeration is 5 ÷ 0.96 = 5.20 cubic feet per minute.

# Measurement of Temperature Rise of Electrical Apparatus by Increase in Resistance

By N. A. CARLE

The rise in temperature of a generator, motor or transformer is one of the most important factors in determining the life of such apparatus and the rating is usually determined by the rise in temperature of the various parts under operating conditions.

The conditions under which tests of this should be conducted are those specified for rise in temperature tests in the Standardization Rules of the American Institute of Electrical Engineers.

The increase in resistance due to rise in temperature is approximately 0.42 per cent. for each degree Centigrade above zero, the resistance at zero being taken as the base. The formula is as follows:

$$R_t = (1 + 0.0042\ t)\ R_0,$$

where

$t$ = Temperature in degrees Centigrade.
$R_0$ = Resistance at zero Centigrade.
$R_t$ = Resistance at the temperature $t$.

In actual tests the resistance is measured before testing at the existing temperature and the equivalent resistance calculated for zero temperature by the formula. The value of the resistance so obtained is used in the formula for the value of $R_0$ for subsequent calculations.

When the period of operation required to raise the temperature to its maximum value is completed, a measurement of the resistance at this temperature is made and this value is taken for $R_t$ in the formula. The value of $t$ is then calculated, transposing the formula to solve for $t$.

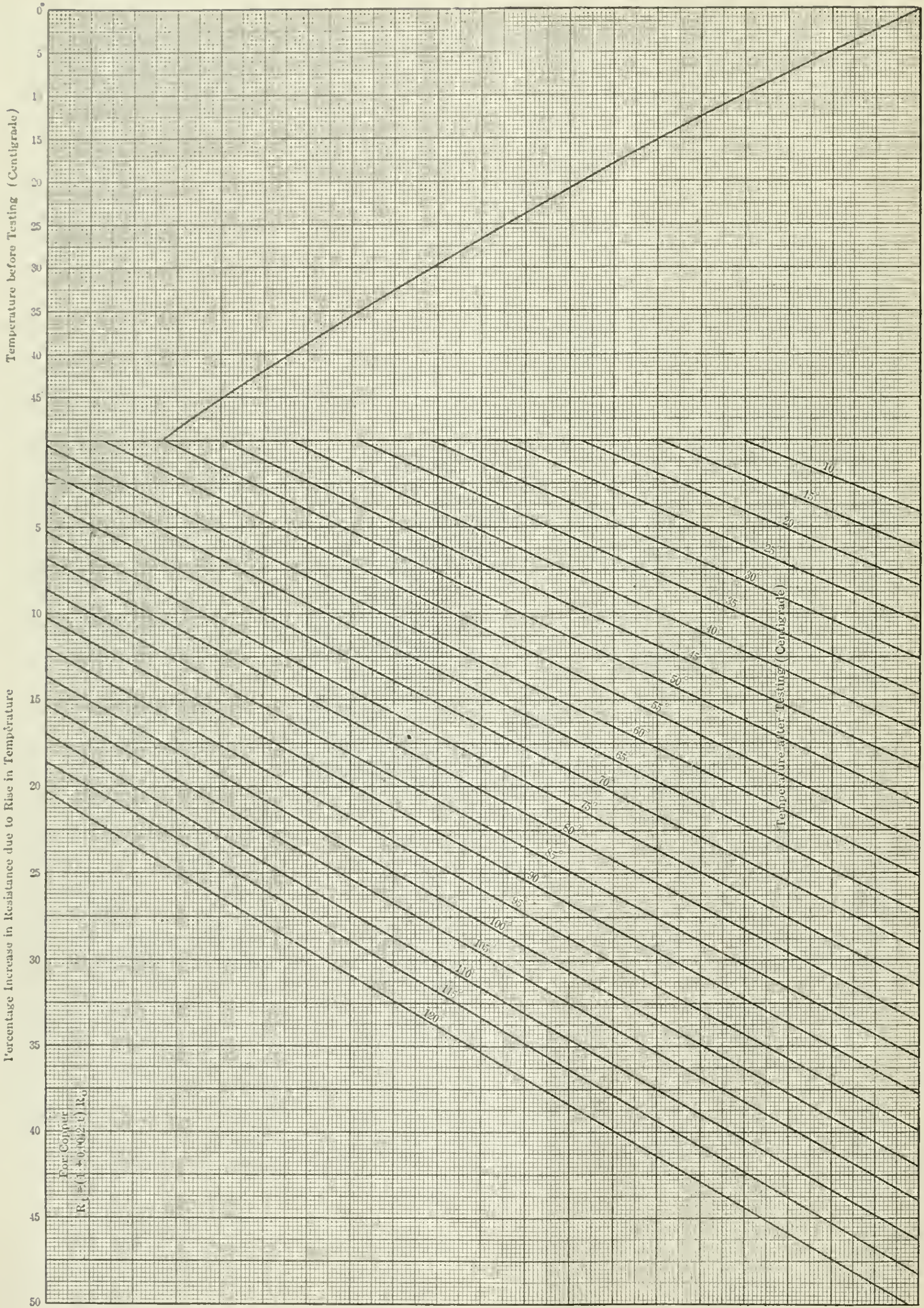
On the assumption that the average air temperature is 20 degrees Centigrade and that the error due to any ordinary variation from this temperature is negligible, the formula is sometimes revised for the resistance at 20 degrees Centigrade instead of zero.

Substituting the value of 20 for $t$ the formula becomes

$$R_{20} = (1 + 0.0042 \times 20)\ R_0.$$

and transposing and reducing,

$$R_0 = \frac{R_{20}}{1.084}.$$



*Power, N. Y.*

GRAPHICAL CALCULATION OF RISE IN TEMPERATURE BY INCREASE IN RESISTANCE

Substituting this value of $R_t$ in the general formula gives

$$R_t = (1 + 0.0042\,t)\,\frac{R_{20}}{1.084}.$$

Rearranging terms and clearing fractions,

$$t = \frac{258\,R_t}{R_{20}} - 238.$$

With this formula it is only necessary to measure the value of $R_{20}$ and determine the value of $\frac{258}{R_{20}}$. The value of $t$ is found by multiplying the value of the resistance at the final temperature by the constant $\frac{258}{R_{20}}$ and deducting 238.

The chart on page 20 is designed to determine the final temperature after testing when the temperature before testing is given and the percentage of increase in resistance is known. The range covered by the chart is somewhat in excess of conditions found in actual practice.

### Examples

1. A transformer is being tested at a room temperature of 25 degrees Centigrade; the resistance of the secondary wiring before testing was found to be 80 ohms and after a 5-hour run, measurement of the resistance showed 92 ohms. What was the rise in temperature?

The temperature of the transformer before testing was that of the room and the resistance at this temperature was 80 ohms. After testing, the resistance was 92 ohms; therefore the increase in resistance was 100 × 12 ÷ 80 = 15 per cent.

Starting with 25 per cent. Centigrade "Temperature before Testing," read up to the diagonal line immediately above this temperature and from this intersection extend a horizontal line to the right crossing the lines of "Temperature after Testing" until it intersects a vertical line projected upward from 15 per cent. "Increase in Resistance." This intersection is between 60 and 65 degrees "Temperature after Testing" and is approximately 64 degrees Centigrade. The room or initial temperature of the transformer was 25 degrees Centigrade so that the rise in the temperature was approximately 64 — 25 = 39 degrees Centigrade.

2. The resistance of a generator field winding is 64 ohms. After a run of 5 hours the resistance was found to be 8 ohms. If the room temperature was 30 degrees Centigrade, what was the rise in temperature during the run?

The increase in resistance from 6.4 ohms to 8 ohms is 1.6 ohms or 25 per cent. Starting with 30 degrees Centigrade "Temperature before Testing," read up to the diagonal line immediately above this temperature and from this intersection extend a horizontal line to the right, crossing the lines of "Temperature after Testing" until it intersects a vertical line projected upward from 25 per cent. "Increase in Resistance." This intersecting is between 95 and 100 degrees "Temperature after Testing" and is approximately 97 degrees centigrade. The room or initial temperature of the generator was 30 degrees Centigrade, so that the rise in temperature was approximately 97 — 30 = 67 degrees Centigrade.

3. After operating a motor for 24 hours continuously, a measurement of its field-winding resistance showed an increase of 10 per cent. over the resistance before starting, with a room temperature of 15 degrees Centigrade. What was the rise in temperature caused by the run?

Starting with 15 degrees "Temperature before Testing," trace up to the diagonal line immediately above this temperature and from this intersection extend a horizontal line to the right crossing the lines of "Temperature after Testing," until it intersects a vertical line projected upward from 10 per cent. increase in resistance. This intersection is at approximately 40 degrees. The room or initial temperature of the motor was 15 degrees so that the rise in temperature was approximately 40 — 15 = 25 degrees Centigrade.

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## Building Pelton Wheels

By W. Burns

A short description of the methods used in the building of pelton wheels, such as are used when a suitable head of water can be obtained for supplying power, or connected to a dynamo for lighting purposes, may be of interest:

The wheel is built up of a series of cups mounted equidistant on a suitable wheel or disk, the water from the nozzle being directed into these cups (Figs. 2 and 3), which are designed to return the water parallel to its original flow. The cups are made interchangeable in order that any worn or broken may be easily replaced.

In the smaller sizes the wheel casing, wheel and nozzle may be mounted on the same soleplate and direct-connected to the dynamo. In the larger sizes it may be found more convenient to support the wheel journals on a suitable arrangement of beams, or on a built foundation, and build a sheet-iron or other cover over the wheel when in place.

The cups in the smaller sizes may be made of hard cast iron, and mounted on a cast-steel disk; while in the larger sizes they may be made of cast steel and mounted on mild-steel disks.

The first operation in machining the smaller sizes is to turn the disk (Fig. 1). It is turned on edge, faced on both sides of the strip, the boss bound out to fit the shaft, and keyseated. If there are a large number of cups it may be advisable to make a jig in which to machine the joint edges of the cups (Fig. 2) so that they will be interchangeable. Should there be only one or two wheels to be built, the edges may be accurately machined by making a wedge, the angle being equal to that formed by radii to the edges of the cup (Fig. 2). This measurement requires to be made very exactly, as the accuracy of the joints depends on it; if it has been exactly machined the cups will assemble on the disk without trouble.

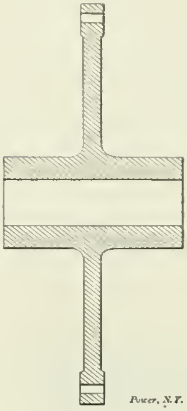

FIG. 1

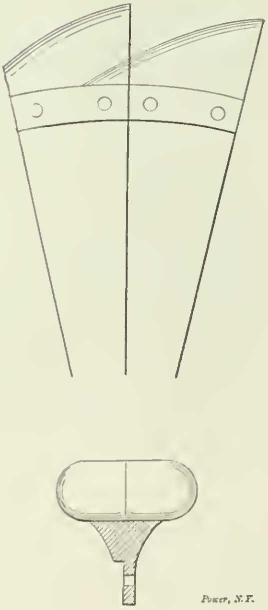

FIG. 2

and a first class job will be obtained, but if it is slightly out, the joints of the cups will show open and will require to be corrected by filing or by slightly altering the wedge and taking a light cut off the cups in the machine.

One method of getting the wedge to the exact taper is to take a long straightedge (the longer the better, provided it does not deflect or bend to the one side), and, taking the length as the radius, or a shorter distance may be taken if it is more convenient, a circle or part of a circle should be drawn on some suitable surface, and divided according to the number of cups required. The idea is to make the radius of the circle as large as practicable so that any inaccuracy in the measurement will be minimized on the smaller radius. Place the straightedge on an accurate planer or lathe bed, and set one end to a mark scribed on the surface, then raise the other end the amount of the division of the circle and support it firmly in this position.

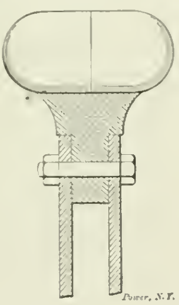

FIG. 3

The bottom, sides and ends of the wedge may now be machined, then, placing it alongside the straightedge, a line should be drawn, to which the wedge should be accurately set and machined. If there is a slight inaccuracy in the taper after machining, it should be connected by filing till it is an accurate fit between table and straightedge.

The wedge should now be fastened to the machine and all the cups machined on the same edge. After machining the second edge on one of the cups to the finished size, a mark or stop pin should be placed on the wedge so that all the cups may be machined exactly alike.

The next operation is to drill the holes for the clamping bolts. To be interchangeable they should be bored in a jig, the locating surfaces being the machined edges of the cup. Both holes should be faced up to the same level, and large enough to fit a finished washer. This is to facilitate the building up of the cups on the disk. Assembling the cups on the disk is the next operation. For this purpose the disk is placed on a level surface and the upper edge whitened. The cups are then placed approximately in position and a narrow clamp of strip iron, fitted with a tightening screw, placed around the ring of cups at the center and slightly tightened up.

Setting the cups concentric with the disk and to a true circle is the next operation. The measurement is taken from the center of the disk to the edges of the holes in the cups. The clamp is then tightened and the holes marked onto the disk. If care is taken, the ring of cups can be lifted off the disk without altering their setting. The holes in the disk should be bored from 1/8 to 1/16 inch less in diameter than the holes in the cups. This operation completed, the ring of cups is again placed on the disk, finished washers of the same thickness being placed between the cups and the disk and, the holes in the cups being faced up, this provides a level surface on which to clamp the cups. To fix the cups to the disk, L-bolts are used, the heads being narrow and offset, so that when the check on the cups is being turned, the tool can cut slightly beyond the center line of the holes. This method of fastening may seem somewhat slim, but as all the cups are tight against one another, and clamped over the top, there is but little chance of shifting. If the machine work on the joint faces has been carefully done, the ring will assemble together without fitting.

The bolts are placed in the holes and carefully tightened, the heads all being turned in the one direction. Measurement is again made from the center of the boss to the edges of the holes, and should be made very exact to secure interchangeable cups. If there are only one wheel and set of cups, it will not matter much if they are slightly out, as with this method of turning, the cups will assemble on the finished disk in the exact position in which they have been turned.

The disk with the cups in place is now mounted on a mandrel, and the checked side on the cups (Fig. 2) turned to a nice fit for the disk. When the check has been turned the bolts are slackened one at a time, and the heads turned onto the finished part; the other part is then machined.

After marking the cups for place, the clamps and bolts are removed and the cups fitted onto the other side of the disk, the check turned on the cups locating them exactly in place. The bolts are then replaced and tightened, and the holes bored out to finished size. It is a good plan, if the finished bolts are available, to place one in each hole as it is drilled, thus locating the cups without any fear of shifting.

When the bolts are tightened, the cups are dressed up slightly and the wheel is ready to be assembled in the machine.

In the larger sizes the construction of the wheel is altered slightly (Figs. 3 and 4). As will be seen, it is built up of two mild-steel disks attached to a cast-iron or cast steel hub by bolts passing through the plates and the hub. The cups are also fastened in the same manner. The machining operations are practically the same as for the smaller sizes.

After the hub and the plates have been turned, the disks are mounted on the hub and the holes for the clamping bolts bored in place, and the bolts fitted in. After the check has been turned on the one side of the cup, the bolts are taken out and the cup placed on the other disk, with the turned side next the disk. The bolts are then replaced and the other side turned.

They are then fitted into place between the two disks. As the holes in cups are full size, it is necessary to remove one of the disks for the drilling operation and when one disk has been bored the other disk is replaced, the wheel turned over and the boring completed. The turned bolts are fitted in at this stage; and, after balancing, the wheel is finished.

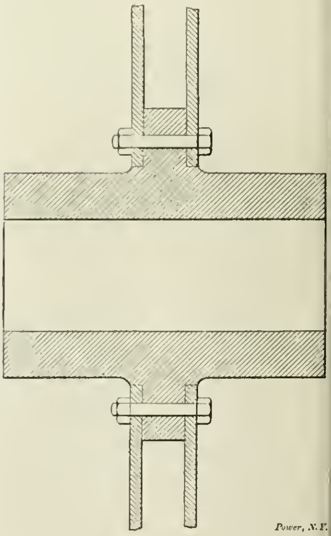

FIG. 4

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Acting upon instructions of the Secretary of the Interior, the United States Geological Survey has begun the investigation of water-power sites on public lands. Since April 23, the date of the secretary's order, the director of the Survey has recommended eleven temporary withdrawals "in air of proposed legislation affecting the disposal of the water-power sites on the public domain." These power-site withdrawals, aggregating 236,365 acres of public lands in Utah, Colorado, Wyoming, Montana, Idaho and Oregon, have been approved by Secretary Ballinger.

# The Largest Coke Oven Gas Engine Plant

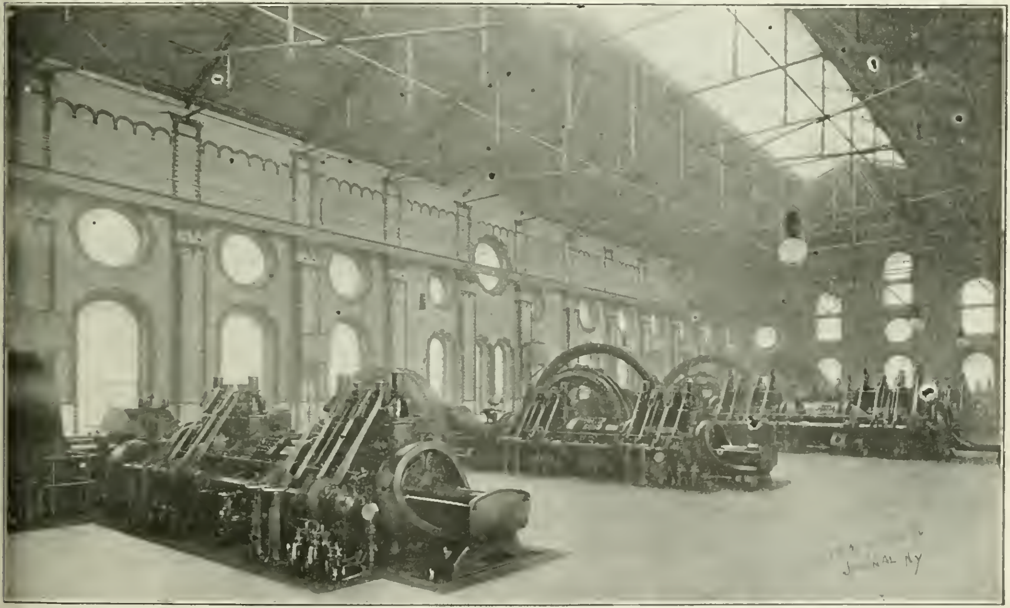
## A Practical Plan Whereby a Modern Colliery Can Cover All Its Power Requirements at a Minimum Cost and with Maximum Efficiency

BY J. B. VAN BRUSSEL*

The development of the gas-engine power station at the Anna II mine, of the Eschweiler Mining Company at Alsdorf, near Aix-la-Chapelle, Germany, is a good example of how an uptodate colliery is able to cover all its power requirements in a practical and economical way by taking full advantage of recent engineering progress. At this colliery, as at most others, the coke-oven gas was used until recently as fuel for boilers, the steam of the latter being consumed by the different steam engines about the works. Each of these comparatively small steam-engine plants needed special spare engines, and, in consequence, the maintenance and working costs were high. The calorific value of the gas was thus utilized inefficiently, as a steam engine of the best design is only able to transform into power 15 per cent. (maximum) of the calorific value of the gas, without even reckoning the great condensing loss in the long pipes.

### Nearly One-third of the Calorific Value Can be Transformed into Power

Good gas engines, however, are able to transform 30 per cent. of the calorific value of the gases into power, and, therefore, the total efficiency of a gas-engine plant is practically more than double that of a steam-engine plant.



GENERAL VIEW OF THE ESCHWEILER PLANT AT ALSDORF, GERMANY

Fully realizing this fact, the directors of the Eschweiler Mining Company decided to scrap the different steam engines, one after the other, and to erect a large power station of gas engines for driving dynamos. The gas engines were to be driven by coke-oven gas sufficiently free from tar, because a byproduct recovery plant was to be provided. A special iron-oxide cleaning plant was to be erected for extracting the sulphur from the gas, such sulphur varying in quantity according to the coal used. The installation began with two gas engines of 500 brake horsepower each, which were ordered from the Maschinenfabrik Augsburg Nurnberg, for direct-coupling to the three-phase dynamos of 500 volts.

### Larger Units Were Installed

The coke-oven gas engines of the Eschweiler Mining Company were set to work during 1904. The engines gave such excellent results that it was decided to erect larger units. During 1904 and 1905 three engines—two of 1000 brake horsepower each and one of 1200 brake horsepower—were erected, and in 1907 two twin-tandem engines each of 2400 to 2600 brake horsepower were installed, all being of the Nürnberg type. These were followed in 1908 by a further order for two engines of 2600 to 2800 brake horsepower each, so that the total output now is 14,500 to 15,000 horsepower.

This total output of 15,000 brake horse-

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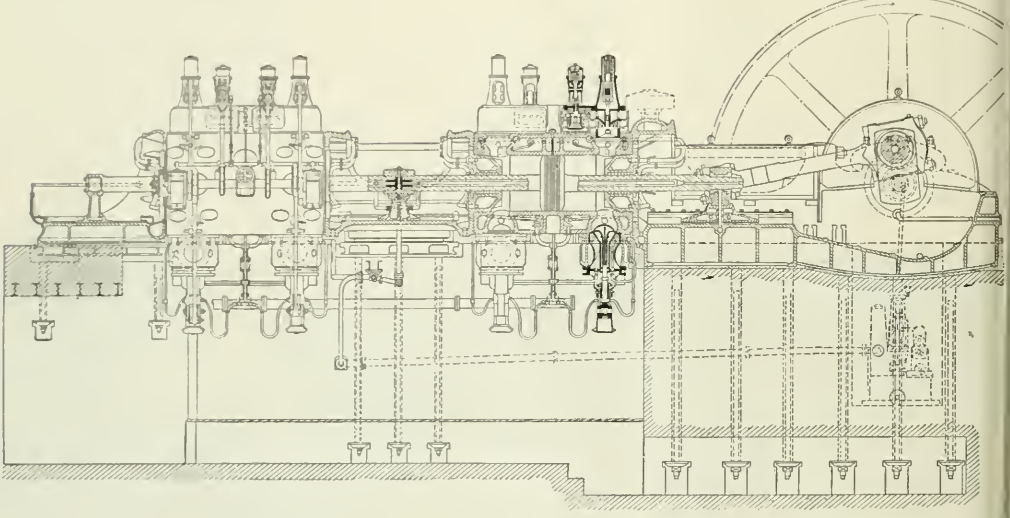
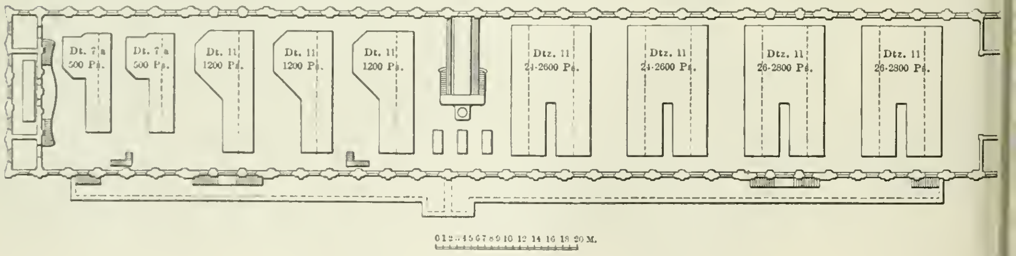
*Brussels, Belgium.



LONGITUDINAL SECTION OF NUERNBERG GAS ENGINE OF 2800 HORSEPOWER



PLAN SHOWING GENERAL ARRANGEMENT OF GAS-ENGINE PLANT

power represents about twice the amount of power formerly produced by the steam plant, and it exceeds to a large extent the power requirements of the colliery itself. Consequently, one part of the current is used at the Edward pit, where the winding engine is driven by means of an Ilgner transformer, the current having a tension of 5500 volts. Another part of the power, about 3000 brake horsepower, is transformed from 5500 into 35,000 volts, and is transmitted to the Eschweiler mine, about 11 miles distant, where it is used as auxiliary power for the pit pumps as well as for other purposes.

It is further intended to take about 1500 to 2000 brake horsepower out of this high-tension conduit to the Maria pit, about 1½ miles distant. The accompanying photograph shows the gas-engine power station of the Eschweiler Mining Company, which, it is understood, is, or will be, when all the engines now ordered have been delivered, the largest coke-oven gas-engine plant in the world.

The following figures give the results of tests made by Professor Lange, of the Technical University at Aix-la-Chapelle, of the two 2400-brake horsepower gas engines in Alsdorf. Owing to these tests taking place on a Sunday, it was impossible to overload the engines, but preliminary trials had shown an overload capacity of 16 per cent. At the same time the reliable parallel running of the gas engine, combined in every possible manner and under different loads was well proved:

RESULTS OF GAS-ENGINE TESTS.

| | Test 1. | Test 2. |
|---|---|---|
| Output in kw | 1530 | 1554 |
| Heat consumption guaranteed in B.t.u. per i.h.p.-hour | 8000 | 8000 |
| Tested consumption in B.t.u. per i.h.p.-hour | 6865 | 6862 |
| Total efficiency, taking the efficiency of the dynamo at 0.945 | 0 794 | 0 794 |
| Proved efficiency at full load | 0.844 | 0.857 |

Following these trials, Professor Lange tested one of the engines—designed for coke-oven gas—with the special object of ascertaining how it would work when driven by producer gas made from coke.

Owing to the quality regulation of the contractors, it was proved that the engine was able to work at full load without any alteration of the valves or governing gear, either with coke-oven gas of 340 to 450 B.t.u. per cubic foot (3000 to 4000 calories per cubic meter), or with producer gas of 113 B.t.u. per cubic foot (1000 calories per cubic meter). Such results would not be possible with the so-called "quantity" regulation which is largely adopted.

The producer-gas plant is erected as an auxiliary plant in case of strikes, or if the coal production and the working of the coke ovens is interrupted for any oth reason.

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Nearly all the British ocean-goi destroyers have been suffering from fu nace defects. The replacement of t burners is, of course, an anticipated n cessity, though not of very frequent o currence; but special care has to be tak that the quality of firebrick employed w withstand the greater heat, and the sy tem of attaching these bricks was not good as it might have been in one two cases.—*Engineer.*

# Practical Letters from Practical Men

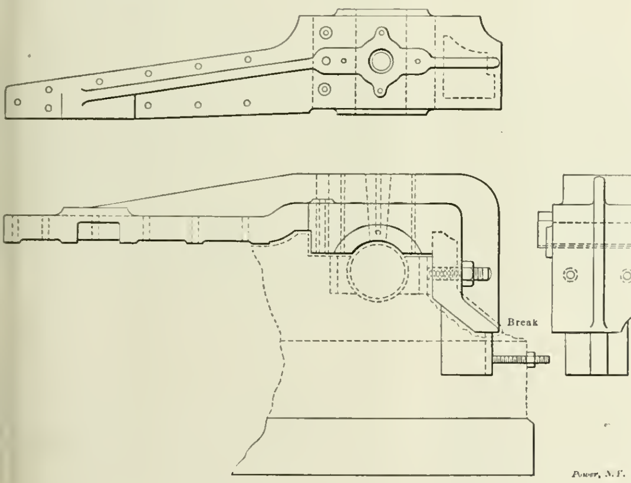
Don't Bother About the Style, but Write Just What You Think, Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

## Repairing a Main Bearing

The following describes the manner in vhich repairs were made to a 300-horseower tandem compound engine, running t 150 revolutions per minute. One day hortly after starting up the nut dropped ff the end of the piston rod in the lowressure cylinder, with the result that the uter jaw of the main bearing was broken ff at the point shown, leaving an openng into the engine bed.

The old cap was discarded and a new ne cast which extended back along the ngine frame as shown, and to which it as securely bolted. The other end was rovided with a tongue which extended wn through the opening in the bed iade by the break.



REPAIRING A MAIN BEARING

This provided a means of taking part f the thrust by two large set screws, ie of which is shown having a bearing gainst the lower end of the tongue.

The new cap was drilled and tapped r oil cups and adjusting bolts similar the old one, with the addition of the vo large set screws for end thrust, which ere in the piece broken off.

After babbitting and adjusting the cap, ie engine was started up and has been running for six months without a bit of trouble.

T. Henry.

West Toronto, Ont.

## A Power Plant Layout

In reference to C. L. Wilson's power-plant layout, in a recent number, it will be found that the 85-horsepower engine will drive the shaft at a speed of 290 revolutions per minute; and the 50-horsepower engine will drive it at 291 revolutions per minute.

If the load were just sufficient for the larger engine and the smaller one were cut in, the large one would carry all the load, and would have a tendency to drive the smaller one; but as the load increases and the larger engine becomes overloaded to the extent of reducing the speed of the shaft to the speed at which the smaller one would drive it, the small engine will begin to take some of the load, and will take all that is added afterward.

The large engine, when running together with the small one, will always be overloaded, the small engine merely carrying that portion of the load which is over and above that carried by the large engine.

If the speed of the small engine is increased to 191 revolutions per minute, it will then take its share of the load as soon as cut in.

Norman S. Campbell.

Detroit, Mich.

In the May 18 number, page 892, under the heading, "A Power Plant Layout," C. L. Wilson asks: "Which engine carries the load or does each take its portion?"

According to my way of figuring both engines do not drive the jack shaft the same number of revolutions per minute. If the pulley sizes and speeds as given are correct, the 85-horsepower engine will drive the jack shaft 299.34 revolutions per minute, while the 50-horsepower engine will drive it only 291.13 revolutions per minute. From this it appears to me that the 85-horsepower engine will carry nearly all the load until its speed is reduced to that of the 50-horsepower engine. When the clutch is thrown in, thereby connecting the two engines, the governor of the small engine will certainly jump to the extreme position, on account of the higher speed of the 85-horsepower engine, and will not admit steam to the cylinder of the small engine until the speed is reduced enough to allow the governor to come back to its normal position.

Louis B. Carl.

Marshfield, Wis.

In the issue of May 18, C. S. Wilson asks: "Which engine carries the load or does each take its portion?"

He says that the larger is capable of developing 85 horsepower and the smaller 50 horsepower. Then under the circumstances the two together would be able to develop 135 horsepower and each would be running to its full capacity, or in the proportion of 85 to 50. Now if the load on the jack shaft were, say, 100 horsepower the larger engine should carry

$$\frac{85}{135} \times 100 = 63$$

horsepower, nearly and the smaller engine

$$100 - 63 = 37$$

horsepower.

It would be interesting to see diagrams

[illegible]

[illegible]

New York City.

## Reducing Rig for a Vertical Engine

Occasion arose recently to set a permanent reducing rig on a vertical engine of 7-inch stroke. The most suitable reducing wheel available gave a reduction of 1 to 4, or a diagram only 1¾ inches long—too small for the purpose.

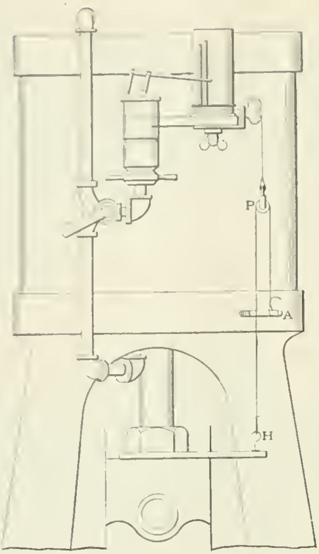
As the engine was constructed, it was particularly difficult to fasten to it any form of pendulum or pantagraph motion. Furthermore, it must be confessed that the writer was unreasonably annoyed at the thought of taking all the time and pains to obtain a reduction of only 1 to 2 that would be necessary for an engine of three times the stroke. In the midst of this annoyance the device illustrated in Fig. 1 occurred as an inspiration. The mechanism, which will be recognized at once, has not before been used as a reducing rig to the writer's knowledge.

To the crosshead of the engine was fastened a flat bar carrying a hook, as shown. The end of the cord leading from the indicator drum was tied to a guide pulley *P* such as is commonly used in indicator work. A separate cord was threaded through this, with one end *A* fastened to the engine frame, while the other was looped over the hook *H*. The resulting reduction is readily comprehended.

It at once occurred to me that there was no reason why this application should not be extended. Thus a 4-inch diagram from an engine of 12-inch stroke could readily be obtained by the combination illustrated in Fig. 2. If the upper pulley is made double a reduction of one fourth would result. It is difficult to say where are the limitations of the adaptation, but the following considerations at once suggest themselves:

If used with a horizontal engine the weight of the moving pulley or pulleys would have to be supported to keep the cord from sagging, if they move horizontally. This, however, could be simply accomplished by supporting the moving weight from above by a cord of such length that the arc through which the pulley swings is nearly a straight line.

With slow-speed engines probably a considerable reduction could be accomplished, as it is conceivable that the drum spring has sufficient tension to keep a number of bights taut. With high-speed engines, however, it is surmised that this force would not be sufficient to draw the indicator cord over a number of pulleys sufficiently fast to keep tight that part of it proceeding directly from the crosshead.

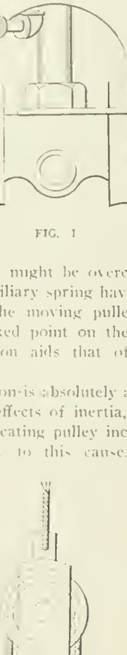


Power, N.Y.

FIG. 1

This difficulty might be overcome by the use of an auxiliary spring having one end fastened to the moving pulleys and the other to a fixed point on the engine, so that its tension aids that of the drum spring.

The reduction is absolutely accurate except for the effects of inertia, the weight of the reciprocating pulley increasing any distortion due to this cause. If, however, this weight is made small by selecting as small a pulley as possible the resulting error should be little. If an auxiliary spring is used it may neutralize entirely the effect of inertia.



Power, N.Y.

FIG. 2

The extended application of the mechanism is here suggested as a possibility. In its simple form there is no doubt of its availability.

JULIAN C. SMALLWOOD.

Philadelphia, Penn.

## Draining a Main Steam Pipe

A. J. Dixon, in the May 11 number, describes a method of draining a steam header, returning the drips direct to the steam space of each boiler by gravity.

This method is by no means new, having been employed satisfactorily in numerous plants, the drip pipe, however entering the boiler below the water lin and in no case, to the writer's knowledge has this connection been made to th boiler above the steam space in the drum as shown in Mr. Dixon's sketch.

It is customary to connect this re turn-drip pipe into the blowoff line a some point above the blowoff valve. A swinging check valve is placed in the re turn line to prevent the boiler wate from backing up when the pressure i off the main steam header. This chec valve should preferably be placed betwee two stop valves, one at the drip main an the other at a point just above where th return pipe enters the blowoff line, fo convenience in examining or removin the check valve, should it get out o order, or should the disk stick to the sea preventing a clear flow of the drip wat to the boiler.

Some engineers do not approve o making a drip connection through th blowoff line. However, the drip wat flowing into the boiler tends to sweep th sediment, scale, etc., away with it, de positing it some distance from the blow connection, which is in its favor. separate connection can be made to th boiler, below the water line, some di stance from the blowoff, if objection made to using the blowoff line.

In order that the drip water from th header shall gravitate back to the boile as it forms, the header should be a su ficient hight above the water line in t boiler in order that the water standing the return pipe will have a head mo than sufficient to compensate for the d ference between the pressure in the boil and the pressure in any part of the stea main, or the drip main, where one is us

Say, for example, the pressure in t boiler is 100 pounds, and the lowest pr sure at any point in the steam header 98 pounds. Then we have a 2-pound dr in pressure between the boilers and t header.

Before any water will flow from t

header into the boilers a column of water equal to

$$\textit{Drop in pressure in pounds} \div 0.434 = 2 \div 0.434 = 4.6$$

feet, or a head 4 feet 7 inches above the boiler water line will form in the return pipes and any water above this hight should gravitate to the boilers as fast as it forms. The 0.434 is the weight of a column of water one inch square at its base and one foot high.

In Mr. Dixon's sketch the boiler is shown connected to the main steam header hrough a long-radius 90-degree bend and an elbow, with a valve placed in the vertical line between the elbow and a tee in he main header

With the valve placed in this position a water pocket is formed above the valve seat when the valve is closed, and any water of condensation forming in the horizontal pipe and in the elbow will in a short time cause this pocket to fill up with a column of water; and when the valve is opened to admit steam to the eader, this water will be thrown to the ottom of the header with great force, nd, unless quickly carried off through he drip pipes, or through a separator, may be swept over to the engines in slugs, ausing pounding and knocking out a ylinder head, or doing, perhaps, more erious damage.

If the steam piping is to be arranged s shown, the valve should be dripped bove the seat in order to keep the pocket rained free of water when the valve is osed. This pocket should be relieved f water in all cases before opening the eam valve.

The steam piping from the boiler could arranged to better advantage by placing the elbow next to the tee, and placing he valve in the horizontal line next to he elbow.

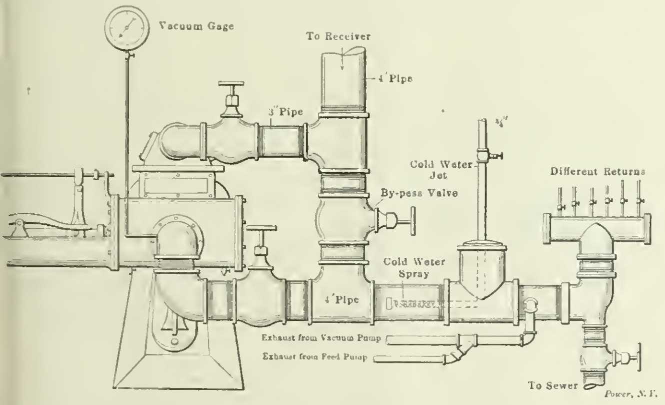
With this arrangement of the piping, e water pocket is entirely eliminated. hen the valve is closed, the water of ondensation, which forms in the bend and orizontal pipe, will drain back to the boiler, and that forming in the elbow and the vertical leg of the tee, will drain back to the header as fast as it forms

William F Fischer

New York City

## Vacuum Heating System

From the accompanying illustration an idea may be got of a "mongrel" vacuum steam-heating system which was formerly run with open ends on the coils and required 15 pounds back pressure on the engine to heat one of the buildings 200 feet away. After installing the present piping, as shown, the returns from the vacuum pump were dumped into an old boiler which I used for a receiver and which I have also found to be the best kind of an oil separator, as no trace of oil can be found in my power boilers. In the coldest weather it is not necessary to carry more than 5 pounds back pressure in the morning; when around the freezing point, 2 pounds, and when above freezing I raise the back-pressure valve and the pump will pull the steam through and get rid of the back pressure. Another great help is to run the pump condensing. It will be seen that the pump exhaust goes to the suction of the vacuum pump pipe, and gets the benefit of 20 inches of vacuum which is carried on the system. This 9½ pounds reduced resistance per square inch of piston is at once noticed when changed over to condensing. For example, if the pump throttle valve is set to give 5 inches of vacuum noncondensing, if changed to condensing it will give 20 inches vacuum with the same throttle opening which gave a 5 inch vacuum, this being due to the speed given the pump condensing. The gain can be seen on the boiler-feed pump in the same proportion and the cold-water injection, shown with perforated pipe and cap on end in the pump suction, must be opened slightly more in this case because of the increased amount of steam in the vacuum suction pipe.



VACUUM HEATING SYSTEM

It is advisable to have a large receiver, so as not to overflow, because in the morning when the heating is greater it accumulates fast, while in the afternoon the heating is less and the water level comes down to normal.

A. C. Waldron.

Lynn, Mass

## Vaporizing Temperature of Kerosene

I noticed two letters in the May 4 number, which gave the vaporizing temperature of kerosene at widely different values. W. S. Durand states that the degrees marked on an oil barrel do not indicate the temperature at which it will vaporize, but gives 338 degrees and upward as the proper figure. I have consulted several reference books and have been unable to find any data relative to the vaporizing temperature or boiling point of kerosene. Would Mr. Durand kindly give his authority for his statement? I suppose he has arrived at this figure from experiments and investigations of his own.

Professor Gill, in his "Engine Room Chemistry," gives the definition of fire test as "that temperature at which an oil gives off vapor in sufficient quantity to burn continuously if a flame is applied." The temperature marked on an oil barrel usually indicates the fire test. In this case it looks as though this would be the vaporizing point in open air, but we have other features to consider when confining it within the boiler.

I am not in favor of using oil of any kind in a boiler, but I have seen kerosene used in small boilers with great success, and it seemed to make very little difference whether the boiler was allowed to stand or steamed up at once after pouring in the kerosene. The pressure carried on these boilers was 80 pounds

Mr. Taylor states that there is danger of the oil showing up weak places in the boiler. Is this not rather more of a benefit than a detriment? Of course if an engineer is up against it for boilers, it would not be good policy to try any experiments that might result in causing a leaky boiler The scale has no business in a boiler, and after once removing it and repairing any leaks that may have appeared, I think the engineer should be able to keep the boiler from getting badly scaled a second time. He should, if possible, arrange for more frequent cleanings and inspections. My reason for not using oil in a large boiler is the danger of blistering the plates, due to overheating, caused by the oil keeping the water from close contact with the plate.

In my opinion the best way to handle the boiler-cleaning proposition is to remove as much sediment as possible before feeding the water into the boiler. A good feed water heater of the open type, cap ble of maintaining a temperature of at least 210 degrees, will remove a large amount of foreign matter I have taken as much as three wheelbarrow loads of sediment from a 3000-horsepower heater after a two-weeks' run Another gain is in frequently blowing down I claim that a boiler should have at least one inch of water blown out, once in twenty-four hours, and in case of very muddy water I have opened the blowoff every three hours until normal conditions were regained

CHARLES A CRYTSER

Windber, Penn

## The Duplex Pump

The duplex steam pump causes the average young engineer an endless amount of trouble and worry, and its actions are sometimes a puzzle to him. After working on one for two or three hours, and examining everything he can think of, without locating any trouble, he will put it together again and start it up, when to his surprise it will work perfectly. He is naturally very much puzzled as to what the trouble really was and too frequently comes to regard the pump as a sort of mystery.

In reality the much abused duplex pump is a very simple machine, and its refusals to work properly are always due to causes which are very simple and easily found after one is able to diagnose the trouble properly. For instance, when a pump makes three of the four strokes comprising a "revolution" and gives a sudden jerk or kick for the fourth, an experienced pump man will immediately look for a broken or missing valve in the water end, yet the writer has seen this action laid to faulty valve setting in the steam end and the engineer has attempted to remedy it by changing the valve setting, when he finally comes to the conclusion that the trouble lies elsewhere. Upon attempting to restore the steam valves to their original position he finds that he does not understand how to set them properly

Do not tamper with the steam end unless you are positive that the trouble lies there, as almost without exception the valve motions of duplex pumps are so constructed that it is impossible for the setting of the valves to change without an actual breaking or bending of some of the connections.

The manner of setting the valves of a duplex pump is as follows: First move the piston to the end of the stroke until it strikes, and mark the rod at this point; then find the striking point at the end of the return stroke in the same way. Next, place the piston in the center of its travel with the lever from the rocker arm plumb. If it is not, and the crosshead is not keyed to the rod so it cannot be moved, adjust it until the lever is plumb, and go through the same operation with the other side After setting both pistons in the center of their travel in this way remove the steam-chest cover and adjust the links so that when the lost motion is equally divided on each end of the valve, the outside edges of the valves will come line on line with the outside edges of the steam ports. When this has been done, the valves are properly set, and cannot get out of adjustment unless the crosshead slips, or some of the links bend or break.

When a pump kicks back suddenly on any one stroke, it is pretty safe to assume that a suction valve on the end toward which it kicks is either broken, or that the stud on which the valve works is broken, although the same trouble may exist in the discharge chamber of the opposite end. For instance, referring to Fig. 1, if the stud holding the valve *A* in place should be broken, it would not make any difference during the stroke in the direction indicated by the arrow, as the valve *A*, being a suction valve, would normally be open during this stroke, but on the return stroke it is very evident that the water would simply surge under pressure through the valve *A*, and be forced into the suction chamber instead of being forced into the discharge. Therefore, during that stroke the piston has practically no resistance, and makes the stroke with a sudden kick. The rapidity of the return stroke is an index to the extent of the trouble in the valve chambers, as, if a valve is simply broken, the amount of water which can surge past will be much less than if one or more valves are missing. If a discharge valve is broken or missing, the action is the same. For instance, if the discharge valve *B* is broken or missing the water will surge from the force chamber *C*, through *B*, into the suction end, as can be clearly perceived. By tracing the course of the water in this way the engineer can tell at a glance just which suction or force chamber he may look into for the trouble, and thus save himself much work and time in removing the wrong caps. When trouble of this nature exists the water can be plainly heard rushing through the passages, which will also help to locate the fault.

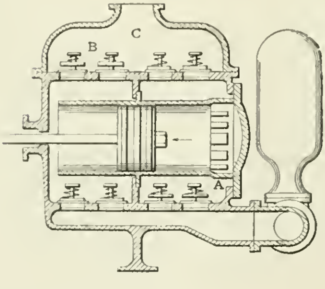


FIG. 1

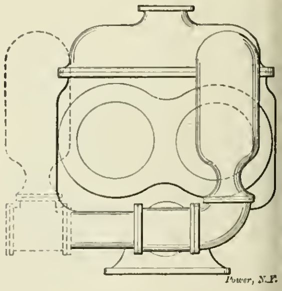


FIG. 2

Knocking in the water end is, perhaps, the most frequent trouble in pumps, and may be the result of a number of causes, the principal one of which is a leak in the suction system, especially if the lift is considerable. A very small amount of air drawn in under a considerable vacuum will occupy a good deal of space, and when compressed to, say, 60 or 100 pounds pressure on the return or force stroke, the piston may travel through a distance of anywhere from ¼ inch to 2 inches, or even more if the leak is a bad one, before it strikes the solid nonelastic water. The result of this is a heavy knock, which jars the entire pump and its connections. Of course, this leakage may be anywhere in the suction system, either in the joints of the pipe, through the stuffing boxes or leaky gaskets.

If the suction pipe is long, the column of moving water in it attains considerable energy, and suddenly to check this, as is done to a considerable extent when the piston stops at the end of the stroke, may reasonably be expected to cause a water ram or knock. This is frequently the case, especially if the opposite side of the pump does not commence its stroke quite as soon as it should, thereby maintaining a more uniform flow in the pipe. By properly installing an air chamber on the suction this ram effect may be largely overcome. In installing this air chambe it should, whenever possible, be placed i direct line with the suction pipe as show by the full lines in Fig. 2, rather than o a tee near the pump, as shown by th dotted lines. The reason for this is tha a great deal of the cushioning effect o the air will be lost if the water has t change its direction at each impulse i order to enter the chamber.

An ample air chamber should also b provided on the discharge side of th pump. If the chamber is completely fille with water it is useless, but if there is n gage the engineer cannot tell whether i contains any air or not. This air gradu lly disappears, owing partly to leakage nd partly to absorption, and this deficiency must be supplied. A very simple nd effective method which the writer has sed on some fairly large pumps with oodresults is to tap a small pet cock into he suction pipe next to the pump. When he air is becoming low this cock is pened slightly, as much as the pump will and without knocking, and left open ntil sufficient air has accumulated in the hamber. It may even be necessary to un a great part of the time with this ock partially open in order to maintain he proper amount of air in the chamber.

When the water contains considerable mud or vegetable matter, such as weeds r leaves which have become water-logged nd sunk, the strainer may soon become ufficiently choked to prevent the cylinders filling completely at each stroke. When his is the case the action is the same as hough the suction leaked. If any doubt xists, a vacuum gage attached to the sucon pipe near the pump will indicate hether the vacuum is much too high for he lift on which the pump is working or ot, and in this way a choked strainer ill be detected.

Much friction may be caused by packig the water pistons too tight. The riter has been called upon to overhaul umps of about one million gallons capaity which were packed so tight that they ould not be moved by one man with a -foot bar. The square linen packing used r this purpose is quite hard, and as it wells to some extent when wet, care ust be taken not to get it too tight. It far better to lose a trifle more water y slippage past the packing than to use great deal more steam in overcoming n abnormal amount of useless friction.

The piston packing in the water end is ot usually fitted as carefully as it should e. A good plan is to soak the packing in ot water for a few minutes, making it oft and pliable and swelling it to its orking size. Then coil it around the iston, or plunger, marking the length of ring very carefully. It should be cut ith a lap joint and fitted as carefully as he rings of a steam piston. It will be ound that this method will give a bearig on each ring throughout its entire circumference, and the packing will wear a reat deal longer than if put in carelessly. he rod packing will wear much longer nd the rods will be kept in much better ondition if a swab is arranged for them, eeping them lubricated with engine oil. might seem that the water in the packig would immediately wash all this oil ff before it could have any beneficial ffect, but a trial will soon convince the ost skeptical. Remove the old packig and repack the rod as loosely as posble, and keep the swab saturated with ltered engine oil. This is also an exellent plan to follow on the steam rods, ut the old packing should be removed obtain the full benefit of it, as the old packing is usually so hard and dry as to be impervious to the oil.

L. S. Brainerd.

St Louis, Mo.

## Hygrometry

As a contribution to the discussion under the title "Hygrometry," but confining attention to the case of steam as made in a boiler, I would submit the following:

Mr. Treeby, January 5, page 63, and especially in May 18, page 893, errs in pressing an analogy which does not hold. In general usage, "saturation" and "saturated" undoubtedly imply "with;" but in the case of steam the term is used in a conventional or arbitrary sense, to convey a special idea which could otherwise be expressed only by a definition. Pure "saturated" steam is not filled up or loaded with anything; not with moisture, for it contains no water in the liquid state; certainly not with heat units, for it contains the least possible amount of heat that it can hold and yet be in the gaseous state.

The meaning of the term "saturation" is clearer if we approach the condition which it defines from the side of superheat. Suppose that we have a certain weight of steam confined in a closed vessel at a temperature much higher than that at which water boils when under the pressure existing within the vessel. Abstracting heat at constant pressure, keeping the pressure constant by contracting the vessel as the steam shrinks in volume, we cool the steam, or lower its temperature. This cooling continues until the characteristic boiling temperature is reached, and then there is an abrupt and radical change in the behavior of the fluid. The pressure being still kept constant, the temperature no longer falls as heat is withdrawn but, instead, the steam condenses.

Steam in such a state that abstraction of heat under constant pressure will not cool but will condense it, is saturated steam. Considering a definite amount of water substance, as in the preceding paragraph, when the whole body of steam is in the pure or dry saturated state, i.e., just when the temperature has been lowered to the boiling point but before any of the vapor has condensed. The least further escape of heat changes the content of the vessel from pure or dry steam to a mixture of steam and water. This may be a nearly homogeneous mixture of vapor and minute particles or drops of water; or the water may collect and settle to the bottom, leaving dry steam above it. In the first case, we have what is properly called wet steam; in the second case the steam just meets the definition, "in the presence of water."

Ordinary usage is, perhaps, best described, by saying that "vapor" stands for a gas at or near saturation, while a "gas" is a more or less superheated vapor, the two terms overlapping. It might be well if the word vapor were confined to the lower limit of the gaseous state, or to the saturated gas which is just ready to condense. Wet steam is not a simple vapor, but is a mixture of vapor proper with water mist. From the side of mechanical condition, as distinct from thermal, we must recognize two states of liquid water; in the first, the liquid is collected in large masses; in the second, it is in more or less minute drops, which float in a gaseous atmosphere; this latter state is properly described by the word mist.

The meaning given in the foregoing, namely, that saturation is the lower limit of the gaseous state, seems to be the best definition of this condition for any fluid. Consider again the process of cooling from superheat under constant pressure; at saturation the steam has the lowest temperature and the smallest volume and the least heat content that it can have and yet be all of it gas and none of it liquid. Or, if a certain weight of the substance be confined in a space of constant volume, then at saturation the steam has the lowest temperature and smallest pressure and least heat content for the gaseous state.

The most obvious reason for the adoption of the term "saturated" in the special sense in which it is used in this connection is probably to be found in the readiness of the steam to condense. Another reason suggests itself in the fact that with the conditions just described—least volume or lowest pressure—goes maximum density. In general, whether the determining variable be pressure, volume, or temperature, at saturation the weight of substance contained in a unit of volume is the greatest that can exist for water in the gaseous state.

R. C. H. Heck.

New Brunswick, N. J.

## Economy of Different Sized Engines

On page 891 of the May 18 number Mr. Guile takes exception to an economy chart published in a previous number by Mr. Snow. Mr. Guile states that there is an old saying that figures do not lie, but he is not so sure that it holds true for this chart. I think that in this case Mr. Guile should apply his doubts to his own figures and not the chart, for that seems to be correct.

If Mr. Guile will go over his work again, using a little care, he may discover that in finding the cubic inches of steam used by an 8x10 engine cutting off at one-third stroke, he has taken the diameter as 10 inches instead of 8 inches. The correct figure should be 329 cubic inches, which would make a decided difference in favor of the [illegible] engine [illegible] used at the [illegible] mentioned in the article under discussion.

Even if Mr. Gade's figures were correct they would prove nothing, as a comparison of the total amount of steam used in two engines is meaningless unless the horsepower of each engine is also given, so that the water rate can be referred to the same basis for comparison.

JOHN FRENCH.

Brooklyn, N. Y.

## Engines at High Efficiency

In reading a recent issue of POWER, I noted the editorial remarks upon the high efficiency of the West Point engines. The paragraph in the latter part states that for turbines the efficiency ratio is from 50 to 72 per cent.

To my mind you misrepresent the conditions to some of the readers who do not understand the different conditions under which a turbine works from those of an engine.

The available energy in the steam between the range of, say, 150 pounds and 29 inches of vacuum on which the turbine will take down from 50 to 72 per cent. is much greater than the available energy in the steam from 150 pounds down to 27 inches of vacuum, or 27½, under which the engines would very likely operate. The point I wish to bring out is that the total work developed per pound of steam is greater in the case of a good turbine than in the case of a good engine, while it may take out the same percentages or a less percentage of available energy in the steam.

C. W. F. CLARKE.

New York City.

## Three Phase Alternating Current

The use of electricity for street lighting, illuminating residences and power work is in reality comparatively young, it not having been many years since the first arc light in St. Louis was to be seen on a pole on the corner of Twenty-third street and Locust avenue, put up as an experimental or trial lamp.

Since that time many changes have been made in the application of electricity for general use in cities; and to draw out arguments I wish to condemn the three-phase alternating-current system as generally used for furnishing electricity for universal use. It is impossible to give entire satisfaction to each particular style of consumer at all times with this system, even when it is working as satisfactorily as it is possible to have it, with the many appliances for regulation, etc., that can be had.

JAMES M. SHERMAN.

Columbia, Mo.

## A Rotor Wreck

A short time ago we had a very serious wreck to one of our 600-kilowatt alternator rotors. As shown in Fig. 1, two spokes were broken entirely through, which caused the periphery of the rotor to be a little elliptical or oval. From the nature of such a breakdown it can well be appreciated that it did not present any easy plan for repair. It was out of the question to await the arrival of a new rotor, so some means had to be devised to get this break repaired for temporary service at least.

Our superintendent seemed to suggest the correct idea at the psychological moment. The arms or spokes were cut out to receive one-half the diameter of the bolts, as shown at *A*, Fig. 2. Next, some ¾-inch boiler plate was cut and drilled to fit in between the arms as shown at *B*, and shown in place at *C*. The outer edge of the plate was turned up as shown at *D*, as the fit would be more snug. Ten 1-inch bolts were used as shown, one plate being upon each side of the arms, and when drawn down it was made practically a solid center.

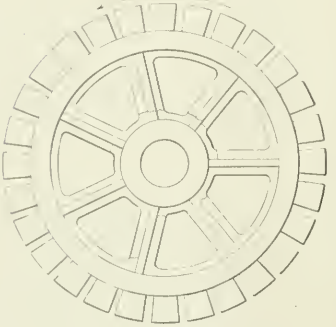
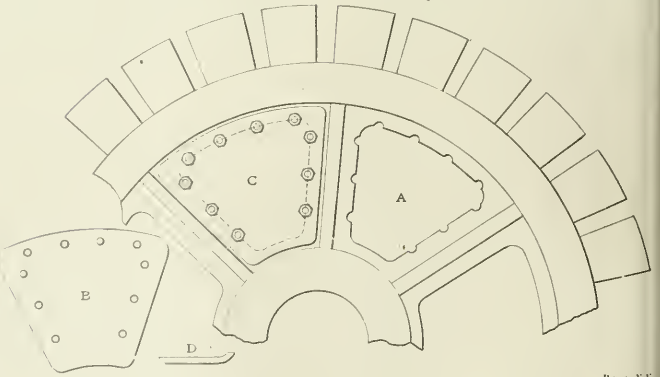

Power, N.Y.

FIG. 1



Power, N.Y.

FIG. 2

The repair was quickly made and the machine put into service. The only noticeable feature was the increased vibration of the stator due to the slight elliptical condition of the rotor. For ten or fifteen days after the machine was put into service, the bolts had to be tightened some each day; other than that, it has been giving good service, carrying as much as 33⅓ per cent. overload for some time. It bids fair to give good service until the new one arrives.

L. EARLE BROWN.

Ensley, Ala.

## Limitations of a Pump Lift

On page 801 of the May 18 number is a letter by W. Ellerbrock. I believe he is mistaken when he states that he had a pump that lifted water by vacuum 31½ feet. I have always understood that the best lift known to science was 30 feet 8 inches, but this was secured by small apparatus which had been made for the purpose, and no expense had been spared to make it as mechanically perfect as possible. We all know that in theory water can be raised by vacuum 33 feet, but as a perfect vacuum is impossible to secure, because of imperfect apparatus, friction, etc., we must figure on securing a much shorter lift. Surely 31½ feet is getting pretty close to perfection. There is no doubt that a well made pump in first-class condition as to packing, etc., wi lift water 27 feet and even a little highe but the average pump will not give satis factory service with a greater lift tha 25 feet.

I once installed a steam pump with lift close on to 27 feet, and a supply o water was secured at the cost of constan attention to the pump and an awful pack ing account.

JAMES E. NOBLE.

Toronto, Can.

# Disastrous Boiler Explosion at Denver

## The Explosion of a Single 400-Horsepower Boiler Results in the Death of Four, Seriously Injures Six and Causes a Property Loss of $75,000

Since our last issue, data more in detail on the Denver boiler explosion have been received and are incorporated in the article following.

### Damage to Station

The power house was built in 1891, but has been frequently added to since, and the equipment now consists of 17 boilers. Fourteen of these are of the Heine water tube type and the other three are 400-horsepower Wickes vertical boilers. Those last mentioned were installed some three years ago and were located in the addition to the station made at that time. The boilers were all arranged on one side of the station in a continuous line and numbered from 1 to 17 consecutively. Nos. 15, 16 and 17, which are the Wickes boilers, were in a battery by themselves, and the last Heine boiler was some 25 feet away, with a feed pump between. In the new part were also located a 2000-kilowatt Curtis turbine and two 1500-kilowatt direct-connected alternators. These units were supplied as much as possible with steam from the Wickes boilers, but as all the boilers were connected to a common header the balance of steam beyond their capacity was drawn from the remainder of the boiler installation, the piping being so arranged that it was an easy matter to switch from the new installation to the older boilers or draw from both as desired.

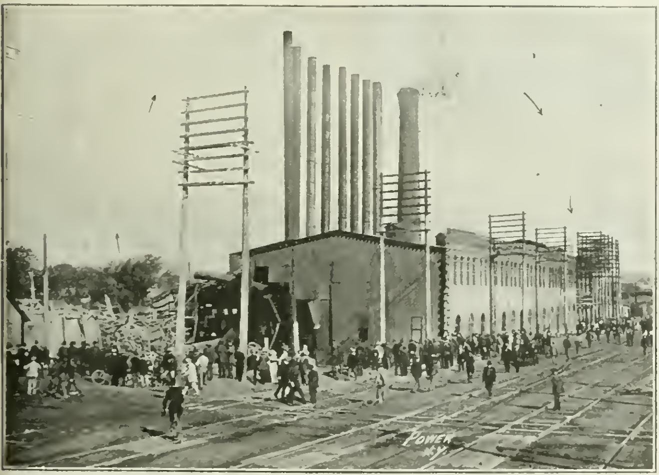


FIG. 1. ARROWS SHOW PATH OF BOILER

Boiler No. 16, that is, one of the Wickes boilers, had been out of commission for several days. Repairs were being made, but on June 15 it was ready for service, and at 3 o'clock a fire was started on the grates. At 6 o'clock one of the firemen was dispatched to throw the boiler in with the others, and at this moment the explosion occurred. The upper or steam drum, with the tubes and lower shell still attached, soared straight up into the air for a distance of 300 feet. Then careening southward for a distance of 175 feet from its foundation, the remains of the boiler dropped down through the roof of the old part of the station, landing directly on top of two generators, one a 500-kilowatt, 500-volt, direct-current belted machine and the other a 600-kilowatt, 2300-volt, alternating-current belted generator. The iron and steel girders of the roof and intervening floors in the immediate vicinity were carried away, and the gallery and railings in front of the switchboard were destroyed at the place of descent. The switchboard was not injured in any way and none of the prime movers in the engine room received damage of any note. The two generators were, of course, destroyed beyond all hope of repair.

In making its ascent the boiler careened slightly and came in contact with the second Wickes boiler, toppling it over, but not causing an explosion, although it was carrying full steam pressure. The piping in the new part of the station was bent and twisted out of all shape, but the remainder of the piping connected to the Heine boilers was left intact, and with practically all the prime movers in working condition the station was giving service on the following day.

At the time of the explosion 100 men were in the building. Three firemen were in charge of boiler No. 16. They had filled the boiler early in the day and at 3 o'clock started the fires going. At 6 o'clock two of them were apparently standing together and preparing to execute the order to connect their boiler with the others, while the third was on top of the boiler cutting it in at the time of the explosion. He was blown high in the air and fearfully mangled and scalded. From the appearance of the wreckage the two employees below were crushed to death by a piece of masonry from the foundation, weighing at least a ton, which was hurled against them when the escaping steam parted the boiler from its base.

In the engine room the employees were more fortunate. Those on the ground floor had presence of mind enough to break for the open immediately upon the sound of the explosion, and the fact that the boiler was hurled so high in the air undoubtedly saved the lives of many. A number of the men had been working in the vicinity of the switchboard. On the first report they immediately made for the door, but before they could reach it the boiler had crashed through the roof and landed almost in the identical spot where they had been working.

### Every Disaster Has Its Hero

One of their number, more courageous than the others, remained behind. His first thought was of the danger to the dynamos and the short-circuits which might easily cause their destruction. Instead of deserting his post of duty he hastily began throwing out the switches, shutting off the current all over the city. He was still at his post when the heavy boiler came crashing past him only a few feet away. A flying missile struck him on the arm, but otherwise he was unhurt.

Every disaster has its hero, but in the present case there were several. As the main steam header had been broken, the plant was being flooded with steam. There was a call for volunteers to close the valve on this main, and two, whose names are unknown, responded. The two rushed into the building, groping their way over the debris, and half blinded by the hot vapor, managed to reach the valve on the header and close it. Both men were badly burned, but not seriously.

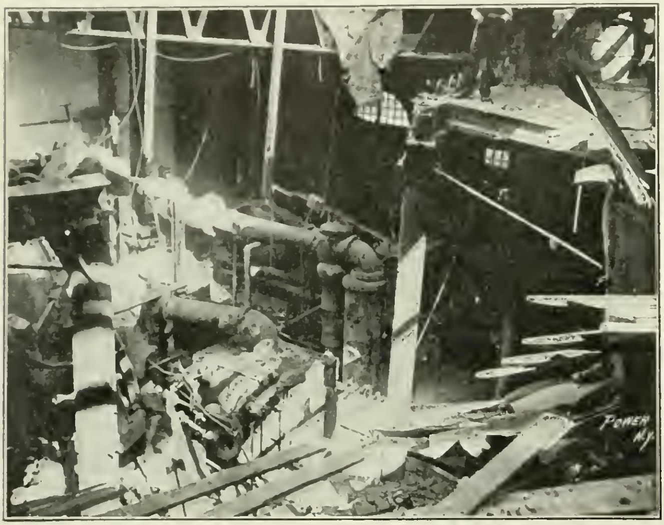


FIG. 2. DESTRUCTION IN ENGINE ROOM

Others did their utmost to aid the injured and rescue those buried in the débris.

### Possible Causes of Explosion

Less than a week before the accident William Lawless, the city boiler inspector, had given the boiler a thorough internal inspection. At the same time William H. Odett, boiler inspector for the Daly Insurance Agency, acting for the London Guarantee and Accident Company, made an exterior inspection, and in February had inspected the boiler on the interior. Neither had located any defects serious enough to advance as a cause of the boiler explosion.

N. A. Carle, of Westinghouse, Church, Kerr & Co., who was in Denver immediately after the explosion and had exceptional opportunities to investigate the disaster, has the following to say as to the cause of the explosion:

The boiler let go at the seam or rivet line of the bumped head of the lower drum, and the entire boiler, with the exception of the bottom head, was blown through the roof. After the wreckage was removed on June 17, I saw the bottom head of the lower drum as it rested on the old foundation, somewhat bent, but otherwise it accounted for all of the boilers.

Here are some of the figures in regard to the strength of the boiler and the fracture. The drums are 8 feet in diameter, and the circular seam consists of approximately 120 rivets 1 inch in diameter, spaced on $2\frac{5}{8}$ inch centers. The shell plate is $\frac{9}{16}$ inch thick and the bottom head $\frac{7}{8}$ inch. The tube sheet of the lower drum is braced by 12 crowfoot braces, each having two $1\frac{1}{4}$-inch rivets. With the exception of 28 rivets which are practically continuous, the shell plate ruptured between the rivet holes all around the drum, and this piece of shell plate is attached to the lower head with most of the rivets in the flange of the head intact.

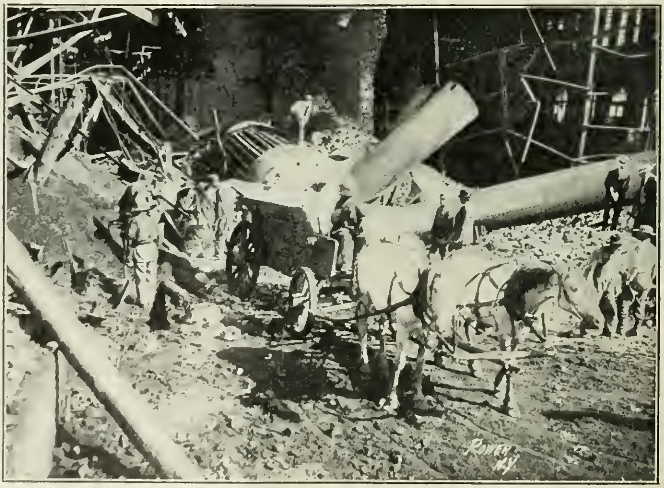


FIG. 3. SECOND WICKES BOILER WHICH WAS TOPPLED OVER AND DID NOT EXPLODE

The 28 rivets above were sheared, and at this point the shell plate shows no sign of tearing between the rivets. The tube sheet braces are intact, but every rivet has been sheared from the tube sheet without any apparent straining of the braces or the rivets in the bottom head.

The probable pressure carried was 150 pounds, and there is no signs to indicate that there had been continued low water or anything that would have burned the plate. The rupture occurred so near the bottom that it was impossible for the condition of cold water coming in contact with overheated surfaces at this point. All in all it is most unusual.

### Data

8-foot diameter at 150 pounds = 1,086,150 pounds.

120 1-inch rivets = 94.25 square inches.

24 $1\frac{1}{4}$-inch rivets = 29.45 square inches.

Tensile strength rivets = 60,000 pounds per square inch.

Tensile strength plate = 60,000 pounds per square inch.

Shearing strength rivets = 38,000 to 42,000 pounds per square inch.

Rupture of the boiler may occur:

1—Shearing 120 1-inch rivets.

2—Shearing 120 1-inch rivets and breaking 24 $1\frac{1}{4}$-inch rivets in tension.

3—Tearing the shell plate between the rivets.

4—Tearing the shell plate between the rivets and breaking twenty-four $1\frac{1}{4}$-inch rivets in tension.

The factor of safety for the above kinds of failure are:

1—3.30 to 3.64.
2—4.92 to 5.27.
3—6.06.
4—6.40.

As it is impossible to set braces under

the proper initial strain to make them act together with the rivets subject to shear, a rupture where the shell rivets are sheared will be a combination of 1 and 2, with a factor of safety between 3.30 and 5.27.

The elastic limit of the steel plate will probably allow the brace rivets to act to their full value before rupture occurs. The factor of safety for cases 3 and 4 will be between 6.06 and 6.40.

Owing to the difference between the shearing action and that of tension as regards a combination of the rivets of the shell and the braces, and the strength of the shell plate and the brace rivets, the tendency will be for a factor of safety for 1 and 2 conditions to be near the lower limit, 3.30, and for the 3 and 4 conditions to be near the upper limit, 6.40.

Rupture did occur under the 3 and 4 conditions or where the boiler was apparently strongest and the factor of safety greatest.

### Station May Not Be Restored

Service was resumed on the day following the accident, the combined capacity of the three stations and 200 horsepower obtained from the Tramway company being sufficient to supply the down-town lighting and the power absolutely necessary to the manufacturers. It is reported that the boilers and dynamos destroyed in the explosion will not be restored. Without them the station will still have sufficient capacity to light the city in case of emergency. Within a few days the substation of the Central Colorado Power Company, situated just outside the city limits, will be ready for operation and current from this source will be then turned into the mains of the Denver Gas and Electric Company. Such an arrangement would obviate the need of a local power plant, but as the Central Colorado wires come in from Glenwood along a single line of towers, it is proposed to keep the present plant in commission in case of emergency. At any rate it will be necessary for the gas company to maintain the present plant until the power plants of the Eastern Colorado Power Company, a subsidiary of the Central, are ready for use. When they have been completed, with wires carrying power to Denver from Boulder as well as Glenwood, it is probable that the plant may be completely dismantled.

## A Method of Determining Pressures for Steam Turbines

At the first summer meeting of the Society of Naval Architects and Marine Engineers, held at Detroit, June 24 to 26 inclusive, Prof. C. H. Peabody, of the Massachusetts Institute of Technology, described a method of determining the distribution of the pressures among the various stages of steam turbines, taking into account the transfer of heat between the stages due to wiredrawing, friction, etc. Were the expansion strictly adiabatic the entropy would remain the same throughout the process and the operation of dividing the pressures would be very simple. The difference between the heat contents of the steam as received by the turbine and those in the steam at the temperature of rejection in the same column of entropy upon an entropy diagram, or in such a table as that which Professor Peabody publishes, could be divided by the desired number of stages and the temperatures corresponding to the heat content of each stage could be found in the tables, the same column of entropy in the table or the same line of entropy upon the chart being constantly adhered to. But as a matter of fact only about 65 per cent. of the heat contents are transformed into work, and the rest of the heat is passed on, increasing the entropy in the next stage. Professor Peabody's paper describes a simple method for taking this into account and working successively by temperatures and by the entropy columns which contain the heat content corrected for the amount thus passed on, so as to give a series of temperatures or pressures which will divide the work equally between the stages.

## McGraw-Hill Book Company

The book departments of the McGraw Publishing Company and the Hill Publishing Company have been consolidated under the corporate name of the McGraw-Hill Book Company, with offices after July 1 at 239 West Thirty-ninth street, New York. This consolidation brings together two of the most active publishers of technical books in the country. The new company takes over the book departments of both houses, with a list of about 250 titles, both industrial and college textbooks, covering all lines of engineering. It will continue as will the retail, importing and jobbing business of the two houses.

The officers of the new company are: President, John A. Hill; vice-president, James H. McGraw; treasurer, Edward Caldwell; secretary, Martin M. Foss.

Mr. Hill is the head of the Hill Publishing Company which controls the *American Machinist*, the *Engineering and Mining Journal* and Power.

Mr. McGraw is head of the McGraw Publishing Company which issues the *Electrical World*, *Electrical Railway Journal* and the *Engineering Record*.

Mr. Caldwell has been manager of the McGraw book department for several years and Mr. Foss manager of the Hill book department.

## For Uniform Boiler Laws

J. C. McCabe, boiler inspector of the City of Detroit, recognizing the desirability of uniformity in the inspection laws and practices of the different States, has undertaken the organization of a National Association of Boiler Inspectors and invites correspondence from all who are interested in the matter. If sufficient interest develops and the idea meets with the required degree of approval, a meeting will be held at Detroit on August 10, 11 and 12 at the time that the American Boiler Manufacturers' Association is having its meeting at the same place.

Thomas Durban, of the Erie City Iron Works, brought this matter up before the National Association of Manufacturers at its recent meeting in New York and Power urged its importance in an editorial appearing in the June 1 issue. All who are interested are urged to write without further invitation to J. C. McCabe, office of the boiler inspector, Room 410, City Hall, Detroit.

## What Engineers Get in St. Louis

By J. Lockwood

There was a bunch of interesting "Help Wanted" advertisements in a recent issue of the St. Louis *Globe-Democrat* which would seem to point a moral to us poor struggling engineers. For instance, one called for a "licensed engineer, salary $1.50 per day, no Sunday work." In the same column were "ads" asking for "handy men around stable, $10-$11 a week," "potwasher and fireman, $30, room and board," "laborers for West Missouri, $1.75, free pass," "handy factory men, no experience needed, $11 to $14 a week," "man to help tend bar, $30, found."

Now, why will an intelligent human being spend years in toil, waste his "gray matter" and tissue for the munificent stipend offered in the first "ad," when he can be just as well thought of, live longer and better and earn more without the least danger of brain fever, or having hanging over him the constant dread of the holder of an engineer's license when an egotistic overlord of an inspector of boilers wields the "big stick?"

Another "ad" in the same paper reads: "Engineers' License Secured. If you do not secure a license it will cost you nothing; reasonable charges; easy payments." And the "suckers" bite at it, although the license will cost $150, and if a man succeeds in getting one, he will have to work four and a half months to pay for the license, all the while receiving less money in wages than the untrained laborer. He-haw!

Volatile matter in various coals has a wide range in heat-unit value, depending upon the carbon and hydrogen contents.

POWER
AND THE ENGINEER

DEVOTED TO THE GENERATION AND
TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

John A. Hill, Pres. and Treas. Robert McKean, Sec'y.

505 Pearl Street New York
355 Dearborn Street Chicago
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of Power solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address "Powerpub," N. Y.
Business Telegraph Code

*CIRCULATION STATEMENT*

*During 1908 we printed and circulated 1,836,000 copies of Power.*

*Our circulation for June, 1909, was (weekly and monthly) 186,000.*

*July 6 . . . . . . 42,000*

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*

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## The Law of Diminishing Returns

In many cases of the engineer's work the law of diminishing returns applies, and, as this law is an uncharted one and capable of only very general expression, its full significance is often lost sight of or learned only through failure resulting from its neglect.

Few commercial processes are perfect. Ordinary apparatus operated with ordinary care will produce a fair result. More refined apparatus and expert supervision will produce a result more nearly approaching perfection, but each added per cent. costs more and more in proportion to its worth, and the time comes when the gain is no longer worth the cost of producing it.

Nobody will deny that it is possible to burn soft coal without smoke. With an entirely practicable investment and with procurable skill in its firing a fair degree of smokelessness can be produced, and usually with ultimate economy to the plant; certainly with economy to the community when the destructive effects of the smoke are taken into account. But to remove the last vestige of smoke at critical periods would cost so much and be so commercially impracticable that smoke ordinances and those entrusted with their enforcement are usually tolerant of this departure from perfection. They recognize the law of diminishing returns.

Most any separator will take out nearly all the water in steam if it is properly proportioned to the volume passing, but to get out the last fraction of the last per cent. would cost more in separator and in loss of pressure than it would be worth.

It would be an excellent thing to have pure boiler water absolutely free from scale- and sludge-producing ingredients. It is possible to treat water so that it is nothing but pure $H_2O$ and will leave nothing behind when it is evaporated, but while greater benefits than are generally appreciated may be realized by a fair degree of purification the law of diminishing returns would come into play long before the water became chemically pure. Practice, therefore, runs all the way from making the boiler itself the purifying apparatus by injecting compounds into the feed water and blowing the precipitated sludge out through the blowoff; through open heaters with or without chemical treatment; and live-steam purifiers, to elaborate plants with automatic apparatus for mixing chemicals and with precipitating tanks and filters of large capacity. One may have any degree of purity for which he will pay and when the cost of cleaning boilers, the reduced efficiency while they are dirty, the loss of their use while they are laid off, the extra investment in spares, etc., are considered it will often pay to go a long way in this respect, but a fair degree of purity, and the use of the blowoff and occasional cleaning are within the limits of the law of diminishing returns, while absolute purity is not.

And so it goes throughout the field of engineering. There are boilers that evaporate thirteen pounds of water from and at 212 per pound of combustible, but the average engineer and owner is satisfied with less than ten. High superheat gives a greater return than low in diminished steam consumption but costs so much in other ways that even the manufacturers of superheating apparatus advise moderation.

Just where it pays to leave off trying, just where it pays to say "that is good enough," it is hard to say, even for a particular instance. Surely one should not be satisfied until he has investigated the possibilities and compared the benefits of greater efficiency with the cost of obtaining them. The tendency is to stay upon the safe side and neglect possibilities although sometimes an engineer who can see but one side of a problem at a time will forget the cost of the high efficiency for which he is straining.

## The Denver Explosion

Many of the most serious boiler explosions occur when the boiler has been laid off for a time and is being cut in. Of such was the explosion at Denver, described in another column. A 400-horsepower Wickes boiler which had been out of use for some days was being put back into service. A fire was started under it at three o'clock and at six, with a pressure as given by one of our correspondents twenty-five pounds in excess of that in the main, the valve was opened wide and the boiler went through the roof.

The Wickes boiler, it will be remembered, consists of two drums, the flat ends of which are connected by tubes which stand vertically when the boiler is in the setting. The other ends of the drums are bumped and the tubes and lower drum stand full of water. When this form of boiler was first proposed there was considerable discussion regarding the distribution of stresses in the tubes due to the tendency of the tube sheets to deflect under internal pressure, putting the middle tubes into compression, with a corresponding increase of the pull upon those at the edges. The completeness with which this suggested weakness has been overcome by internal bracing is evidenced by the fact that in this, the first disastrous failure of a boiler of this type that we have been called upon to report, the rupture took place at quite another point, and the tubes remained in position and held the boiler intact throughout its initial shock, flight and impact. Further, a boiler of the same type which stood alongside that which exploded was knocked off from its setting and extended at full length upon the débris without parting at the tube sheets or elsewhere.

The manner of failure of the boiler was most peculiar. One would not expect a horizontal tubular boiler to fail in the riveted joint connecting the shell with the head. These roundabout seams have only one-half the stress upon them per unit of section that the longitudinal seam has, and even when single-riveted are stronger than the seams joining the plate lengthwise of the boiler. It is inexplicable why this boiler should have failed where it was apparently the strongest, where, as Mr. Carle shows in our account of the accident, it had the largest factor of safety.

The presumption is that something was done to the boiler in the act of getting it into commission which brought an enormously exaggerated stress upon this portion of the sheet. The boiler had been recently inspected by both the State Inspector and the inspector for the company by which it was insured. The State Inspector says that the steel showed no signs of crystallization, and the fact that the rupture was divided between plate and rivets would indicate that the steel were of the strength allowed to it when the joint was calculated, unless deterioration, if such there were, was localized. An examination of the fracture for reduction of area and crystallization will throw much light upon this phase of the question.

In the meantime, here is a boiler amply strong by every test and rule for the pressure to which it was subjected, built by a firm whose name is a guarantee for all that is best in design, material and workmanship, which breaks where it ought not to break from steadily applied internal pressure, not in regular service but while being cut in after a period of idleness. The Colburn-Lawson theory of the swelling of the liquid contents by the instantaneous generation of steam throughout its mass under the reduced pressure and the rupture from the liquid impact has been invoked. The possibility of an initial external explosion has been suggested. The furnace of this boiler mulling from the middle of the afternoon until the time of the explosion, with closed dampers would make an excellent gas producer. The opening up of the furnace when word was given to put the boiler in would have touched off any accumulation of gas in the setting and while the energy so generated would be unsufficient to project the boiler through the roof it would be enough to lift it from its setting and drop it again with force enough to bring an excessive and destructive stress upon the lower head.

All this, however, is speculative and profitless. We hope in a later issue to present some photographs and measurements of the fracture with some of the results of test pieces cut from the sheet which parted and additional particulars of the accident.

## The Right to Be

Someone once said that "many men are valuable not for what they do, but for what they are." While this is unquestionably true, an analysis will usually, if not always, show that those whose value is measured by what they are have demonstrated that they became what they are by their ability to do. What they did and the way it was done proved their titles to be classed with those who are instead of with those who only do.

In the middle of a very busy time the gasket under a four-inch pipe flange blew out. The fire was drawn, the boiler allowed to cool, and a new gasket put in. A new fire was built, and as the steam pressure crawled upward toward the working point, the men began to get ready for work; but just as the engineer was about to open the throttle, with a sharp hiss followed by a bang, the new gasket let go. With maledictions both blunt and pointed on the part of those who had participated in the work of putting in the gasket which failed, the fire was drawn and the entire performance repeated, and with the same final result, and then once more.

Discouraged and disheartened, weary and supperless, the engineer confessed his defeat and suggested that perhaps some other engineer might have better luck, if called upon for consultation or advice. At the central station there was a man who had never had any bad luck with gaskets, hot boxes or broken follower bolts, and who had the reputation of being a good engineer. He it was who was sought, routed out of bed, and got to the plant. Here he was asked to take charge of the job of putting in a new gasket and one that would stay.

After hearing the story, the man from the central station made an examination. He found the surface of the flange and the boiler head in good shape, and the gasket material of good quality. Then the studs in the boiler head which passed upward through the flange on the end of the pipe were examined. On one of the studs the threads were bright and slightly deformed as though a nut which did not fit had been used. Such proved to be the case. One of the nuts would not screw easily onto any of the studs, while all of the other nuts would run on all of the studs except the one that appeared damaged. Here was the seat of the trouble. The nut on the damaged stud went hard, and the power put on the wrench was expended in overcoming friction instead of producing pressure on the flange, and this lack of pressure allowed the gasket to fail.

A split screw-cutting die of the proper pitch and a new nut were found, and with the die held in a pattern maker's clamp, it was run up and down on the stud until any and all of the nuts could be screwed up and down with the fingers. With a new gasket the parts were assembled, and as steam was raised the joint was "followed up" by one of the helpers. Steam was raised and the joint held; pressure was increased until the blowing of the safety valve told that the limit of pressure had been reached, but the joint held, and it is certain that two years afterward it was still holding.

The man from the central station was its chief engineer, and was one of those who are paid for being rather than for doing, for at the station he seldom or never did anything; packing, joint making, keying and indicating being attended to by subordinates.

But the fundamental difference between the two men lay in something deeper than the manual skill necessary to cut gaskets or turn nuts on flange-bolts. There was a failure where failure was not expected. One simply repeated the process that made failure possible, the other sought and found the cause of failure before taking even the first step in the making of the joint. It was a simple matter but, like all other problems that come to the man who operates a steam plant, it required the exercise of plain common sense. There was an effect that must have had a cause; the cause found and removed, the effect disappeared. The man who sought, found and removed the cause did nothing wonderful, but he showed that he could do and by his ability to do proved his right to be.

## Contemptible if True

Is it true that large central-station "interests" have threatened to withdraw their patronage from manufacturers who advertise in *The Isolated Plant* unless the advertising is discontinued, and for no other reason? It is hard to believe that prominent business men would stoop to such petty methods; yet the assertion is made in the June number of the little magazine devoted to private plants that its advertisers have been threatened and that one has been intimidated to the extent of canceling his contract.

Users of machinery or other commodities have a perfect right to buy where they choose, and, quality and service being equal, they naturally buy from dealers and makers who are most friendly or inclined to serve their interests in other ways than by meeting specifications and guarantees. But to cut off business relations which have been perfectly satisfactory for no other reason than the one mentioned would be an incredibly dirty and contemptible procedure of which we cannot believe representative central-station managers would be guilty. There must be a mistake somewhere; certainly the central-station men whom we know are not built on any such lines.

## The Low-pressure Turbine in Marine Service

A few issues back a short note was published on the trial trip of the "Laurentic" and information more in detail is now available from *Engineering*. The "Laurentic" was designed for the Canadian trade to run between Liverpool and Montreal and made her first trip during the latter part of April. She is the first Atlantic liner to be fitted with a combination of reciprocating and turbine machinery and is also notable from the fact that she inaugurates the White Star service to Canada, besides being larger than any other ship in the Canadian service. Her length is 505 feet 6 inches over all; beam, 67 feet 3 inches, and depth, molded, 45 feet 6 inches. The registered tonnage is about 15,000 tons and the displacement at service draft about 20,000 tons. The ship has a passenger-carrying capacity of 260 first-class, 430 second-class and 1000 third-class.

A sister ship, the "Megantic," differing only in the machinery installed, has also been built for the same service. The latter vessel left Liverpool on her maiden trip to Montreal on June 17, and there will soon be available accurate comparative data of the performances of the two different types of machinery, the "Megantic" being equipped with reciprocating engines only. The data will be all the more interesting as the results obtained will be utilized in selecting and proportioning the machinery of the two immense White Star liners, "Olympic" and "Titanic," now being built at Belfast. These vessels will be put in commission about 1911 and will register about 45,000 gross tons, with machinery of nearly 50,000 horsepower capacity to give a speed of 21 knots.

In both the "Megantic" and "Laurentic" six double-ended steam generators have been installed for a working pressure of 215 pounds. The allowance in heating surface is in accordance with the usual White Star practice, about 2½ square feet per horsepower, while the ratio of heating surface to grate area is 37 or 38 to 1. In the "Laurentic" the two reciprocating engines are of the triple-expansion type with four cylinders, 30x46x53x53x54-inch stroke, to insure perfect balance. The general design follows Harland and Wolff's practice, with single columns, which gives an open engine.

The low-pressure turbine of Parsons' latest type is in the center of the ship and abaft the main engines, with one condenser on each side, while the auxiliary machinery is arranged in the wings. The exhaust pipes from the two low pressure cylinders, which are at the extreme ends of each engine, are led with the usual expansion, or bellow, joint to the forward end of the turbine. On each pipe there is a double-beat valve, operated each by a separate high-pressure engine secured to the after bulkhead in the engine room, and controlled by levers at the reciprocating-engine starting platforms. These engines and valves can be worked independently, but are normally connected and worked simultaneously.

For all maneuvering, the turbine will be thrown out of action, that is, when the telegraph indicates "stand by," the double-beat valve will pass steam to the condenser and the ship will maneuver as a twin-screw steamer. The benefit in having an independent valve is that should one of the engines break down two propellers will be available for driving the ship, one rotated by the reciprocating engine in service and the other by the turbines. There is thus the advantage that with one engine out of use two-thirds of the total power would be available instead of one-half, as in an ordinary twin-screw ship, so that the reduction in speed would be considerably less. The trial-trip results showed the possibility of this maintenance of high power with one engine out of service, as the low-pressure turbine developed 4600 horsepower out of a total of 12,400 horsepower. The exhaust pressure from the reciprocating engine, and therefore the initial pressure in the turbine, was about 18 pounds absolute. The speed obtained exceeded the 16 knots anticipated by the design, and the main engines operated at 83 revolutions per minute, while the turbine made 220 revolutions.

The turbine gives 28-shaft horsepower per ton. The thrust bearing is at the forward end, with the forward main bearings between this thrust and the rotor, and the after bearing abaft the rotor. The blading is arranged for six expansions, the lengths being from 6 inches to about 10 inches, while the average clearance is about ⅛ inch. There is the usual arrangement for adjustments, and the bearings are lubricated by gravity, with two standby oil pumps. The shaft bearings are also water cooled, and in order to obviate any matter passing over with the steam to the turbines, strainers have been fitted in the steam pipes.

In the "Megantic," which is twin-screw, the engines are of the quadruple-expansion type, the cylinders being 29x41½x61x87x60-inch stroke, which proportions give a very satisfactory range of expansion. The condensers form part of the framing, and the air and circulating pumps are placed contiguous to the condenser. The auxiliary machinery in both ships is of the most comprehensive type.

While it is too early to speak with confidence as to the measure of economy obtainable under service conditions in the "Laurentic," the full power trials, although of short duration, gave highly efficient results. The water consumption for the main engines was appreciably under 13 pounds per horsepower per hour, as compared to 16 pounds required by the average Atlantic liner with triple-expansion engines. The rate of evaporation in the boilers was eight pounds per pound of Welch coal and slightly less with Yorkshire coal. It must be considered, however, that the weight of engines and space occupied are greater when the turbine supplements the reciprocating engine, but the reduction in steam consumption justifies less boiler power and less coal in the bunkers, so that on a balance the weight may be about the same. The system is especially applicable to vessels of less than 18 knots speed, in which neither weight nor space is of such importance as in high-speed ships. Primarily the question of engine-turbine combination is one of economy, and the comparative data obtained from the two sister ships should prove of exceptional interest.

## California N. A. S. E. Convention

The sixth annual convention of the California State Association, N. A. S. E., was held at the Auditorium, San Francisco, during the week ending June 19. In connection with the convention was held a "Mechanics' Fair," as the supplymen's exhibit was called. The convention was the most successful held in the State, and it was honored by the presence of National President Fred J. Fischer. Mr. Fischer did not arrive in time to open the convention, however, and that duty was performed by State President Harry D. Saville, who delivered the address of welcome.

After prayer by the Rev. William Rader, the chairman of the convention committee, P. L. Ennor, introduced Mayor Edward R. Taylor, who welcomed the delegates to the city. The attendance was large, and the convention, the fair and the entertainment features were thoroughly appreciated.

## Indiana N. A. S. E. Convention

The convention of the Indiana State Association, N. A. S. E., which was held at Evansville, June 18, 19 and 20, was pronounced an unqualified success, both as regards the business sessions and the entertainment features. The supplymen were quite pleased, also, their exhibit being well attended throughout.

The usual order of business was transacted at the morning sessions, including the election of the following officers: Past president, George O. Harris, Evansville; president, William Pierce, Terre Haute; vice-president, W. E. Smith, Terre Haute; secretary, Charles Streithof, Evansville; treasurer, F. P. Ohmer, South Bend; conductor, M. J. Jungling, Evansville; doorkeeper, H. E. Waters, Hartford City. The new officers were installed by Past President James C. Carter.

OFFICERS OF INDIANA STATE ASSOCIATION N. A. S. E.

The entertainment features included visits to the power plants of the large breweries in Evansville, a banquet at Mayer's pavilion and a Sunday outing at West Heights park, whither the visitors went as guests of Evansville No. 7.

There were some very excellent exhibits and several of the supplymen went away with orders enough to convince them that Evansville is a good convention town. The firms represented included the Lunkenheimer Company, H. W. Johns-Manville Company, Keystone Lubricating Company, Louisville Roofing and Supply Company, Jenkins Brothers, Dearborn Drug and Chemical Works, Brownell Company, Crandall Packing Company, Piley Packing and Flue Brush Company, Dodge Manufacturing Company, Garlock Packing Company, V. D. Anderson Company, Ajax Valve Company.

South Bend was chosen for next year's meeting.

## Wisconsin State Convention N. A. S. E.

Favorable weather aided in making this year's annual meeting of the Wisconsin State N. A. S. E. the success which all had anticipated and which was to be expected from the clean little city of La Crosse.

A. A. Schroeder, chairman of the local committee, opened the meeting in the city hall, June 18, and introduced City Attorney John F. Doherty, who welcomed the visitors in behalf of the mayor. F. W.

DELEGATES TO INDIANA N. A. S. E. CONVENTION AT EVANSVILLE, JUNE 18-20, 1909

Raven, national secretary, of Chicago, presented, and in speaking of association affairs in the State hoped that some progress would be made toward the establishment of an engineer's license law.

Charles Oswald, State president, was then introduced and took charge of the meeting, appointing the various committees necessary in the regular order of business. Twelve delegates were found qualified to sit in the meetings, representatives being present from Milwaukee, Oshkosh, Madison, Stevens Point, Ashland, Green Bay, La Crosse and Racine.

In the afternoon Samuel Furst spoke on "Illumination and High-efficiency Lamps." After explaining the process of manufacture of the carbon-filament lamp, the matter of tungsten lamps was taken up and many points of interest were brought out regarding this method of illumination. Mr. Furst's talk was clear and concise, and to show appreciation of his efforts a rising vote of thanks was extended to him.

E. P. Gould then read a paper on the "Relation of the Supply Man to the Engineer," calling attention to the benefits the engineer may derive by friendly relations with the mechanical salesman who in traveling through the country gathers a kind of knowledge which he is always glad to share with an interested engineer.

An honored guest at the meeting was William Glynn, of Lansing, Wis., founder of the State association, and one of its most respected members. Mr. Glynn spoke briefly of his pleasure in marking the progress made among the engineers in educational work since the old days.

The per capita tax was raised to thirty cents, and a committee was appointed to get bids from various cities for the next meeting. For the ensuing year the officers chosen were Alfred Balzer, of Sheboygan, president; A. A. Schroeder, La Crosse, vice-president; H. W. Ziebell, Oshkosh, secretary, and Fred Ruck, Milwaukee, (reelected) treasurer.

A dance at Elks hall was one of the leading social events and was thoroughly enjoyed by all, as was also the Dutch lunch furnished by the local committee. Saturday evening a launch ride to Dakota park was on the program, with fireworks and orchestra furnished by the supplymen, and as a wind up to the hospitalities there was a steamboat excursion up the Mississippi river to Winona Sunday morning. Altogether La Crosse lived up to its reputation for entertaining, and those who attended the convention expressed freely the hope that it would not be the last time the city would welcome the State body.

DELEGATES, VISITORS AND LADIES AT LA CROSSE CONVENTION

## Connecticut N. A. S. E. Convention

The annual convention of the Connecticut State Association of the National Association of Stationary Engineers was held in Hibernian hall, Waterbury, Conn., on June 25 and 26.

On Friday evening, the meeting was called to order by W. J. Blacker, treasurer of the local association, who after a brief address introduced the chairman of the local committee, W. E. Crane, who made the address of welcome. The first speaker introduced by the chairman was L. L. Willard, representing the Allis-Chalmers Company. The "Low-pressure Steam Turbine" was his topic and a number of lantern slide illustrations were presented.

C. D. Osborn, State secretary, was the next speaker, and he was followed by Past National President P. H. Hogan, who gave a most interesting address on the importance of State associations. Mr. Hogan looked forward to the time when the delegates to the National convention would be chosen from the State associations instead of from the local organizations, as is now done.

Jack Armour, of Power and The Engineer, entertained with recitals and stories, after which the meeting adjourned until 9 o'clock the next morning. At this session, the several committees were appointed and the regular business of the convention was dispensed with. The following officers were elected: George Cleveland, president; C. H. Ostrander, vice-president; Henry Vandeberg, secretary-treasurer; John Gaffney, conductor; F. S. Chapman, doorkeeper; G. P. Thomas, George Cleveland, P. J. Grace, trustees. The officers were installed by P. H. Hogan assisted by Thomas Burke.

In the line of entertainment, the feature was a clambake at Reidville, which was heartily enjoyed, as were also the trolley rides to points of interest in Waterbury.

DELEGATES AND SUPPLY MEN AT WATERBURY

A large room in the local association hall was tastefully fitted up for the use of the supplymen, and the following firms were on exhibition: Jenkins Brothers, Ashton Valve Company, Donegan & Swift, Lake Erie Boiler Compound Company, Garlock Packing Company, William R. Winn & Co., Home Rubber Company, McLeod & Henry Company, Connecticut Metal Boiler Company, Heine Boiler Company; Dearborn Drug and Chemical Works, Cochran Feed Water Company, M. T. Davidson, Improved Steam Pump Company, Quaker City Rubber Company, Harris Oil Company, Perfection Grate Company and Power and The Engineer.

On the local committee were H. B. Moore, Paul Duprey, E. R. Snagg and M. J. Hannon. The next meeting of the State association will be held in New Haven.

## A Brake Horsepower-hour on Less than One Pound of Coal

This remarkable good record was made by the gas engine and producer recently put on the market by the New York Engine Company. The engine showing this economy is rated at 56 brake horsepower, which is 85 per cent. of the maximum possible output at catalog speeds. It is a single-cylinder engine, 15x21 inches, and runs at 235 revolutions per minute.

The appended "log sheet" taken at random shows that the consumption of nut coal falls below 1 pound per brake horsepower-hour whenever the load rises above 56 brake horsepower. The compression is high, being about 190 pounds gage pressure, and the explosive pressure rises as high as 500 pounds. The tests were made with a 50-kilowatt generator loaded with a water rheostat, taking voltmeter and ammeter readings 10 minutes apart throughout each test.

LOG SHEET OF SEVERAL DAYS' RUN.

| Date, May, 1909. | Total Coal Used Includ. Starting, Lb. | Hours Run. | Average Brake Horsepower. | Average Coal per B.H.P. per Hour, Lb. | Weight of Ash, Lb. | Percentage Ash. |
|---|---|---|---|---|---|---|
| 7 | 570 37 | 9¾ | 54 66 | 1.07 | 130 | 22 80 |
| 8 | 592 00 | 10½ | 57 20 | 0.98 | 137 | 23 15 |
| 11 | 580 00 | 10 | 66 20 | 0.876 | 140 | 24 12 |
| 14 | 498 00 | 8½ | 53 80 | 1 08 | 95 | 19 00 |
| 15 | 525 00 | 9 | 61 96 | 0 94 | 102 | 19 00 |
| 18 | 580 00 | 10 | 65.78 | 0 88 | 145 | 25 00 |
| 21 | 550 00 | 10 | 60.13 | 0 90 | 110 | 20 00 |

## National Boiler Inspection Movement

The movement, recently inaugurated, looking toward the organization of a National Association of State and Municipal Boiler Inspectors or Inspection Departments, attention to which was called in this number, is meeting with marked favor; and it is expected that a call will soon be issued for a meeting of those interested, to be held at Detroit, Mich., at the time of the American Boiler Manufacturers' Association convention, August 10, 11 and 12.

The trial for obtaining money under false pretences of John E. Carroll, the alleged inventor of the $CO_2$ motor, for the exposure of whom the editor of Power was prosecuted for criminal libel by the Commonwealth of Pennsylvania, has been postponed until some time in September.

## Personal

W. J. Collins took charge of the mechanical and power departments of the Manomet Mills, New Bedford, Mass., on June 1.

## Obituary

William P. Lundy, chief engineer of the Majestic building, Chicago, Ill., died June 18 last, of heart failure. He was 60 years old, and had been engineer of several of the largest office buildings in Chicago.

## Business Items

Ernest Schmatolla, consulting engineer, of London and Berlin, has established a New York office at 150 Nassau street.

A contract was recently placed by the Potlatch Lumber Company for a 600-kilowatt Westinghouse exhaust-steam turbine to be installed in the company's central power plant at Potlatch, Idaho. There are at present located in this plant one rope-driven Corliss engine and a 100-kilowatt, high-speed triple engine driving a generator. The low-pressure turbine will take steam at about 15 pounds absolute from both of these units. The equipment ordered also includes a Westinghouse Leblanc condenser designed for carrying a 28-inch vacuum.

The business of the Foos Gas Engine Company, of Springfield, Ohio, during May was reported to be larger by considerable than that of the same month of any previous year. April showed the largest business ever done by the company in a single month, and the first five months of the present year show a greater business than has ever been done by the company in the same period. They are adding to their facilities, anticipating a still larger increase in business. This plant, which is the largest exclusively devoted to the gas-engine business, is being worked to its fullest capacity fourteen hours per day. The latest Foos catalog is "K."

The Wisconsin Engine Company, of Corliss, Wis., reports a volume of business for the last two months equal to that of good times two years ago. Orders include three 800-horsepower complete-expansion gas engines for the Lumbermen's Portland Cement Company. Each engine will be direct-connected to a 500-kilowatt alternator and the machines will operate in parallel. The engines are of the horizontal single-tandem double-acting type, and the use of the complete-expansion principle reduces the exhaust pressure and temperature of the gases to an unusually low point, thus getting better working conditions and about 20 per cent. more power out of the same amount of gas.

The Dearborn Drug and Chemical Works, of Chicago, has just issued an illustrated booklet of 44 pages, 4x9 inches, entitled "Lubrication versus Friction." It treats chiefly of the following: Object of Lubrication, Kinds of Lubricant, Sources of Lubricant, Methods of Distillation and Refining, Steam Cylinder Lubrication, Engine and Dynamo Lubrication (including Gas Engines), Semi-Solid Lubricants, Greases, Physical Properties of Lubricants, Gravity or Density, Fire and Friction Tests, Viscosity, Chemical Examination of Lubricants, Selection of Lubricants. There is also a table showing the comparative differences in the physical properties and market prices of some of the well-known crude petroleums of the United States. It will be sent to anyone interested upon application.

The largest pressure regulator ever made was recently shipped by the G. M. Davis Regulator Company to the General Fire Extinguisher Company, of New Orleans, to be installed in the service of the new municipal water system of the city of New Orleans. The size of the regulator was 30 inches and it was designed to reduce a variable initial water pressure of from 55 to 80 pounds to a uniform reduced pressure of 25 or 30 pounds, and to deliver twenty million gallons of water per day. The valve was installed in a connection between the new high-pressure mains and the old piping and passes at a reduced pressure the filtered water from the filtration plant into the old mains. It was essential that a well-made, simple and reliable valve be furnished on account of its importance. Mr. Davis designed this valve to have no springs, exterior toggles ner diaphragm. A large piston controls the movement of the main inner valve, which is of the double-disk pattern. This piston is actuated by differential pressures of water brought to bear on the one side by communication with the low-pressure side of the regulator, and on the other by water pressure supplied at the desired pressure by an auxiliary reducing valve. The present normal demand through the valve is about 13,000,000 gallons a day, with a maximum demand of 15,000,000 gallons during the busy hours. The valve has a capacity of 30,000,000 gallons a day.

## New Equipment

Gotfredson Bros., Green Bay, Wis., will erect a central heating plant.

Mercy hospital, Springfield, Mass., will erect a new power plant.

F. C. Drischac & Co. will erect an electric-light plant at Mattoon, Wis.

The Interstate Light and Power Company will erect a large power plant at Galena, Ill.

The Victor Talking Machine Company, Camden, N. J., is erecting a new boiler house.

The Lowell Manufacturing Company, Erie, Penn., is building a new power house.

The John Walters Brewing Company, Eau Claire, Wis., will build a new bottling plant.

The Layton Packing Company, Milwaukee, Wis., is enlarging its refrigerating and power plant.

The Gugler Litho Company, Milwaukee, Wis., is installing a new power-plant equipment.

The E. J. Balza Company, Green Bay, Wis., will erect a pickle factory at Seymour, Wis.

The Crookson Pure Food Company, Crookston, Minn., will erect a new factory and cold-storage plant.

John Theime, of the Oastburg (Wis.) Evaporized Milk Company, will build a new $15,000 factory.

The Downer College, Milwaukee, Wis., will install additional boiler, engine and other equipment.

The Keystone Leather Company, Camden, N. J., will install a new engine and boiler in its power plant.

The Public Service Corporation of New Jersey will install a new engine and boilers in its Camden, N. J., power plant.

The Leinkugel Brewing Company, Chippewa Falls, Wis., will boild a bottling house and several other buildings.

The American Ice Company, Philadelphia, Penn., has let contract for the construction of an ice-manufacturing plant.

The Chippewa Falls (Wis.) Woolen Company will boild a new two-story mill and also a two-story addition to the boiler room.

The Orono (Me.) Pulp and Paper Company is building an addition to be used as a boiler room. New boilers will be installed.

The J. Buerger Malting Company, Fond du Lac, Wis., contemplate erecting a plant at Lomira, Wis., to cost about $10,000.

Plans are being prepared for the erection of a two-story cooling house at the plant of the Danahy Packing Company, Buffalo, N. Y.

The Joseph Campbell Company, Camden, N. J., is building two additions to its main plant; also a new power plant to be equipped with a refrigerating system.

The city of Wheeling, W. Va., will increase the capacity of its pumping plant. Specifications are now ready. R. J. Commer, Pittsburg, Penn., is engineer of construction.

J. N. Oswald, general manager of the Rapid River Light, Power and Transit Company, Rapid City, S. D., would like to hear from manufacturers of equipment and supplies for a new power plant.

An American consul in the Far East reports that an electric-light and power plant will be constructed in his district within two years to cost $500,000. Copy of report can be obtained from the Bureau of Manufacturers, Department of Commerce and Labor, Washington, D. C.

## New Catalogs

Hart-Parr Company, Charles City, Iowa. Catalog. Traction engines. Illustrated, 48 pages, 6x9 inches.

Kerr Turbine Company, Wellsville, N. Y. Bulletin No. 8. Steam Turbines. Illustrated, 20 pages, 6x9 inches.

Fort Wayne Electric Works, Fort Wayne, Ind. Bulletin No. 1114. Fan motors. Illustrated, 24 pages, 8x10½ inches.

The Weber Company, Marquette building, Chicago, Ill. Pamphlet. Review of Concrete Chimneys. 24 pages, 6x9 inches.

Fox Machine Company, Grand Rapids, Mich. Catalog No. 92. Tube or pipe cutters. Illustrated, 12 pages, 6x9 inches.

J. A. and W. Bird & Co., Boston, Mass. Booklet. Belt Talks. Bird's bull's eye belting. Illustrated, 98 pages, 3½x7 inches.

The Strong Machinery and Supply Company, 48 Franklin street, New York. Catalog. Motive power specialties. Illustrated, 256 pages, 6x9 inches.

Grönkvist Drill Chuck Company, 18 Morris street, Jersey City, N. J. Catalog. Johansson combination standard gages. Illustrated, 28 pages, 9x11 inches.

Gould Storage Battery Company, 341 Fifth avenue, New York. Pamphlet. Gould storage battery in isolated lighting plants. Illustrated, 36 pages, 6x9 inches.

McNab & Harlin Manufacturing Company, 50 Church street, New York. Catalog. Valves, cocks, brass and cast-iron fittings, etc. Illustrated, 284 pages, 5x7 inches.

Nargil Manufacturing Company, Utica, N. Y. Catalog. Nargil vacuum mufflers for automobiles, marine and stationary engines. Illustrated, 8 pages, 3½x6 inches.

Montgomery & Company, 105 Fulton street, New York. Catalog No. 28. The Tool Monger. Tools, supplies and machinery. Illustrated, 288 pages, 4x6¼ inches.

George H. Thacher & Co., Albany, N. Y. Catalog G. Coe shaking and dumping grates. Illustrated, 6x9 inches. Catalog. Coe improved combustion and draft system. Illustrated, 6½x10 inches.

B. F. Sturtevant Company, Hyde Park, Mass. Bulletin No. 161. Economizers in Power Plants of Textile Mills. Illustrated, 16 pages, 6½x9 inches. Bulletin No. 163. Economizers in Power Plants of Steel Mills. Illustrated, 16 pages, 6½x9 inches.

# Coal: What It Is and How It Was First Burned

## Interesting Discussion of a Subject of Vital Import; Early Experiences with Anthracite Coal; Unmined Coal in the United States

BY WARREN O. ROGERS

What is coal? Of what was it formed, and how? These are three interesting questions and form the topic of this article.

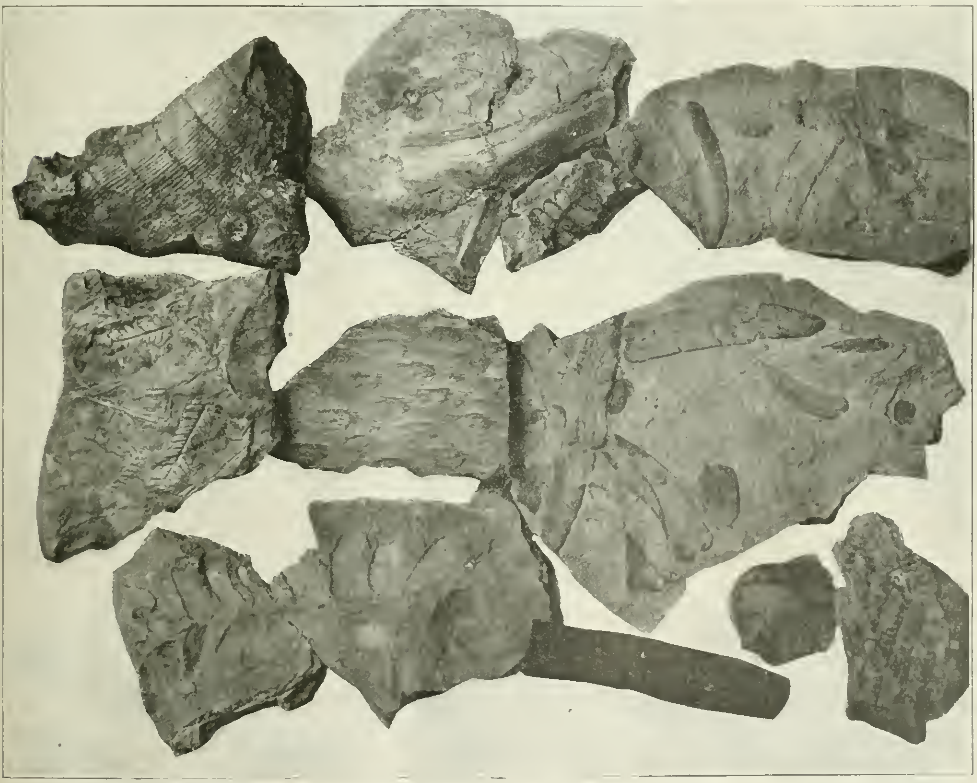


FIG. 1. COLLECTION OF SEVERAL SPECIMENS OF VEGETABLE MATTER, LEAVES, ETC., FOUND IN LIMESTONE FORMATION

The theory that coal originated from vegetation of dense forests and thick swamp growths, is generally accepted, but is not wholly satisfactory. Many persons believe that large swamps or marshes covered the area now occupied by coal seams and that some time this area sank below the water level and mud and sand covered the vegetable deposit, which, hardening, formed solid beds of shale, sandstone, etc., and these in time accumulated and filled up the shallow beds in which they were deposited. Then a new growth of dense marsh vegetation was submerged, more mud and sand were deposited and the cycle of transformations was repeated over and over.

The other, and perhaps less tenable, theory is that the swamps and forests grew somewhere else, and large masses of decomposed vegetation were transported by water and deposited where it is now found in the character of coal.

It is an open question whether coal is being formed at the present day from the peat bog, but there are indications that in time the peat bogs will become beds of coal, as they contain many of the elements found in coal seams. For instance, live plants are found growing on the surface, forms of plants are still visible lower down, while the bottom portion is compact and little, if any, vegetable structure can be distinguished; and as the depth of the mass increases the quantity of carbon increases. If coal is the result of solidification, it is evident that thousands of years must elapse between the first vegetable growth and the time the coal is fit to mine. This assumption is based upon the estimation that the rate of growth of a peat bog, which varies considerably, does not exceed 20 inches in a century.

Lignite forms a connecting link between peat and bituminous coal and contains in an advanced state of decomposition fragments of leaves, bark and tissues of vegetable matter. Peat has a woody texture, is very smoky and varies in color from brown to black.

Next in the process of solidification is bituminous or soft coal. In fact, the graduation from the one to the other is almost imperceptible. When bituminous coal comes in contact with intrusive igneous material, such as rock, the characteristics of which indicate that it has been discharged from a volcano, anthracite is the result. This is but local, however, and the indications are that the earth's pressure is responsible for a certain amount of anthracitation; but, as in other forms of coal, the original composition must necessarily be taken into account. Thus, anthracite is the result of the alteration of bituminous coal under heat and pressure. This is evident in the coalfields of Pennsylvania, where numerous deposits of this class of coal are found; that is, seams where bituminous coal predominates often terminate with anthracite.

### Fossils

When coal is in the carboniferous state, fossils of various nature are very numerous, consisting chiefly of the remains of plants, while fresh-water shells have been found in some districts. Frequently the fossil formation is shown merely by the impression of the outer surfaces of the remains of plants or animals formed by the mold in which they lay. In rare instances fossils have been found in a state of petrifaction, retaining their original structure more or less perfectly.

In the shale associated with coal seams are found at times abundance of plant remains and frequently various forms of animal life. This applies to the layers of shale overlying coal seams. These fossil plants are accounted for by the supposition that at the time of the formation of the seam of coal, when large tracts of forests and country were partly, or totally submerged, the sea water—containing a large amount of lime, silica, etc., in solution—formed small lakes, swamps or lagoons which were joined by small streams of water. The water would naturally gather vegetable matter which becoming coated with earth, petrified. As these petrified plants, etc., are usually found embedded in or taking the place of coal, it would indicate that they have been deposited in the streams cut through the decaying vegetable matter which eventually became a seam of coal.

FIG. 2. REPRODUCED PHOTOGRAPH OF TREE TRUNK FOUND 650 FEET UNDERGROUND

In Fig. 1 is shown a collection of specimens of vegetable matter, leaves, etc., usually found in limestone formation. Fig. 2 is a photograph taken by the writer, showing a tree trunk, 650 feet below the surface. It is embedded in the slate formation, and was found in No. 4 mine of the Kingston Coal Company, Kingston, Penn. How it got to such a depth affords material for conjecture.

From statistics, it is evident that the vast coalfields of the world were formed during the carboniferous age, the age of plants and dense vegetable growth. At the close of this age there were tremendous upheavals and disturbances of the earth's crust and in the final convulsion the coal beds were thrown comparatively near the surface of the earth.

### Coal Seams

In Fig. 3 are shown coal seams illustrating some of the formations found in an anthracite mine. Two of the seams of coal terminate at the earth's surface and are known as outcrops. If this occurs on the slope of a hill, the line of outcrop may frequently be traced for some distance.

When the pressure has been too great, or applied suddenly, or the rock formation has refused to give, and broke instead of bending, a segment is thrown out of level, one side being higher than the other. This is known as a fault, and is shown at the left of Fig. 3; there are several kinds of faults. At the left of Fig. 3 is also shown a roll, which consists of a mass of rock taking the place of coal, and is said to be due to the coal seam being deposited on an uneven surface. A swelly,

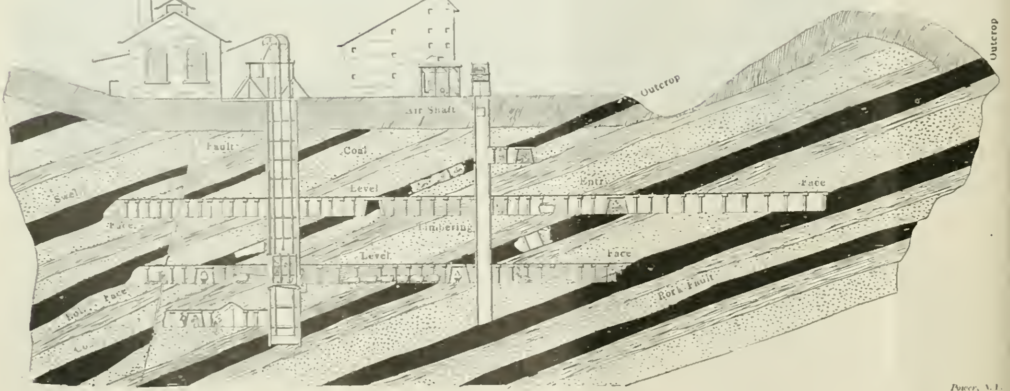


FIG. 3. SHOWING THE FORMATION OF COAL SEAMS IN AN ANTHRACITE MINE

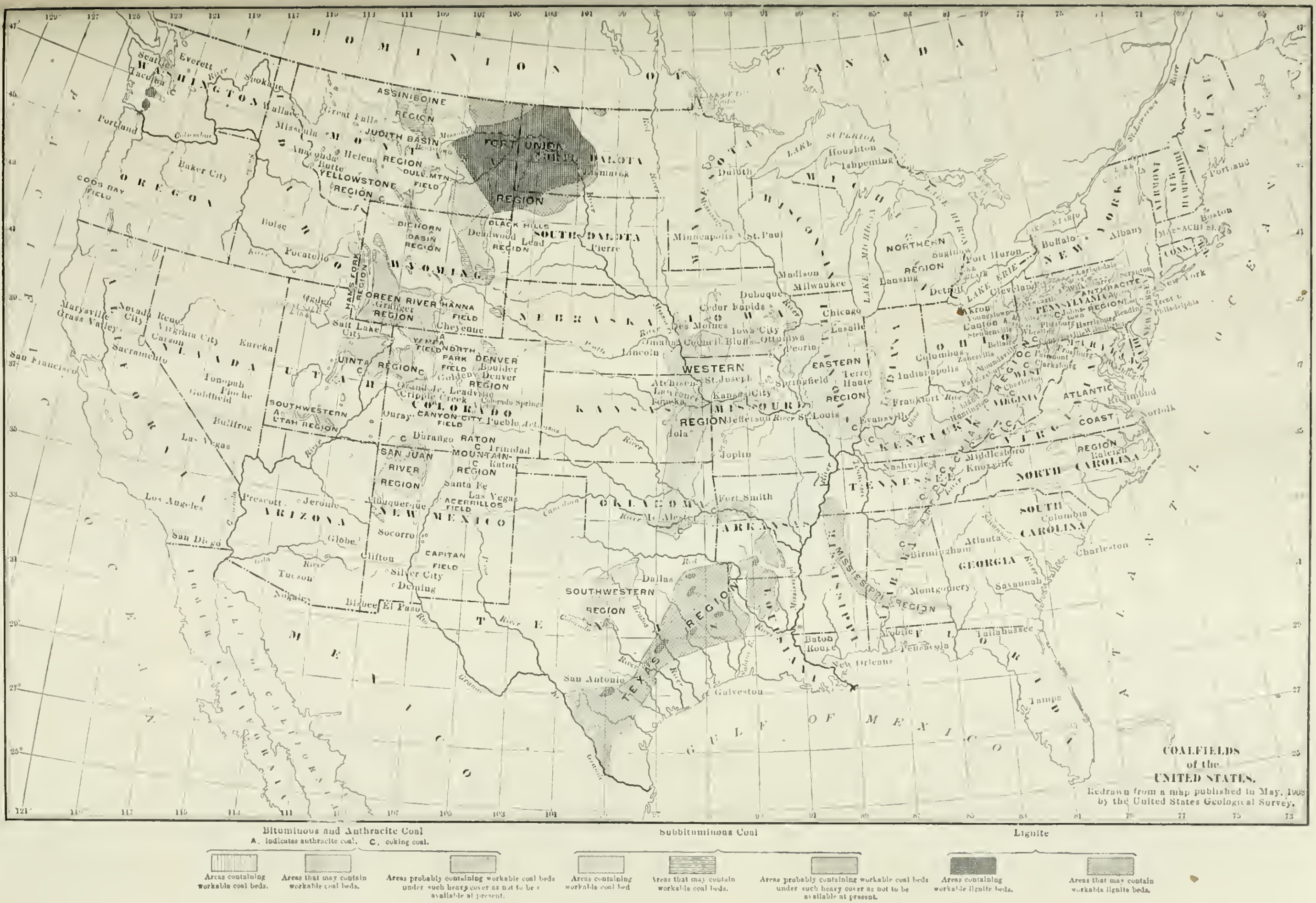

COALFIELDS
of the
UNITED STATES.
Redrawn from a map published in May, 1908 by the United States Geological Survey.
DOMINION OF CANADA
ASSINIBOINE REGION
JUDITH BASIN REGION
BULL MTN. FIELD
YELLOWSTONE REGION
FORT UNION REGION
BLACK HILLS REGION
BIGHORN BASIN REGION
HAMS FORK REGION
GREEN RIVER REGION
HANNA FIELD
YAMPA FIELD
NORTH PARK FIELD
DENVER REGION
UINTA REGION
SOUTHWESTERN UTAH REGION
CANYON CITY FIELD
RATON MOUNTAIN REGION
SAN JUAN RIVER REGION
CERRILLOS FIELD
CAPITAN FIELD
COOS BAY FIELD
NORTHERN REGION
WESTERN REGION
EASTERN REGION
SOUTHWESTERN REGION
MISSISSIPPI REGION
ANTHRACITE REGION
ATLANTIC COAST REGION
GULF OF MEXICO
Bituminous and Anthracite Coal
A. indicates anthracite coal. C. coking coal.
Areas containing workable coal beds.
Areas that may contain workable coal beds.
Areas probably containing workable coal beds under such heavy cover as not to be available at present.
Subbituminous Coal
Areas containing workable coal bed
Areas that may contain workable coal beds.
Areas probably containing workable coal beds under such heavy cover as not to be available at present.
Lignite
Areas containing workable lignite beds.
Areas that may contain workable lignite beds.

FIG. 5. SHOWING KNOWN COAL FIELDS OF THE UNITED STATES, EXCLUSIVE OF ALASKA

shown in the same illustration is an abnormal thickness of the coal seam caused by a depression in the surface upon which the coal was originally deposited, the increase in thickness, therefore, being from the bottom. This formation may also be due to the washing away of the coal from one place and the depositing of it in another. Coal seams are not always found in one continuous horizontal seam, as Fig. 3 shows, although that is the impression held by many not familiar with the subject.

After a shaft has been sunk to a seam of coal, a series of passages or levels are driven, their direction being governed by the relative position of the shaft and the area of the coal field to be worked, and other factors, such as the system of working, the inclination of the seams and the question of haulage.

Usually a blueprint of the workings of the mine is kept in the office on the surface and by means of surveys the exact position of any particular part of the underground working is known by a corresponding point on the surface, and as the mine is worked the progress is marked on the blueprint, thus showing the exact condition of the mine regarding area worked and unworked.

## EARLY MINING OF COAL

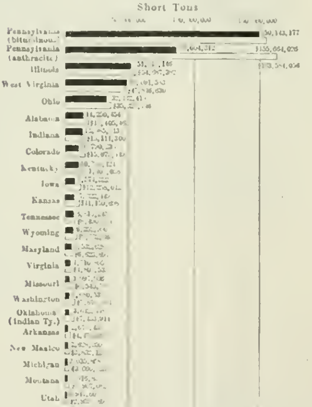
In 1814 only 20 net tons of coal were mined in the United States, while in 1907, there was mined a total of 480,363,424 short tons, having a spot value of $614,798,898. In Fig. 5 is shown a chart indicating the output in short tons in the United States by States during 1907; also the value, as tabulated by the United States Geological Survey.

In digging over the old records pertaining to the first mining of coal it is found that the coal mine was discovered by a Father Hennepin, a Jesuit missionary, in 1679. This mine was located on the Illinois river, near the present city of Ottawa, Ill. The first actual mining of coal did not begin until about 1749, or 70 years later in Virginia, but the first record of coal production from the Virginia mines is for 1822. It is estimated that prior to this date the total production of coal was between 2500 and 3000 tons. It is also estimated that from 1814 to the close of 1907, the total coal produced in the United States amounts to 6,865,097,567 short tons, and that more than 55 per cent. of this amount has been mined in Pennsylvania, Illinois ranking second and Ohio third.

## EARLY EXPERIMENTS WITH ANTHRACITE

Early attempts to utilize anthracite as a fuel presented problems which we of today little realize. For instance, in 1808, under date of February 11, Judge Jesse Fell made an experiment of burning what was then called common "stone coal," in the grates of an ordinary fireplace in the barroom of his hotel in Wilkes-Barre, Penn. It was found to produce a better fire than wood and cost less but it was difficult to ignite. Judge Fell was of the opinion that the "stone coal" would burn if a sufficient body of it were ignited. In carrying out ideas of his own he made, in 1808, a grate of small iron rods 16 inches in depth and 10 inches high and set it up in the "common room" of the hotel. This was the first successful attempt to burn anthracite, as far as has been ascertained. From illustrations this grate looked similar to the iron seats commonly found in public parks. In 1768 or 1769, Obadiah Gore, a blacksmith, used anthracite in his forge and found that it answered very well but had the disadvantage of easily going out unless blown by the bellows.

In November, 1803, it is stated that two boat loads of anthracite were shipped to Philadelphia, where attempts were made to burn it, but the only result obtained was that of putting out the fire. What coal was left was spread on the park walks, in place of gravel, which would indicate that the attempts to burn this kind of coal at that time were not crowned with success.



(a) Includes the Production of Oregon, North Dakota, Georgia, Idaho, Nevada, Nebraska, California and Alaska.

*Power, N.Y.*

FIG. 5. CHART OF OUTPUT BY STATES DURING 1907

In 1814, two boat loads of anthracite were shipped down the Susquehanna river to Philadelphia. It was advertised for sale by means of handbills. Some of the coal was purchased by White & Hazard for use in their manufacturing plant, but the attempt to burn it met with defeat. Being used to soft coal, attempts were made to burn the hard variety in the same manner, by poking and stirring. The fireman becoming disgusted with the manner in which the coal burned, shut the door of the furnace with a bang and went away for a time. When he returned he was surprised to find a good hot furnace; and in this way the method of burning anthracite was discovered. It may be said in passing that it is recorded that anthracite at this date sold for $21 per ton, and as the price was insufficient to remunerate the mine owners, the mine was consequently shut down. From the foregoing it appears that the anthracite trade of Pennsylvania had its beginning and can be traced directly to Judge Fell's experiment in the barroom of his hotel 100 years ago. Coal land at that time could be purchased for $5 per acre, while today it is worth $5000 per acre.

## COAL SUPPLY

In Fig. 4 is shown a map of the coal-fields of the United States, as their outlines are now known, and the coals they contain, as tabulated by the United States Geological Survey.

There has existed a general idea that the coal supply in the United States was practically inexhaustible, and that the present generation need give no thought to this question. There is still an uncertainty regarding the future consumption, but more is known about the estimated amount of coal yet remaining in the ground than was known a few years ago. According to the latest available estimate of the total original tonnage of the coal-fields of the United States, not including Alaska, which was made by the United States Geological Survey in 1906, the amount is given as 2200 billion short tons. This estimate was given without regarding many of the most important fields of the Western States, and a later estimate based on the data used in compiling the map shown in Fig. 4 gives a much larger amount than that made two years ago.

The area of the more accessible coal-fields of the United States is about 327,000 square miles, carrying an estimated content available for future use of nearly 2000 billion tons. It is not possible to predict the rate of consumption with any degree of certainty, but as the price increases, greater economy will be shown in the matter of fuel consumption; if the rate of increase that has held for the last thirty or forty years is maintained, however, the supply of easily available coal, it is estimated, will be exhausted before the middle of the nex century. If this is correct, there are those living who will feel the results of a coal scarcity.

What will take its place is not known. Will it be peat, of which there are estimated to be 200,000 square miles in the world, 30,000 square miles being found in the United States; or will some method of utilizing the heat unit in coal be discovered that will reduce the consumptio to such extent that the available coal supply will be saved for consumption over longer period than is now estimated?

# Transposing Formulas

By George W. Richardson

The formula by which the horsepower an engine is usually obtained is,

$$H.P. = \frac{P\,L\,A\,N}{33{,}000},$$

here

$P$ — Mean effective pressure per square inch acting on the piston.
$l$ — Length of stroke in feet.
$A$ — Area of the piston or cylinder in square inches,

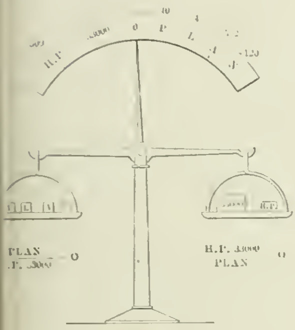


FIG. 1

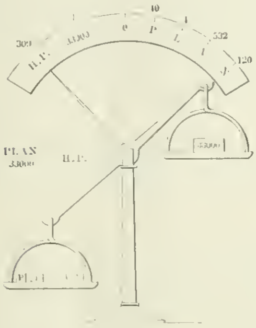


FIG. 2

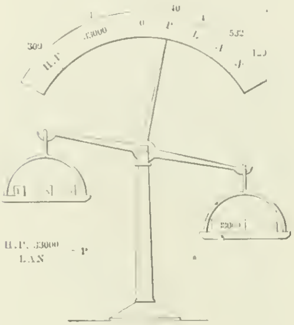


FIG. 3

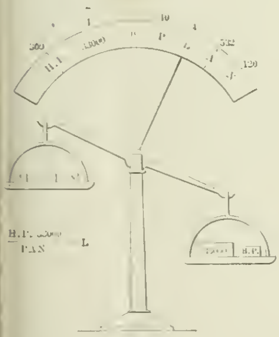


FIG. 4

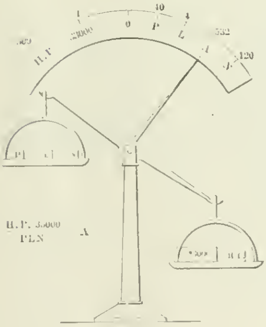


FIG. 5

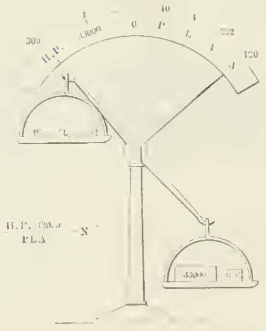


FIG. 6

$N$ = Number of strokes per minute.
$HP$ = Horsepower.

Many engineers, after committing to mory this formula, for some reason or er when called upon to solve the rsepower of a given engine, use N in formula for the number of revolu-ns per minute, when the number of okes of the engine is required per min-. So many engineers "fall down" on simple formula that the writer wishes call special attention to it.

n the above formula it is evident that horsepower is required, as the $HP$ nds to the left of the equality sign and signifies such. Now let us suppose that some other quantity is required besides the horsepower, because this is as important to the engineer, and because many compilers of civil-service examination questions know that the average person cannot transpose a formula (even if he knows, or is given it) to solve for more than one quantity, and that one, the most familiar quantity to him. A person should be able to solve any formula, no matter which quantity is required, but it is no small task to make this plain to the student. For this reason the analogy illustrated in Figs. 1 to 6 has been adopted.

When expressed in its simplest form the formula reads as follows:

$$\frac{P\,L\,A\,N}{H.P. \times 33{,}000} = 0$$

It will be noted that when all quantities above the line are multiplied together and divided by all quantities below the line, the quotient is zero, or in other words the formula is said to be in balance. Reference to Fig. 1 will make this plain. The index pointer shows that the scales are in balance when $P\,L\,A\,N$ is supported by one lever arm and $H\,P$ and 33,000 rest on the other, because

$$\frac{P\,L\,A\,N}{H.P. \times 33{,}000} = 0$$

or

$$\frac{H.P. \times 33{,}000}{P\,L\,A\,N} = 0.$$

To prove the above equation, assume the given dimensions of an engine, substitute these values in the equation and work it out. Let $P$ equal a mean effective pressure of 40 pounds per square inch; $l$ equal 4 feet, the stroke of the engine; $A$ equal 532 square inches, the area of the cylinder; $N$ equal 120, the strokes of the engine per minute; $H\,P$ equal 309, the horsepower. Substituting these values in the formula,

$$\frac{P\,L\,A\,N}{H.P. \times 33{,}000} = \frac{40 \times 4 \times 532 \times 120}{309 \times 33{,}000} =$$

$$\frac{10{,}214{,}400}{10{,}197{,}000} = 0$$

practically.

From what has been said of the above formula, it is evident that when the formula is in balance nothing is required of it, see Fig. 1 and note the difference between it and Fig. 2. In the latter the $H\,P$ has been taken from the right-hand side of the lever arm causing the left side to become heavier and the pointer to deflect accordingly.

If it is wished to solve for the unknown quantity, say, for instance the horsepower $H P$, take the $H P$ out of the original formula, thus

$$\frac{P\ L\ A\ N}{33,000}$$

To find the $H P$ all of the known quantities must be given, therefore use the quantities or values given in the previous example. Thus substituting,

$$\frac{P\ L\ A\ N}{33,000} = \frac{40 \times 4 \times 532 \times 120}{33,000} =$$

$$\frac{10,214,400}{33,000} = 309 \text{ horsepower}$$

In Fig. 1 the formula was in balance, but in Fig. 2 the $H P$ has been taken out of the formula, throwing it out of balance and making the pointer deflect contrary clockwise until it pointed at $H P$ 309. Now assume that the $H P$ has been placed back into the scale pan as in Fig. 1, the horsepower has been found, and it is wished to find the mean effective pressure $P$. Note that in taking $P$ from the formula, that it is removed from the left side of the lever arm, and consequently the pointer deflects to the right instead of to the left as before. When the pointer deflects to the right, it is an indication that the conditions are reversed, and this being the case the formula must be reversed, or in other words turned upside down. Thus,

$$\frac{H.P \times 33,000}{P\ L\ A\ N} = 0.$$

Taking $P$ from the formula as just given leaves

$$\frac{H.P. \times 33,000}{L\ A\ N}$$

as shown in Fig. 3. Substituting the previous values gives

$$\frac{309 \times 33,000}{4 \times 532 \times 120} = \frac{10,297.000}{255,360} = 40$$

pounds mean effective pressure, or simply $P$.

Likewise the stroke of the engine $L$ may be found. $P$ is placed where it came from, as in Fig. 1, and the symbol $L$ is removed. Then

$$L = \frac{H.P \times 33,000}{P\ A\ N},$$

as in Fig. 4. Substituting the same values gives the following.

$$L = \frac{309 \times 33,000}{40 \times 532 \times 120} = \frac{101.970}{25,536} =$$

$$4 \text{ feet.}$$

To find the area $A$ of the cylinder, see Fig. 5, proceed as before by placing the equation in balance. Then take away the required symbol $A$ and solve for it with what is left. Thus,

$$A = \frac{H.P \times 33,000}{P\ L\ N} = \frac{309 \times 33,000}{40 \times 4 \times 120} =$$

$$532 \text{ square inches}$$

Proceed in the same way to solve for the number of strokes per minute, the symbol of which is $N$, see Fig. 6. Substituting the values given and solving,

$$N = \frac{309 \times 33,000}{40 \times 4 \times 532} = 120,$$

or 60 revolutions per minute.

The writer believes that the above scale pan analogy will greatly assist the operating engineer and others to transpose any formula, as the analogy is just as applicable to any formula as to the one given.

## Rotary Strainers for Circulating Water

At the Greenwich station of the London County Council Tramways the condensing water is taken from the Thames and holds in suspension a large amount of mud, straw, hair and other foreign matter liable to cause trouble in the pumps and condensers. In a description of this station recently presented to the Institution of Electrical Engineers by John Hall Rider, a circular strainer designed by Bailey and Jackson of the City of London Electric Lighting Company, which has proved very successful in use, is mentioned.

The apparatus consists of a circular casing some 10 feet in diameter and about 5 feet in width. In the center of the casing and capable of very slow revolution is a wheel containing, between its spokes, grids formed of sheet-brass strips, interlaced or corrugated in a particular manner so as to form small channels for the passage of water, these channels being about 5/16 of an inch in diameter. On either side of the wheel the casing forms a chamber, each of these chambers being divided by a partition of considerable width into two compartments; the first receives the unstrained river water which, after passing through the strainer wheel, reaches the compartment immediately opposite and passes thence into the main circulating pipe to the condensers.

On its return the water is led into the fellow compartment on the same side of the casing, and after passing through the strainer wheel in the opposite direction reaches the compartment immediately opposite, whence, together with the solid matter previously separated out and temporarily retained upon the strainer surface, it is returned to the river.

The wheel is rotated very slowly by means of a circular rack, about one revolution in two minutes being sufficient for ordinary conditions of Thames water. The rack is driven through worm gearing by a small three-phase motor.

To provide against the wheel becoming choked or jammed by foreign substances between the rim of the wheel and the casing a special form of packing is provided, and sealed with water at a slightly greater pressure than the circulating water. This is found effectually to drive back foreign substances, grit, etc., and to prevent jamming and undue wear on the surfaces of the wheel and the casing, which would otherwise take place. It will be seen that with this arrangement the circulating-pipe system is completely sealed, the full advantage of siphonic action and consequent saving of power for pumping is obtained, and also all fibrous refuse is automatically rejected and returned to the river. The only disadvantage is that a certain amount of water, amounting to about 15 per cent. leaks past the partition and is returne to the river without flowing through th condenser.

The effect of reversing the flow of th water in the fixed strainers and suctio pipe has been very successful, and on recent occasion when one of the pipes i the strainer house was opened in order t couple up one of the new river pipe hardly any mud or deposit was found while no trouble has been experienced i the condenser tubes, showing that th rotary strainers effectively prevent all foreign matter from passing into the pip system.

To relieve the condenser-pipe system o any air which might accumulate, two inch barometric siphon pipes are arrange which extend about 40 feet vertically an are connected at the bottom to the highe points of the pipe system. Two dry-ai pumps take the air from the top of th barometric pipes.

Although the pipes terminate in th river compartment close together, exper ments have shown that even at dead lo water there is a difference of only tw or three degrees Fahrenheit between th temperature of the water in the riv in front of the pier and the suction pip in the pump house. As the tide rises th difference in temperature becomes les until at high tide no difference can noticed. The flow of water in the riv is so rapid that the warm discharge wat is carried away very quickly indeed.

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The length of time required for t gases to pass from the coal to the hea ing surface probably averages conside ably less than one second, a fact whi shows that the gases and air must intimately mixed when large volumes gas are distilled, as at times of hand firin for the gas must be distilled uniform as in a mechanical stoker

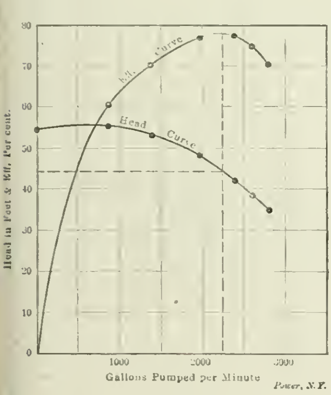
# Special Duty Centrifugal Pumps

## Plain Directions for the Use of Standard Pumps for Special Duty and Thus Avoid the Expense of Special Pumps; Some Good Suggestions

### BY JOHN B. SPERRY

Manufacturers of centrifugal pumps receive many inquiries for pumps that will operate at different pressures, delivering the same quantity of water per minute when running at a fixed speed. They are also asked if they can furnish pumps that will at times throw a relatively large amount of water at a low head, and at other times deliver a smaller quantity of water at a higher head, when running at a constant speed. The writer has endeavored in what follows to explain how these problems have been solved, and also methods of employing standard pumps, without the necessity of going to the expense of having patterns made for special pumps.

Before going farther it is best to be sure that the reader understands one of he chief characteristics of the centrifugal pump. Whoever has had anything o do with a centrifugal pump has noticed hat with the least change in the quantity of water pumped, when running at a uniform speed, there occurs a change in the pressure. This change is generally in the pposite direction, that is, if the quantity f water pumped is increased, the head, r pressure, is decreased, depending upon the design of the pump runner.



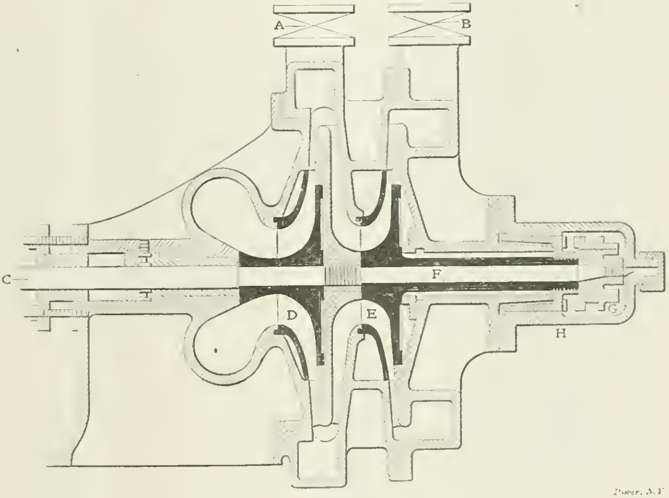
Power, N.Y.

FIG. 1

This characteristic is very well illustrated in Fig. 1, which shows the performance of a 10-inch pump when running at a constant speed. As will be seen from the head curve, as the number of gallons pumped per minute is increased, he head pumped against is decreased. Another feature that will be noticed is the efficiency curve. This curve shows the variation in the efficiency of the machine as the head and gallons per minute vary. It also shows that for the quantity of water pumped at the maximum efficiency there is a corresponding head. The point to remember is, when a centrifugal pump is running at a uniform speed and the head operated against is changed there also occurs simultaneous changes in the efficiency and the quantity of water pumped.

From this the reader will probably realize that to fulfil the conditions stated at the beginning of this article to the best advantage, the pump must be adapted to the special duty required. For instance, take the first proposition where the pumps are required to operate against different heads, but deliver the same quantity of water at the same speed. Fig. 1 shows very plainly that the ordinary centrifugal pump will not fulfil the required conditions. For the second pumping proposition, ordinary pumps could be used if the quantity of water required did not vary very widely, but if double the quantity were wanted, then a special arrangement should be employed to secure the best economy and results.

Fig. 2 is a vertical sectional view of a special pump built by Rateau and designed to raise water to two different hights without altering the speed. As will be seen, it consists of two runners, one fastened to the main shaft *C*, and the second runner *E* is secured to the hollow shaft *F*. At *G* is the shifting clutch by means of which jaws *H* are thrown in or out of mesh, and are thus able to cause the runner *E* to rotate or remain stationary as desired. Surrounding both runners are shells that have outlets controlled by valves *A* and *B*. By closing valve *A* and opening valve *B*, and throwing the teeth *H* into mesh, the runners can be made to work in series and pump to a great hight.



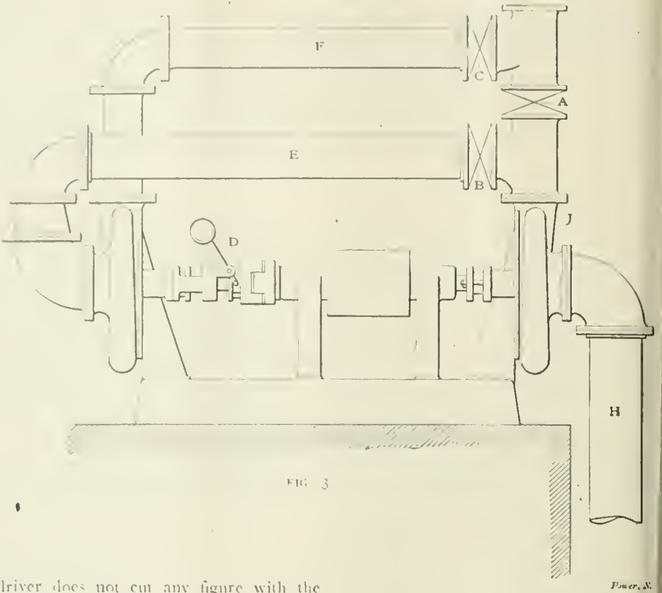
Power, N.Y.

FIG. 2

Or by closing *B* and opening *A*, and throwing out *G* the pump can be made to operate as a single-stage apparatus and pump water to a lesser hight at the same speed. The relation of these two hights will depend upon the diameters of the two runners and the vane design. If they both have the same diameter and the same design of vanes, then the pump will raise water to one-half the hight, when operating as a single-stage, as it will when working double-stage.

By changing the diameters and runner design the relations of the heads can be changed to different proportions. In place of having just runners *D* and *E*, pumps are sometimes built with two series of runners, that is, in place of *D* there may be two, three or four runners, and the same may be the case with *E*. One series is keyed to the main shaft, and the other to the sleeve. The two series need not contain the same number of runners, but can be made to differ and thus give different relations in the proportion of the heads. The method of operating is the same.

Fig. 3 is a pumping apparatus designed to accomplish the same thing as Fig. 2; but using, in the main, standard pump parts, with the addition of a special bed plate, shafts and shifting clutch *D*. The illustration shows it as a belt-driven machine, but a motor, steam or gasolene engine can be used. When pumping single stage, valve *A* is opened, valves *B* and *C* closed and the clutch *D* thrown out. To use it as a two-stage pump, close valve *A*, open valves *B* and *C*, and throw in the clutch *D*. The course of the water through the machine when working two-stage is up the suction pipe *H*, through the pump *J*, the pipe *E* and into the second pump and out into the discharge line by way of the pipe *F*. This arrangement makes an ideal pumping plant for town and city water supply where a low pressure only is desired for domestic use, and a high pressure for fire purpose.

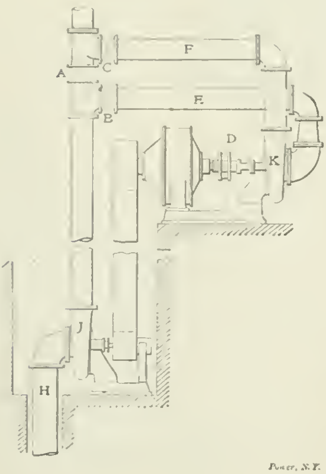


Power, N.

FIG. 3

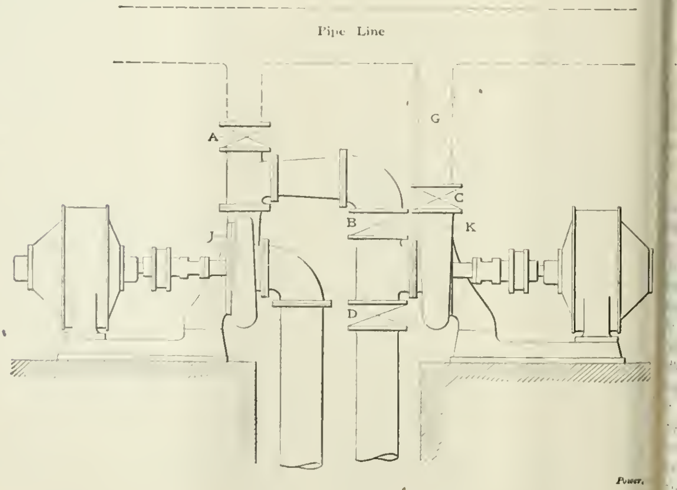
In Fig. 4 is shown an arrangement for pumping water from a well, using pumps that can be secured in the open market. The conditions in this case are such that the first pump *J* has to be placed in a pit on account of low water level in the well. The pit is too small to accommodate both pumps. This apparatus is shown electrically driven, but the form of the driver does not cut any figure with the scheme in general. As will be seen, the pump *K* above ground is direct-connected to the motor by means of a clutch coupling, and the pump *J* in the pit is belted to the motor. The arrangement of the pipes and valves is similar to that shown in Fig. 3. When pumping as a single-stage pump valves *C* and *B* are closed and the clutch *D* thrown out. When running as a two-stage pump, valve *A* is closed, valves *C* and *B* opened and the clutch *D* thrown into mesh. The relation in the proportion of the two pressures put up by this pump will depend upon th pulley ratio between the pump *J* and th motor.

Fig. 5 shows a method of piping t duplicate direct-connected motor-driv pumps so that they will act as rela to each other when working single-stag also to be used as a two-stage pump and double-capacity pump. The illustratic shows them placed on opposite sides the pit, but this is only to show th pumps diagrammatically and is not nece



Power, N.Y.

FIG. 4



Power.

FIG. 5

sary, in fact, it will probably be more convenient to have them parallel to each other. When pumping single-stage either pump can be used, and in this way they serve as relays in case of accident to one or the other. To use pump *J* single-stage, valve *A* is opened and valves *B* and *C* closed. If there is a check valve in the line *G* it is not necessary to close *C*. To use pump *K* as a single-stage pump, valves

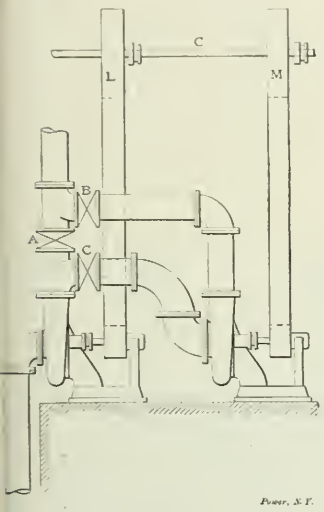


FIG. 6

*B* and *A* are closed and valves *D* and *C* opened. When the apparatus is used as a two-stage, or high-pressure machine, valves *A* and *D* are closed and valves *B* and C opened. To transform the apparatus into a double-capacity machine, open valves *A*, *D* and *C* and close valve *B*. Such an apparatus is cheap and economical, and appears to be the solution to the water-works problem of the ordinary-sized town, where a far greater capacity in pumping is required in the summer than in the winter, due to the irrigating of lawns, gardens, etc. It can readily be seen that with a plant such as described, a town pumping station would be able to cover every emergency, as the plant could be run at one-half capacity during the winter, full capacity n the summer and, in case of fire, the pressure could be doubled and water pumped directly into the mains.

Fig. 6 illustrates the scheme employed n connecting up and piping two equal-sized belt-driven pumps, so as to act either as a single-stage machine or a two-stage pump. The pumps are driven from a countershaft *C*, on which there are two riction clutches *L* and *M*. The arrangement of the valves *A*, *B* and *C* is the same as in Figs. 2, 3 and 4. The proportion of he two pressures to each other will depend upon the ratio of the belt transmission.

In Fig. 7 is illustrated still another arrangement for belt-driven pumps. These pumps received their power from a motor having its shaft extending on both sides and a friction clutch on each end. One pump is left-hand and the other is right-hand, and they are so placed that their suction ends point in opposite directions. The arrangement of the piping and valves is such as to allow this outfit to be used as a single-stage pump, both single and double capacity and in relay, and also as a two-stage centrifugal pump. If the pump *J* is used as a single-stage pump, open valve *A*, close valves *B* and *C* and throw out the clutch *L*. If the pump *J* should break down, the pump *K* can be used by throwing out the clutch *M* and throwing in the clutch *L*, shutting valves *A* and *C* and opening valves *B* and *D*. When run as a double capacity pump, throw in both clutches, close valve *C* and open valves *A*, *B* and *D*. To change it into a two-stage high-pressure pump have both clutches in and all the valves open except *A* and *D*.

In closing it might be well to add a few suggestions, in general as to the piping of these special duty pumps.

Place the pump as close to the water level as possible. This prevents the liability of air leaking into the pump through the suction pipe or the stuffing box.

If other pumps are discharging into the sump from which the pump is drawing water, see that these discharge pipes are arranged so that air is not carried down into the water and up into the suction pipe.

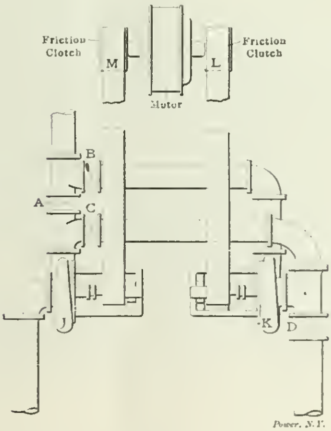


FIG. 7

Don't use smaller suction and discharge pipes than the pump flanges call for.

Use as few elbows as possible, and those that are used should be of the long-radius type.

If the pump is to raise hot water, don't try to pump it by suction, but have the water run into the pump.

# Fuel Consumption of Steam and Gas Engines in Practice

By Dr. F. E. Junge

Some time ago I reported that the world's record in steam-power economy was held by the firm of R. Wolf, Magdeburg-Buckau, Germany, whose "Locomobile," a semi-portable steam engine and boiler inclosed in a common casing and working with superheated steam, showed on test a coal consumption of 0.473 kilogram per effective horsepower-hour. In the meantime a new record was made by the rival firm of Heinrich Lanz, Mannheim, Germany, whose "Lokomobile" is equipped with valves instead of slides and in a test lasting several days of 8 hours each, made by the "Association for the Inspection of Steam Boilers" in Mannheim, showed a coal consumption of only 0.455 kilogram per effective horsepower-hour. At the same time that this report was published the Wolf firm announced a further reduction of coal consumption to 0.44 kilogram with a corresponding steam consumption of 3.67 kilograms per effective horsepower-hour. This neck-to-neck fight of the two rival firms emphasizes the advantage of healthy competition, since the latter not only brings tangible profits to the manufacturers themselves but also benefits the export industry of the country and furthers the rational utilization and conservation of the latter's resources.

Yet the figures mentioned are of more theoretical interest and importance than they are of economic value because, in practice, conditions prevail which do not allow of the attainment of maximum efficiency, attendance being less careful and loads varying, while on test the load is kept uniform during each run. Therefore, when comparing engines of different systems, for instance steam and oil engines, in order to get at their relative economic importance a correction must be made in the calculation in order that the prospective power user and the industrial economist may be benefited by the comparison as well as the manufacturer.

Viewed in a broad way, a compilation of facts made by E. Hoeltje and contributed to the *Verein deutscher Ingenieure* is particularly significant, since it emphasizes the necessity of employing in the power plant, besides high-class machinery, high-class attendance in order to remain within the limits of guaranteed fuel consumption and derive the full benefit from the high efficiency of machinery. Even in America, where steam-engine efficiencies as high as those here recorded are unknown, at least to the writer, and where high-class attendance is very expensive and difficult to get, the results of Herr Hoeltje's inquiry will be of interest.

The investigation is limited to two competing types of engine, which are very widely used in small electric central sta tions in Germany: steam semi-portable and Diesel oil engines. The results, whicl were arrived at on the basis of the yearly reports of these works, and which are ab solutely reliable, are condensed in th accompanying table. The main objec of the investigation was to find out jus what additions had to be made in th various plants to the fuel consumptio as guaranteed by the respective manu facturers. To arrive at reliable con clusions the operating conditions in th different plants had to be as nearly iden tical as possible, and this condition is ir deed fulfilled in the stations in question.

The table shows that the above fuel cor sumption with semi-portable steam er gines is from 256 per cent. to 42.5 pe cent. below that guaranteed, giving mean of 102 per cent. in excess of th guarantee, while with Diesel oil engine it varies from 72.5 above to 10.3 per ce below the guarantee, the mean being per cent. excess. The best steam engin figures are from plants working wi saturated as well as with superheate steam, and the comparatively small exce of 66.7 per cent. in the Eisenach plar compared with the mean excess of t per cent., is attained with saturated stear This result emphasizes the fact that supe heat without proper attendance is n capable of effecting high fuel economi whereas with oil-engine plants the co sumption of fuel is much more inc pendent of the skill of the attendant.

Oil-engine plants also have the a vantage that fuel waste, such as may caused by broken piston rings or otl abnormal conditions, is easily visible the oil gage, while the record of c consumption cannot be so easily served by the inspector, who must r on the fireman for information. No solutely final or determining conclusi as to the comparative fuel economy steam semi portable engines and oil gines can be drawn from the table. cause the sizes of the plants and th localities differ widely. Only stations N 3, 4, 5, 6, 10, 11, 15, 16, 17 and 18 wh the sizes of engines are almost eq may be compared with fairness to b types. With these the mean cost of f consumption in the steam plants is o. mark and that of the oil engines o. mark per kilowatt-hour. Also the act heat consumption, which is stated in last column of the table, is in all ca better for the oil engines than for steam engines, in spite of the extra dinary efficiency of the latter. It wo seem, therefore, that in places wher is difficult to get high-class attenda the Diesel engine of modern design hold its own against steam competit on account of the greater discrepancy tween guaranteed and actual fuel sumption of high-class steam engine practice.

TABLE SHOWING DISCREPANCY BETWEEN GUARANTEED AND ACTUAL FUEL CONSUMPTION OF HIGH-CLASS STEAM AND OIL ENGINES IN PRACTICE.

| Test No. | | Central Station | Year Built | Size and Type of Engine | | | Fuel | Heat Value of Fuel = Heat Units per Kilogram | Fuel Consumption per Annum | Cost of Fuel Delivered at Power Plant per 100 Kilogram | Electrical Energy Generated per Year | Fuel Consumed per Kilowatt Hour | Fuel Cost per Kilowatt-hour. | Fuel Consumption per H.P.-hour based on = 7,500 Heat Units (steam engines) = 10,000 Heat Units (oil engines) | Guaranteed Fuel Consumption Based on = 7,500 Heat Units (steam engines) = 10,000 Heat Units (oil engines) | | Difference from the Guaranteed Figure | Heat Consumption per Horsepower hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Number | H.P. | Steam Quality | | | | | | | | | Kg. Per H.P. hour | Kg. Per Kw.-hour | | |
| | | | | | | | | | Kilograms | Marks | Kw.-hours. | Kilograms | Marks | Kilograms | | | Per Cent | Heat Units |
| 1 | Steam Engines. | Oberstaufen | 1905 | 1 | 28 | Superheated | Fat coal | 7,200 | 61,900 | 2.60 | 33,786 | 1.83 | 0.048 | 1.11 | 0.8 | | 42.5 | 8,550 |
| 2 | | Seeburg | 1906 | 1<br>1 | 27<br>15 | | Silesian coal | 6,400 | 130,000 | 2.38 | 46,566 | 2.78 | 0.066 | 1.53 | | 1.8 | 54 | 11,490 |
| 3 | | Bramstedt | 1906 | 1 | 55 | | English coal. | 7,000 | 141,000 | 2.39 | 48,151 | 2.99 | 0.069 | 1.8 | 0.77 | | 140 | 13,890 |
| 4 | | Ziesar | 1906 | 1 | 60 | | Brown coal. | 4,500 | 230,000 | 1.50 | 41,655 | 5.5 | 0.083 | 2.15 | 0.75 | | 192 | 16,420 |
| 5 | | Rellhausen | 1905 | 1<br>1 | 40<br>80 | | English coal. | 7,000 | 245,774 | 2.19 | 103,513 | 2.38 | 0.052 | 1.47 | 0.75 | | 96 | 11,020 |
| 6 | | Gosslershausen | 1906 | 2 | 80 | | Silesian coal. | 6,400 | 225,000 | 2.38 | 89,300 | 2.52 | 0.06 | 1.43 | 0.73 | | 96 | 10,720 |
| 7 | | Gollub | 1905 | 1<br>1 | 100<br>55 | | Silesian coal | 6,400 | 130,000 | 2.38 | 30,000 | 4.33 | 0.01 | 2.46 | 0.69 | | 256 | 18,450 |
| 8 | | Wolfenbüttel | 1908 | 1<br>1 | 117<br>140 | | Hard coal | 7,800 | 266,000 | 2.12 | 131,487 | 2.02 | 0.043 | 1.4 | 0.63 | | 122 | 10,500 |
| 9 | | Lahr | 1906 | 2 | 178 | | Ruhr-Saar coal. | 7,000 | 573,400 | 2.15 | 294,562 | 1.95 | 0.042 | 1.25 | 0.61 | | 105 | 9,370 |
| 10 | | Schirmeck | 1899 | 1<br>1 | 70<br>74 | Saturated<br>Superheated | Half fat Ruhr coal | 7,300 | 385,800 | 2.10 | 208,156 | 1.85 | 0.039 | 1.2 | 0.92 | | 30.1 | 9,000 |
| 11 | | Heiligenstadt. | 1900 | 1<br>1 | 75<br>80 | Saturated<br>Superheated | Ruhr No. III. | 7,400 | 339,325 | 2.19 | 199,713 | 1.7 | 0.037 | 1.12 | 0.92 | | 21.7 | 8,400 |
| 12 | | Eisenach | 1892 | 1 | 130 | Saturated | Ruhr and Zwickau coal | 7,100 | 1,851,000 | 1.91 | 777,170 | 2.38 | 0.046 | 1.5 | 0.90 | | 66.7 | 11,260 |
| 13 | Oil Engines. | Rottenburg a. L. | ? | 1 | 30 | | Moravian gas oil. | 10,000 | 10,000 | 10.35 | 12,750 | 0.784 | 0.081 | 0.507 | | 0.785 | 0 | 5,070 |
| 14 | | Hochheim | 1906 | 2 | 40 | | Paraffin. | 10,000 | 30,000 | 9.36 | 58,712 | 0.511 | 0.048 | 0.331 | | 0.57 | 10.3 | 3,310 |
| 15 | | Bhf. Neudietendorf | 1905 | 2 | 70 | | Paraffin | 10,000 | 43,100 | 7.50 | 116,710 | 0.369 | 0.028 | 0.245 | 0.245 | | 11 | 2,450 |
| 16 | | Plattling | 1902 | 3 | 70 | | Paraffin | 9,870 | 70,000 | 9.60 | 220,000 | 0.318 | 0.031 | 0.268 | | 0.31 | 6.5 | 2,680 |
| 17 | | Dieburg | ? | 1 | 80 | | Brown coal tar oil. | 10,000 | 30,000 | 11.00 | 93,000 | 0.323 | 0.036 | 0.214 | | 0.32 | 1 | 2,140 |
| 18 | | Brochenzell | 1906 | 1 | 80 | | Roumanian gas oil | 10,000 | 10,330 | 10.40 | 24,750 | 0.416 | 0.043 | 0.277 | | 0.33 | 26 | 2,770 |
| 19 | | Hartha | 1904 | 2 | 100 | | Galizian crude oil. | 10,000 | 63,780 | 10.00 | 201,197 | 0.312 | 0.031 | 0.208 | 0.204 | | 2.0 | 2,080 |
| 20 | | Fürstenhof (Berlin) | 1907 | 2 | 120 | | Galizian crude oil. | 10,500 | 360,000 | 9.60 | 950,000 | 0.379 | 0.036 | 0.265 | 0.201 | | 30 | 2,650 |
| 21 | | Untersuchungs-Gefängnis (Berlin) | 1905 | 2 | 140 | | Paraffin. | 10,000 | 72,000 | 9.75 | 211,179 | 0.341 | 0.034 | 0.229 | 0.204 | | 12.3 | 2,290 |
| 22 | | Landshut | 1906 | 2 | 200 | | Galizian crude oil. | 10,000 | 110,000 | 10.50 | 337,450 | 0.326 | 0.034 | 0.223 | 0.204 | | 9.3 | 2,230 |
| 23 | | Passau | 1906 | 2 | 200 | | Galizian crude oil. | 10,000 | 144,000 | 9.69 | 280,000 | 0.514 | 0.049 | 0.352 | 0.201 | | 72.5 | 3,520 |
| 24 | | Friedenau | 1905 | 2 | 200 | | Paraffin. | 9,900 | 133,300 | 8.39 | 365,327 | 0.364 | 0.031 | 0.252 | 0.204 | | 23.5 | 2,520 |
| 25 | | Linden | 1905 | 1 | 250 | | Galizian crude oil. | 9,900 | 47,000 | 10.10 | 156,323 | 0.300 | 0.03 | 0.208 | 0.204 | | 2.0 | 2,080 |
| 26 | | Lindau | 1900 | 1 | 250 | | Galizian crude oil. | 9,810 | 107,000 | 9.59 | 346,866 | 0.308 | 0.03 | 0.212 | 0.204 | | 1 | 2,120 |
| 27 | | Rheingold (Berlin). | 1906 | 3 | 300 | | Galizian crude oil. | 10,500 | 360,000 | 9.60 | 1,000,000 | 0.360 | 0.035 | 0.264 | 0.198 | | 33.4 | 2,640 |

# Running a Westinghouse Steam Turbine

## The Important Points of Present-day Practice in Operating Westinghouse-Parsons Turbines Explained in a Practical Manner

While the steam turbine is simple in esign and construction and does not re uire constant tinkering and adjustment i valve gears or taking up of wear in ie running parts, it is like any other iece of fine machinery in that it should eceive intelligent and careful attention om the operator by inspection of the orking parts that are not at all times in lain view. Any piece of machinery, no atter how simple and durable, if ne-cted or abused will in time come to ef and the higher the class of the ma- ne the more is this true.

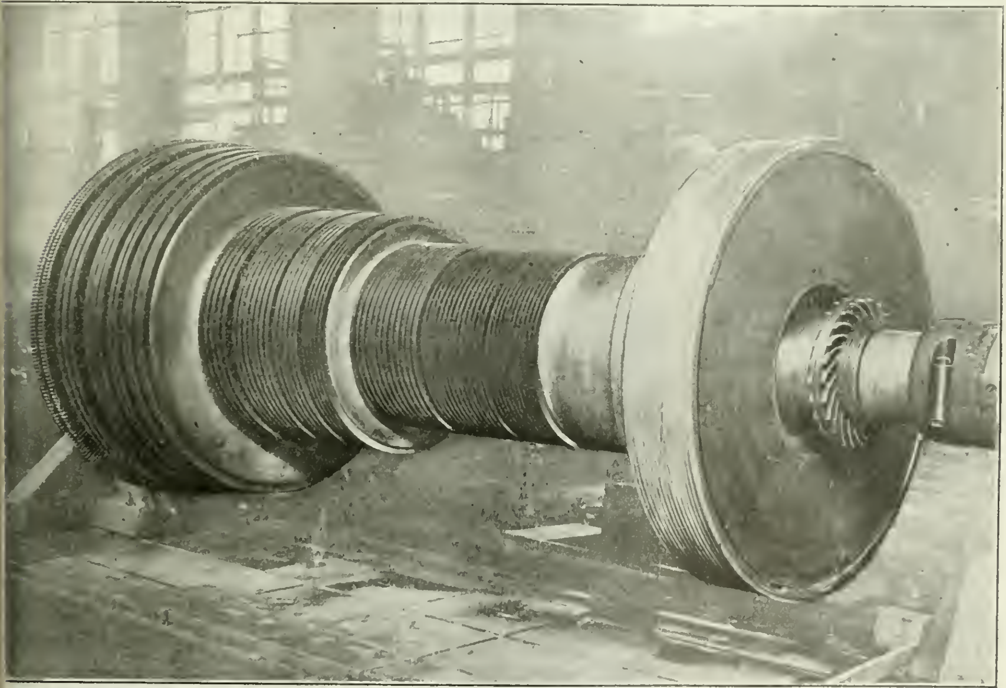


FIG. 1.

Any engineer who is capable of run- ng and intelligently taking care of a iprocating engine can run and take ce of a turbine, but if he is to be any- ng more than a starter and stopper, s necessary that he should know what inside of the casing, what must be ne and avoided to prevent derangement and to keep the machine in continued and efficient operation.

In the steam turbine the steam instead of being expanded against a piston is made to expand against and to get up velocity in itself. The jet of steam is then made to impinge against vanes or to react against the moving orifice from which it issues, in either of which cases its velocity and energy are more or less completely abstracted and appropriated by the revolving member. The Parsons turbine utilizes a combination of these two methods.

Fig. 2 is a sectional view of the standard Westinghouse-Parsons single-flow turbine. A photograph of the rotor *R R R* is reproduced in Fig. 1, while in Fig. 3 a section of the blading is shown upon a larger scale. Between the rows of the blading upon the rotor extend similar rows of stationary blades attached to the casing or stator. The steam entering at *A*, Fig. 2, fills the circular space surrounding the rotor and passes first through a row of stationary blades, *1*, Fig. 4, expanding from the initial pressure *P* to the slightly lower pressure $P_1$, and attaining by that expansion a velocity with which it is directed upon the moving blade *2*. In passing through this row of blades it is further expanded from pressure $P_1$ to $P_2$ and helps to push the moving blades along by the reaction of the force with which it issues therefrom. Impinging upon the second row of stationary blades *3*, the direction of flow is diverted so as to make it impinge at a favorable angle upon the second row of revolving blades *4* and the action is continued until the steam is expanded to the pressure of the condenser or of the medium into which the turbine finally exhausts. As the expansion proceeds, the passages are made larger by increasing the length of the blades and the diameter of the drums upon which they are carried in order to accommodate the increasing volume.

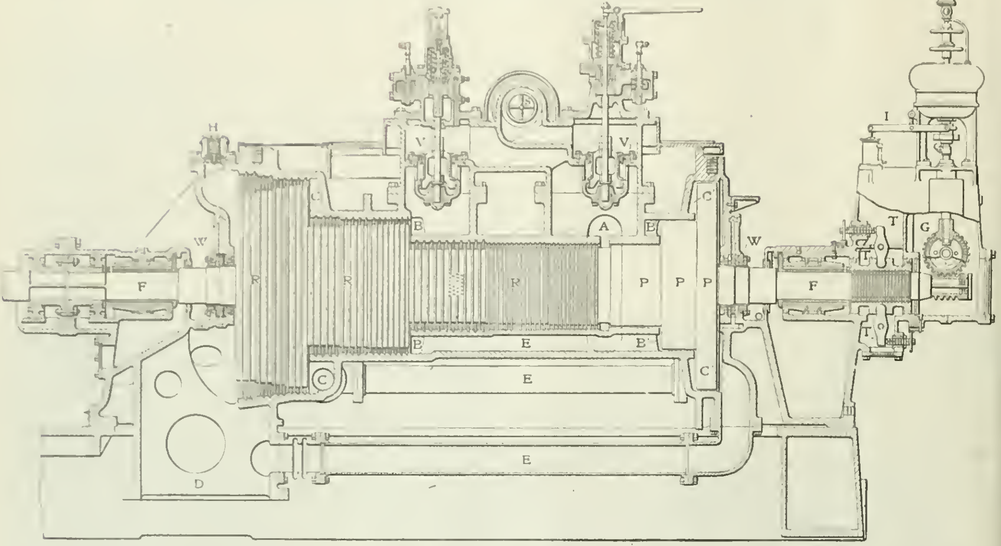


FIG. 2.

It is not necessary that the blades shall run close together, and the axial clearance, that is the space lengthwise of the turbine between the revolving and the stationary blades, varies from ⅛ to ½ inch; but in order that there may not be excessive leakage over the tops of the blades, as shown, very much exaggerated in Fig. 5, the radial clearance, that is the clearance between the tops of the moving blades and the casing, and between the ends of the stationary blades and the shell of the rotor, must be kept down to the lowest practical amount, and varies, according to the size of the machine and length of blade, from about 0.025 to 0.125 of an inch.

In the passage *A*, Fig. 2, exists the initial pressure, in the passage *B* the pressure after the steam has passed the first section or diameter of the rotor, in the passage *C* after it has passed the second section. The pressure acting upon the exposed faces of the rows of vanes would crowd the rotor to the left. They are therefore balanced by pistons or "dummies" *P P P* revolving with the shaft and exposing in the annular spaces $B^1$ and $C^1$ the same areas as those of the blade sections which they are designed to balance. The same pressure is maintained in $B^1$ as in *B* and in $C^1$ as in *C* by connecting them with equalizing pipes *E E*. The third equalizing pipe connects the back or right hand side of the largest dummy with the exhaust passage so that the same pressure exists upon it as exists upon the exhaust end of the rotor. These dummy pistons are shown at the near end of the rotor, Fig. 1. They are grooved so as to form a labyrinth packing, the face of the casing against which they run being grooved and brass strips inserted, as shown in Fig. 6. The dummy pistons prevent leakage from *A*, $B^1$ and $C^1$ to the condenser and must, of course, run as closely as practicable to the rings in the casing, the actual clearance being from about 0.005 to 0.015 of an inch, again depending on the size of the machine.

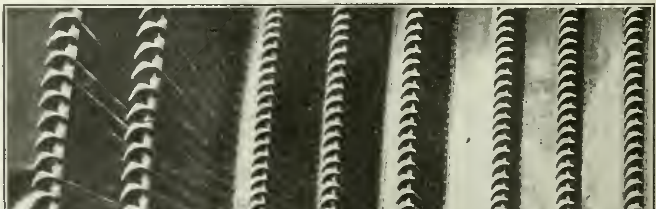


FIG. 3.

The axial adjustment is controlled by the device shown at *T* in Fig. 2 and on a larger scale in Fig. 7. The thrust bearin consists of two parts, $T_1$ $T_2$. Each con sists of a cast-iron body in which ar placed brass collars. These collars f into grooves *C*, turned in the shaft a shown. The halves of the block ar brought into position by means of screw

$S_1$ $S_2$ acting on levers $L_1$ $L_2$ and mounted in the bearing pedestal and cover. The screws are provided with graduated heads which permit the respective halves of the thrust bearing to be set within one one-thousandth of an inch.

The upper screw $S_2$ is set so that when the rotor exerts a light pressure against it through the thrust block and lever the grooves in the balance pistons are just unable to come in contact with the dummy strips in the cylinder. The lower screw $S_1$ is then adjusted to permit about 0.008 to 0.010 of an inch freedom for the collar between the grooves of the thrust bearing

These bearings are carefully adjusted before the machine leaves the shop and to prevent either accidental or unauthorized changes of their adjustment, the adjusting screw heads are locked by the method shown in Fig. 7. The screw cannot be revolved without sliding back the latch $L_2$. To do this the pin $P_2$ must be ithdrawn, for which purpose the bearng cover must be removed.

In general this adjustment should not e changed except when there has been ome wear of the collars in the thrust aring; nevertheless it is a wise preaution to go over the adjustment at inrvals. The method of doing this is follows: The machine should have een in operation for some time so as to well and evenly heated and should run at a reduced speed, say 10 per nt. of the normal, during the actual opration of making the adjustment. Adust the upper screw which, if tightened, ould push the spindle away from the rust bearing toward the exhaust. Find a position for this so that when the other screw is tightened the balance pistons can just be heard to touch, and so the least change of position inward of the upper screw will cause the contact to cease. To hear if the balance pistons are touching, a short piece of hardwood should be placed against the cylinder casing near the balance piston. If the ear is applied to the other end of the piece of wood the contact of the balance pistons can be very easily detected. The lower screw should then be loosened and the upper screw advanced from five to fifteen one-thousandths, according to the machine, at which position the latter may be considered to be set. The lower screw should then be advanced until the under half of the thrust bearing pushes the rotor against the other half of the thrust bearing, and from this position it should be pushed back ten or more one-thousandths, to give freedom for the rotor between the thrusts, and locked. A certain amount of care should be exercised in setting the dummies to avoid straining the parts and thus obtain a false setting.

The object in view is to have the grooves of the balance pistons running as close as possible to the collars in the cylinder but without danger of their coming in actual contact, and to allow as little freedom as possible in the thrust bearing itself but enough to be sure that it will not heat. The turbine rotor itself has scarcely any end thrust, so that all the thrust bearing has to do is to maintain the above-prescribed adjustment.

The blades are so gaged that at all loads the rotor has a very light but positive thrust toward the running face of the dummy strips, thus maintaining the proper clearance at the dummies as determined by the setting of the proper screw adjustment.

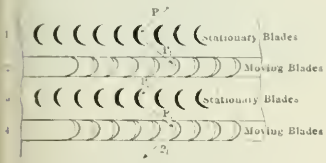


FIG. 4

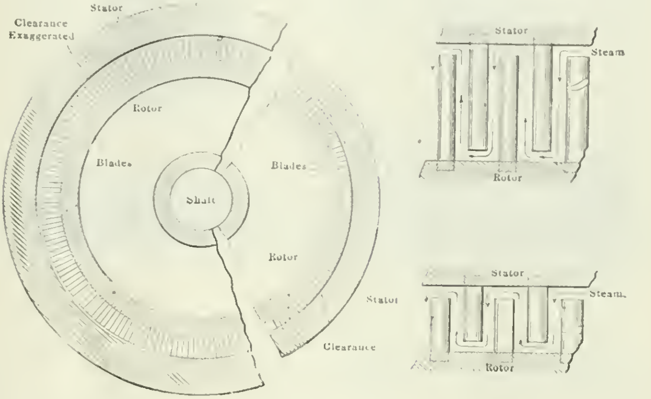


FIG. 5

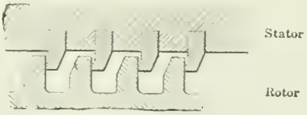
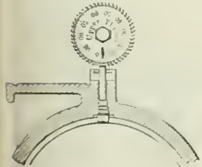


FIG. 6



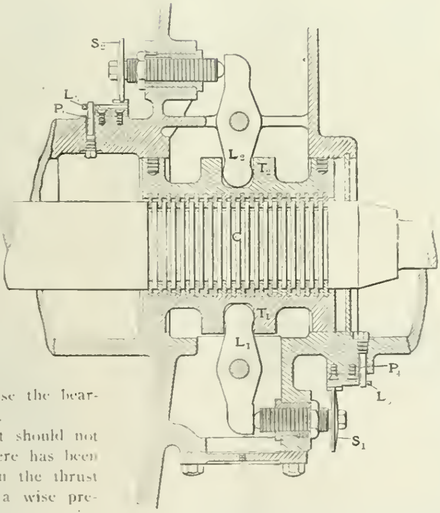


FIG. 7

### MAIN BEARINGS

The bearings which support the rotor are shown at $F$ $F$ in Fig. 2 and in detail in Fig. 8. The bearing proper consists of a brass tube $B$ with proper oil grooves It has a dowel arm $L$ which fits into a corresponding recess in the bearing cover and which prevents the bearing from turning. On this tube are three concentric tubes $C$ $D$ $E$, each fitting over the other with some clearance so that the shaft is free to move slightly in any direction. These tubes are held in place

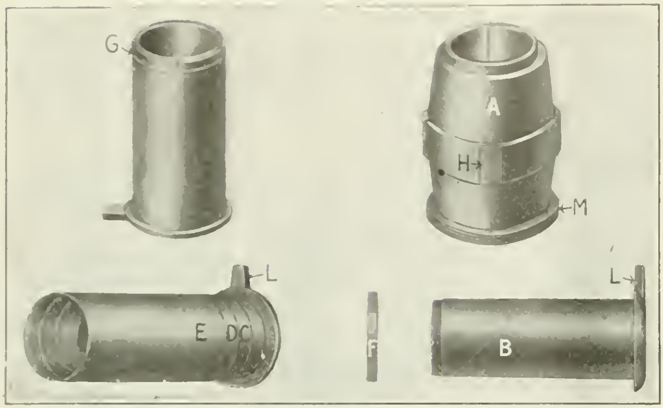


FIG. 8

by the hex nut F, and this nut in turn is held by the small set screw G. The bearing with the surrounding tubes is placed inside of the [illegible] shell L, which rests in the bearing [illegible] on the block and liner H. The packing ring M prevents the leakage of oil past the bearing. Oil enters the chamber at one end of the bearing at the top and passes through the oil grooves, lubricating the journal, and then out into the reservoir under the bearing. The oil also fills the clearance between the tubes and forms a cushion which dampens any tendency to vibration.

The bearings, being supported by the blocks or "pads" *H*, are self-alining. Under these pads are liners 5, 10, 20 and 50 thousandths in thickness. By means of these liners the rotor may be set in its proper running position relative to the stator. This operation is quite simple. Remove the liners from under one bearing pad and place them under the opposite pad until a blade touch is obtained by turning the rotor over by hand. After a touch has been obtained on the top, bottom and both sides, the total radial blade clearance will be known to equal the thickness of the liners transferred. The position of the rotor is then so adjusted that the radial blade clearance is equalized when the turbine is at operating temperature.

On turbines running at 1800 revolutions per minute or under a split babbitted bearing is used as shown in Fig. 9. These bearings are self-alining and have the same liner adjustment as the concentric-sleeve bearings just described. Oil is supplied through a hole *D* in the lower liner pad, and is carried to the oil groove *F* through the tubes *E E*. The oil flows from the middle of this bearing to both ends instead of from one end to the other, as in the other type.

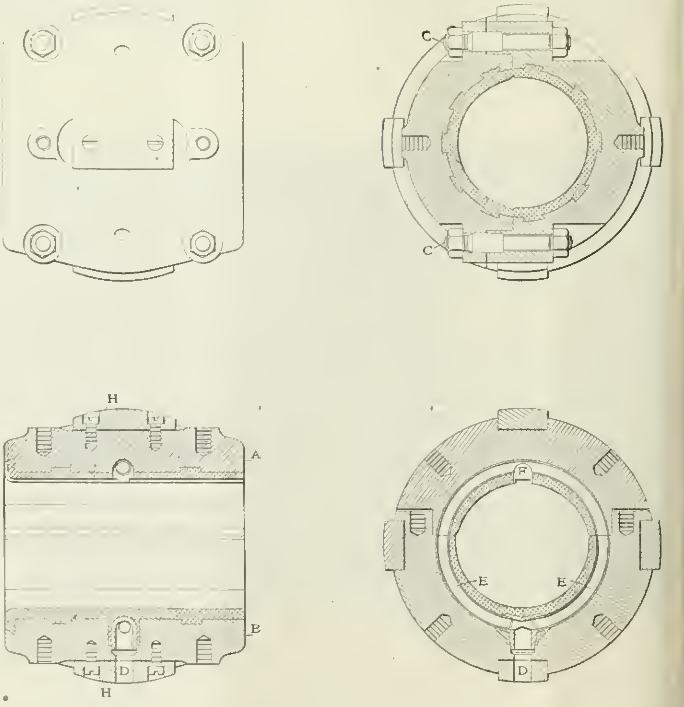


FIG. 9

### Packing Glands

Where the shaft passes through the casing at either end it issues from a chamber in which there exists a vacuum. It is necessary to pack the shaft at these points, therefore, against the atmospheric pressure and this is done by means of a water-gland packing *W W*, Fig. 2. Upon the shaft in Fig. 1, just in front of the dummy pistons, will be seen a runner of this gland packing, which runner is shown upon a larger scale and from a different direction in Fig. 10. To get into the casing the air would have to enter the gland at *A*, Fig. 11, pass over the projecting ring *B*, the function of which is to throw off any water which may be creeping along the shaft by centrifugal force into the surrounding space *C*, whence it escapes by the drip pipe *D*, hence over the five rings of the labyrinth packing *E* and thence over the top of the revolving blade wheel, it being apparent from Fig. 10 that there is no way for the air to pass by without going up over the top of the blades; but water is admitted to the centrally grooved space through the pipe shown and is revolved with the wheel at such velocity that the pressure due to centrifugal force exceeds that of the atmosphere, so that it is impossible for the air to force the water aside and leak in over the tips of the blades, while the action of the runner in throwing the water out would relieve the pressure at the shafts and avoid the tendency of the water to leak outward through the labyrinth packing either into the vacuum or the atmosphere.

The water should come to the glands under a head of about 10 feet, or a pressure of about five pounds, and be connected in such a way that this pressure

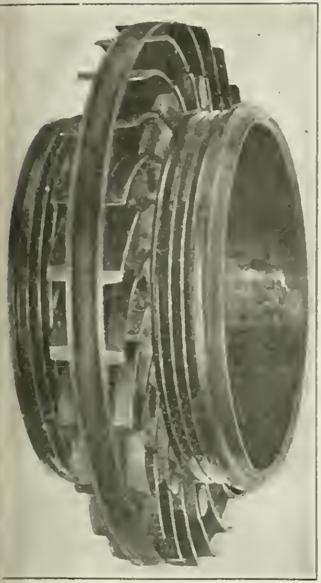


FIG. 10

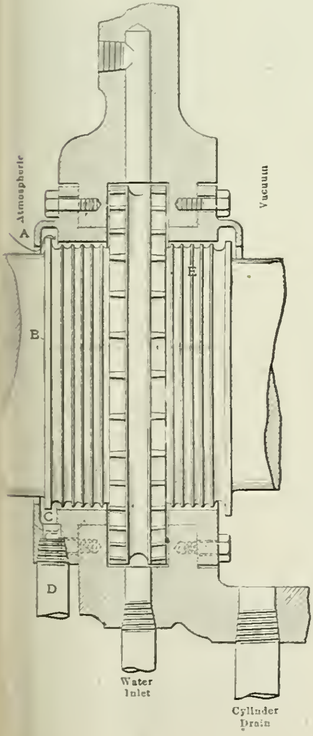


FIG. 11

may be uninterruptedly maintained. Its temperature must be lower than the temperature due to the vacuum within the turbine, or it will evaporate readily and find its way into the turbine in the form of steam.

In any case a small amount of the steaming water will pass by the gland collars into the turbine, so that if the condensed steam is to be returned to the boilers the water used in the glands must be of such character that it may be safely used for feed water. But whether the water so used is to be returned to the boilers or not it should never contain an excessive amount of lime or solid matter, as a certain amount of evaporation is continually going on in the glands which will result in the deposit of scale and require frequent taking apart for cleaning.

When there is an ample supply of good, clean water the glands may be packed as in Fig. 12, the standpipe supplying the necessary head and the supply valve being opened sufficiently to maintain a small stream at the overflow. When water is expensive and the overflow must be avoided, a small float may be used as in Fig. 13, the ordinary tank used by plumbers for closets, etc., serving the purpose admirably.

When the same water that is supplied to the glands is used for the oil-cooling coils, which will be described in detail later, the coils may be attached to either of the above arrangements as shown in Fig. 14.

When the only available supply of pure water is that for the boiler feed and the condensed steam is pumped directly back to the boiler, as shown in Fig. 15, the delivery from the condensed-water pumps may be carried to an elevation 10 feet above the axis of the glands where a tank should be provided of sufficient capacity that the water may have time to cool considerably before being used. In most of these cases if so desired, the oil-cooling water may come from the circulating pumps of the condenser, provided there is sufficient pressure to produce circulation, as is also shown in Fig. 15.

When the turbine is required to exhaust against a back pressure of one or two pounds a slightly different arrangement of piping must be made. The water in this case must be allowed to circulate through the glands in order to keep the temperature below 212 degrees Fahrenheit. If this is not done the water in the glands will absorb heat from the main castings of the machine and will evaporate. This evaporation will make the glands appear as though they were leaking badly. In reality it is nothing more than the water in the glands boiling, but it is nevertheless equally objectionable. This may be overcome by the arrange-

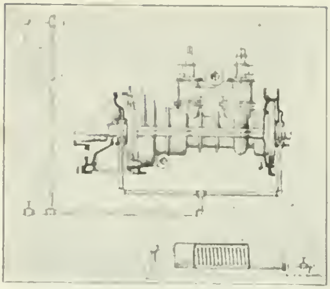


FIG. 12

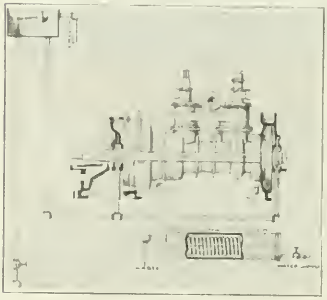


FIG. 13

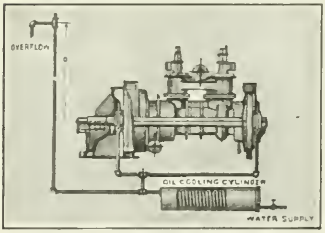


FIG. 14

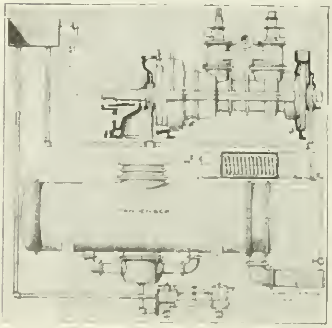
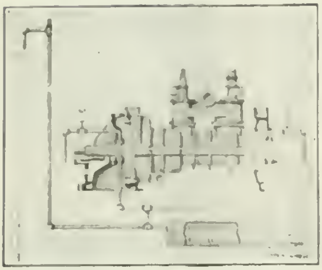


FIG. 15

ment shown in Fig. [illegible] where [illegible] [illegible] [illegible] and [illegible] are installed at M and [illegible], which lead [illegible] way to any suitable tank or sewer. These valves are open just enough to keep sufficient circulation so that there is no evaporation going on which is evidenced by steam coming out



as though the glands were leaking. These circulating valves may be used with any of the arrangements above described.

# Questions in the Parallel Running of Alternators

By J. W. Himmelsbach

The following questions, recently asked the writer, are of general interest to all who have anything to do with the parallel operation of alternators. Referring to the accompanying diagram, the questions were as follows:

*Question No. 1*: Connected as shown, can there be any difference in phase and any difference in frequency between the two generators while they are connected together electrically?

*Question No. 2*: With meters connected as shown what will be indicated by them severally and relatively?

While the following explanation will apply to machines of any capacity but of the same voltage, number of phases and frequency, it will be understood that the units are of the same capacity, which will make the answer to question No. 1 seem more simple. Let us assume, to begin with, that both machines are carrying load in proportion to their capacity. Running under these conditions, with the power factors of the units alike, it is impossible for the two machines to be out of phase or at different frequencies. There is, however, one condition under which intermittent differences of frequency and time phase will occur and that will be due to angular variation in the velocity of the moving members of the generators, when reciprocating engines are employed as prime movers, or turbines of the type equipped with governing apparatus such that it causes periodic variations of speed dependent on the load. This variation, however, is not continuous and therefore it can hardly be said that under these conditions any difference in frequency exists.

Let us now assume that the supply of steam is gradually cut off from the No. 1 unit. This will result in this unit dropping its load, and in order to keep the frequency constant it is obvious that more steam must be supplied to unit No. 2. The power factor may be kept at unity (providing the generators are carrying a noninductive load) by proper adjustment of the existing current. If this procedure is continued until all the steam has been cut off from No. 1 unit, and during this time the load has been transferred gradually from No. 1 unit to No. 2 unit, the frequency should be held constant, and the power factor at a maximum. As soon as all the steam is cut from No. 1 unit, No. 2 unit will have to supply the energy necessary to keep No. 1 up to synchronous speed, the latter machine then running as a motor and driving its engine or turbine. If the frequency of No. 2 unit is held constant, the speed and frequency of No. 1 will also be constant and there will be no difference between the two units, as the speed of No. 1 is directly dependent on the speed of No. 2. There will also be no difference in phase, as the power factor can be held at maximum by the adjustment of the field currents. At this point, the statement may be made that as long as both machines have normal field excitation there can be absolutely no difference in phase or frequency when the machines are operative under the conditions previously stated.

If the conditions are changed still farther, by gradually decreasing the field strength of No. 1 unit, this will result in the flow of "wattless" or synchronizing currents between the two machines and a decreased power factor, as the currents in No. 1 unit will lag. Other conditions (the load in the external circuit) remaining unchanged, the output of No. 2 unit will increase as the cross currents increase, due to the $I^2R$ losses in the conductors, and while these losses may not be very high, yet if the cross currents should reach a high figure (the loss increases in proportion to the square of the current), the total loss may reach a figure which is appreciable. A farther decrease in the field current of No. 1 will magnify these conditions until zero excitation on No. 1 is reached. Up to this point No. 1 will run as a synchronous motor, and under the conditions described phase differences will exist, but not a difference in the rate of speed of the two units. This holds good as long as both machines have their fields excited, either normally or otherwise. Immediately on opening the field circuit of No. 1 unit the characteristics of its operation are changed. It is no longer a synchronous motor, but runs as an induction motor, which is never in absolute synchronism with the supply generator; some difference in speed always exists. When running thus, No. 1 unit will have all the characteristics of a squirrel-cage induction motor. It is a well known fact that for such a motor to exert any torque a certain amount of slip or difference in speed is necessary, and this will be the case when No. 1 unit is running with an unexcited field; there will be just enough slip to provide sufficient torque to pull around the prime mover to which it is coupled. This slip will be of small value, perhaps not more than 1 per cent., but it must be there or the unit would come to a dead stop. It is under this condition, and this one only, that any difference in speed between two identical machines can exist.

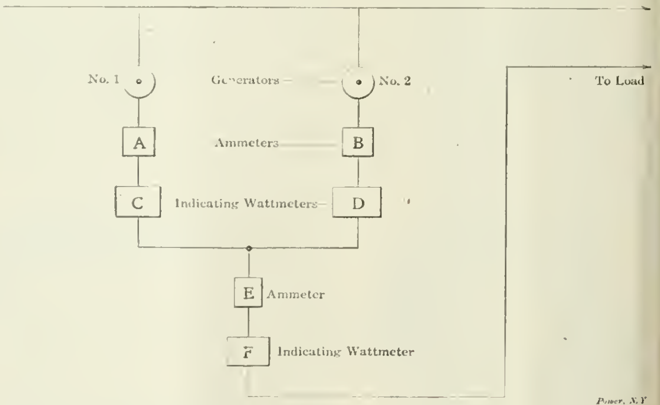


DIAGRAM OF CONNECTIONS OF ALTERNATORS

Answer to question No. 2: With bot units carrying load the meters will indi cate as follows:

Meter *F* will indicate the true combine output of both machines, regardless of th power factor, and will be equal to the sur of the readings indicated on the meters and *D*. Meter *E* will indicate the curre flowing to the line, while meters $A$ and $B$ will indicate the current flowing from the respective machines to the line and also the cross currents passing between the two machines. In other words, the sum of the indications of the ammeters $A$ and $B$ will always be greater than that of $E$, regardless of the power factor at which the two units are operating.

## Discussion on "Small Steam-Turbines"

In our June 29 number, an abstract was given of Charles B. Burleigh's discussion at the local Boston meeting of the A. S. M. E., on George A. Orrok's paper on "Small Steam Turbines," presented at the Washington meeting of the society in May. Besides Mr. Burleigh, a number of those present at the Boston meeting had something to say on the subject, and in the following is given a brief abstract of their remarks.

Mr. London, of the Terry Steam Turbine Company, of Hartford, thought that there was not much room for discussion of efficiency as between one turbine and another of the smaller sizes. In the large turbines a pound of steam pressure may mean $2000 to $4000 a year added to the coal bill, but in the case of the small turbine, where it means only $10 $15 or 25 a year, there is no good reason for so much talk about efficiency. This small sum is amply repaid by the difference in cost of the machines. It was Mr. London's opinion that the most valuable part of Mr. Orrok's paper was that part bringing out and showing the simplicity of the construction of the turbine at the present time. In a very few years every engineer will understand the construction of the steam turbine as thoroughly as he now knows the engine, and he will be able to make his own repairs, which is the principal argument now used against the turbine. The steam turbine is all right. The point is to get something to couple up to it. Pump builders are now making pumps to suit turbine speeds, the generator people are doing likewise, and those making blowers take the speed into account. This in itself is an acknowledgement that the turbine is here to stay.

Charles B. Rearick was firmly convinced that in all classes of pump service the turbine could take care of its end of the work. Pump speeds are not always ideal for the turbine. This means a compromise and usually a sacrifice in the efficiency of the pump to get the best speed for the turbine. Even when the turbine is run at low speeds and consumes 50 per cent. more steam than the engine, it is a small matter when it is considered that 80 per cent. of the heat in the steam is returned to the boilers, and the operation and maintenance are simplified. Where efficiency is of importance, such as in isolated-dynamo work, the speeds are usually high enough to give results quite as good as those of the reciprocating engine, and in some cases better.

Professor Reid, was of the opinion that the amount of coal burned did make a difference. Several times lately a manufacturer had said: "I am exceeding the capacity of my plant. What shall I put in? Shall I put in an engine large enough for the peak load and carry the whole thing on it, or put in a small engine and a turbine to carry it part of the time?" If the manufacturer finds that his coal bill is running up with the turbine, there is going to be trouble for whoever recommended the turbine. The coal bill does make a difference.

In reply to Professor Reid and a similar question by Professor Hollis, Mr. Rearick enlarged on his previous talk and gave his opinion that the question of steam consumption on an auxiliary should not be considered on the auxiliary itself. What is wanted is a low coal consumption for a complete installation. An auxiliary may require 70 pounds of steam per horsepower, but if the exhaust is all returned to the heater, no more coal is required than for a more efficient unit, for the heat is returned to the boiler to evaporate the extra water. Over-all efficiency is the prime consideration.

R. H. Rice, of the General Electric Company, gave an interesting explanation of the reason why the turbine-water rates decrease as the load goes up. The impulse turbine is essentially a turbine of partial admission, using, except in special cases, only a portion of the initial circumference for passing steam through the buckets. In the case of the condensing turbine, multistage, the last stage is usually designed at the right hight of bucket and proportion of nozzle to use the entire circumference. If it is a four-stage machine, the next to the lowest stage will use, perhaps, one-half of the circumference. The area could be so distributed as to include the entire circle, but that would involve excessive shortening of the buckets. For that and other reasons half the circumference is used. In the second stage a still further narrowing of the steam path is used, and in the first stage, for convenience in making the buckets, a short arc is used, perhaps 90 degrees. If it were attempted to use the entire circumference of the wheel in a noncondensing turbine, it would be necessary to use so minute a bucket that the machine would be impracticable to manufacture, and would be inefficient. It is, therefore, necessary to use a short arc, and this short arc decreases the cost of the machine, and enables a reasonable bucket speed to be achieved, the particular speed of the bucket depending on the size of the turbine.

One of the reasons why the turbine increases its economy as the load goes on is that it uses a larger circumference; and a smaller percentage of the total power developed is lost in friction, eddy currents and leakage. The steam pressure and area of the nozzle system determines the amount of steam that can be used through a turbine. In a machine with nozzles wide open, the area must be so proportioned that the maximum load intended to be put on it can be carried. Otherwise, the machine would be shut down before the overload came on. It follows that the nozzles which are designed to utilize this pressure at this overload will be too large for running a light load, and consequently the efficiency must drop off, because the full benefit of the steam pressure available is not being obtained. Therefore it has been found advisable to design the nozzle system for full boiler pressure, and to use a larger or smaller number of nozzles, according to the load. When using a smaller arc of the wheel, the full economy of which the nozzle is capable can be secured, and only the proper number of nozzles are open to give the proper load condition. Therefore, the choice of the turbine diminishes for certain powers, and is a compromise between the proper wheel speed and the permissible cost, and the efficiency of the machine at light loads depends on the governing system.

## The Diesel Engine

By W. H. Booth

A paper on the Diesel engine, as the motive power in substation work, more particularly, was read recently before the Institution of Electrical Engineers in London. The peculiarity of the Diesel engine as made in Europe and probably elsewhere is that it is extremely regular in its performance and turns out power for a certain fixed number of thermal units of fuel value.

As one of the speakers in discussion of the paper showed, the Diesel engine has the virtues and the defects of its qualities. No matter how far out of order a steam engine may be, it will run if steam is turned into it; it is, therefore, possible to run a steam engine when in a very uneconomical state of repair. There is, of course, a certain advantage in this, for sometimes it is desirable that an engine should run no matter what its condition.

The Diesel engine works with a very high initial pressure due to the high compression of a charge of pure air. Ignition of the fuel is caused by the high temperature of this highly compressed charge. It is not possible to obtain high compression unless the piston and cylinder of the engine are in good order and tight; so the engine will not work unless it is in good order. This is an advantage where economy is the prime consideration. Unless kept well up to the mark the engine stops. Proper maintenance, therefore, cannot be neglected and this is why the Diesel engine is so efficiently economical.

The early troubles of the engine have been cured by attention to good workmanship, liberally proportioned parts and the elimination of weak parts in design and of the method of operation. The consumption of oil on loads of one-quarter up to full load was given by one speaker as 0.20 to 0.33 pound per indicated horsepower-hour, the oil being assumed to be of 19,300 B.t.u. capacity per pound, being a similar oil to one which previously tested up to that figure. The oil used per brake horsepower was 0.09 to 0.40 pound per hour, and it was pointed out that the particular tests which showed these results were made with a long and somewhat small exhaust pipe.

The exhaust gases of a Diesel engine escape at over 900 degrees Fahrenheit, or over 1360 degrees absolute temperature. The air is taken into the cylinder at ordinary atmospheric temperature, or say 520 degrees absolute. The exhaust volume must, therefore, be about two and a half times the intake volume, not counting the increase of volume due to the steam formed from the hydrogen in the fuel. Thus for each cubic foot of air drawn into the cylinder about three cubic feet of mixed gases are rejected; hence, the exhaust gases must push away two cubic feet of atmospheric volume in excess of the initial volume taken in. Though the exhaust is not all condensible to liquid it is all reducible in volume to some extent and might be reduced by passing it through a suitable water-cooled tubular cooler. With an engine running at 160 revolutions per minute, giving 80 exhaust strokes, for each cubic foot of cylinder capacity there will be two cubic feet excess of gases at each exhaust stroke, or 160 cubic feet per minute. Now, to displace a cubic foot of atmosphere requires about 2000 foot-pounds of work. The energy wasted, therefore, is

$$2000 \times 160 = 320,000$$

foot-pounds or, say, 10 horsepower which might be economized by cooling the effluent gases to atmospheric temperature before they leave the exhaust outlet. The inference is that an appreciable economy is possible if the exhaust is reduced in velocity by means of gradually enlarging pipe discharging into a cooling chamber whence the escape is free to the atmosphere.

The worst of such papers as this is that the authors always draw comparisons between what they advocate and what is already at work. The author of this paper compared costs of Diesel equipment with those of steam and of gas plants, and, of course, men who thought they were affected rose and demolished all his figures, even though they themselves had furnished some of them. Such comparisons are useless at best, for every case must be worked out for itself. That the Diesel engine has come to stay is pretty conclusively proved by the fact that already there are at work engines to the amount of 35,000 horsepower.

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## Catechism of Electricity

### TYPICAL FORMS OF DIRECT-CURRENT GENERATORS

1072. *Are small direct-current generators ever used in a three-wire system?*

The generators supplying the working current to a three-wire system are usually large machines, but two small generators are sometimes used in connection with them to compensate for an unbalanced load on either side of the system. A pair of small generators used in this way is called a balancer set.

1073. *Explain how a balancer set operates.*

When the load is balanced, both the balancer generators operate as unloaded motors, but when unbalanced, one machine operates as a generator and the other as a motor, the combined current of the two machines compensating for the increased load on the generator side. Balancer sets are flat-compounded so as to keep the voltage on each side equal, irrespective of load. They afford a very convenient method for obtaining a neutral on three-wire systems, and a small balancer can be used on systems of large capacity. The amount of unbalancing between the two sets on the system determines the capacity of the set.

1074. *Illustrate and describe a typical form of balancer set.*

Fig. 303 shows a balancer set made by

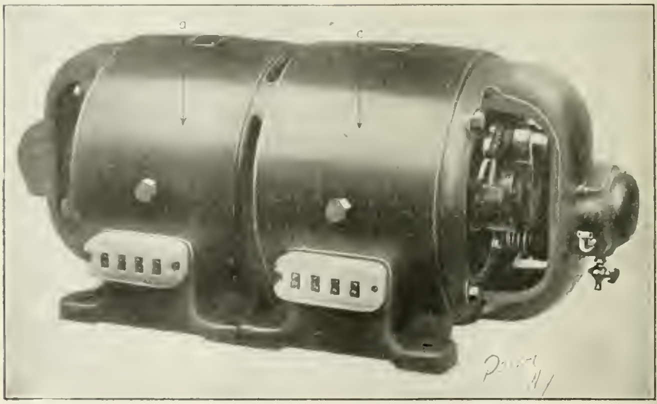

FIG. 303. 1.75-KILOWATT BALANCER SET MADE BY THE GENERAL ELECTRIC COMPANY

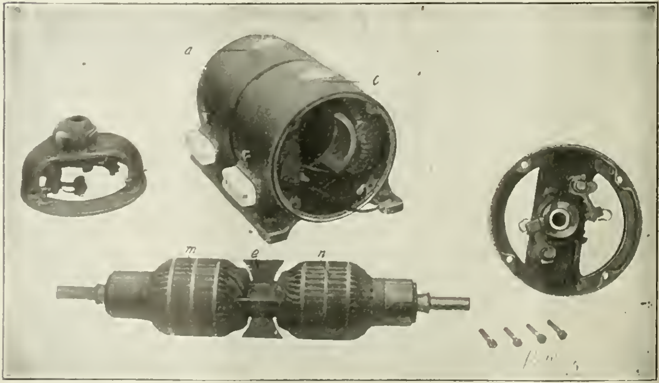

FIG. 304. DISSEMBLED VIEW OF THE BALANCER SET SHOWN IN FIG. 303

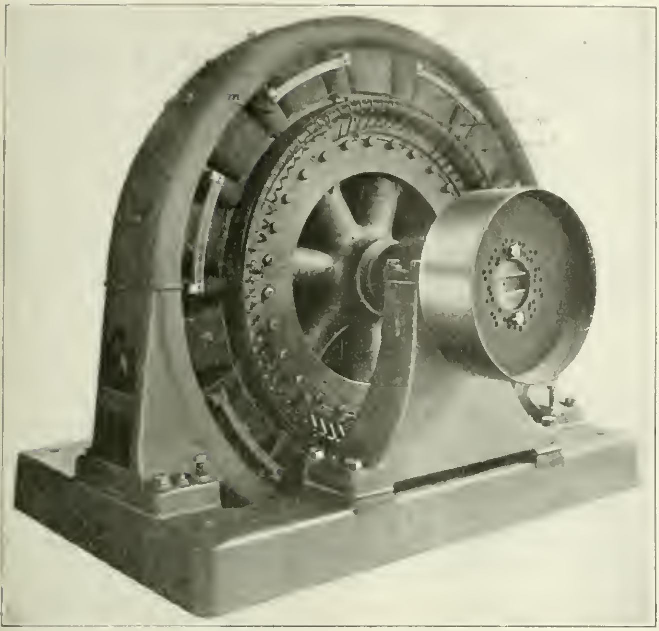

FIG. 305. LARGE DIRECT-CURRENT BELTED GENERATOR OF THE COMMUTATING-POLE TYPE MADE BY THE GENERAL ELECTRIC COMPANY

the General Electric Company for use in a 250-volt three-wire system. The principal parts composing the set are shown separately in Fig. 304. The two generator frames *a* and *c*, Fig. 303, are riveted together through spacing blocks, and both armatures *m* and *n*, Fig. 304, are mounted on a common shaft which is strengthened by means of an increase in size between the armatures. A fan *e*, mounted between the armatures, draws air into the space between the two machines to prevent undesirable heating.

1075. *What advantage is gained by the use of auxiliary magnet poles in a generator?*

The size of generator for a given output is less and larger overloads can be carried for short periods.

1076. *Explain the effect of such poles.*

Auxiliary poles between the main field-magnet poles produce a magnetic field, of such strength as to reverse the current promptly in the armature coils short-circuited during commutation, the brushes remaining in a fixed position. The interference by armature reaction, which ordinarily produces sparking at the brushes, is neutralized because the strength of the auxiliary field produced by the auxiliary poles is always proportional to the load, the coils being in series with the armature.

1077. *Illustrate and describe a generator of the auxiliary-pole type.*

Fig. 305 shows a 2100-kilowatt generator containing 14 main field-magnet poles *n*, *s*, etc., and the same number of auxiliary poles, *m*, *m*, etc., located midway between the main field-magnet poles. They are wound with insulated copper wire or strips connected in series with the armature circuit so that the current through the coils around the auxiliary poles varies with the load. The main field winding is usually of the simple shunt kind but a compound or series winding may be used when service conditions require it. The generator shown has a shunt winding.

1078. *Is there any other special form of field magnet used in standard commercial generators?*

Yes; one builder employs a compensating winding and a peculiarly constructed field magnet to neutralize armature reaction and improve commutation. The field magnet, with its windings, is shown in Fig. 306.

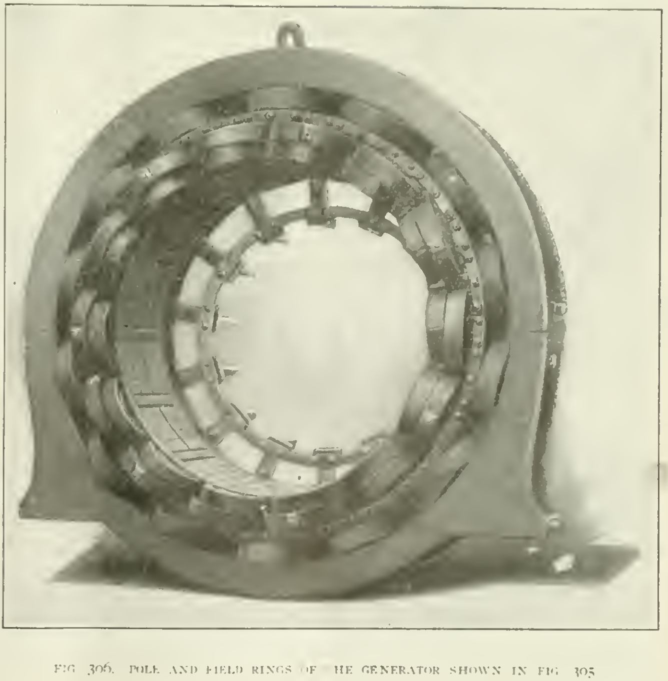

FIG. 306. POLE AND FIELD RINGS OF THE GENERATOR SHOWN IN FIG. 305

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There is no hand-fired furnace from which, under average conditions, as good results can be obtained as from many different patterns of mechanical stokers, and of two equipments the one which will require the less attention from the fireman gives the better results. The most economical hand fired plants are those that approach most nearly to the continuous feed of the mechanical stoker.

# Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think, Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

## Voltage Problem

Recently, while making some changes in a power station, one of the pilot lights on the switch panel of a 1100-volt two-phase generator was removed from socket No. 1 and placed in socket No. 3, replacing a broken one; socket No. 2 had no lamp.

When the lamp was in socket No. 1 the voltage read 116 and when taken out the voltage remained the same, but when put in socket No. 3 the voltage fell back to 112.

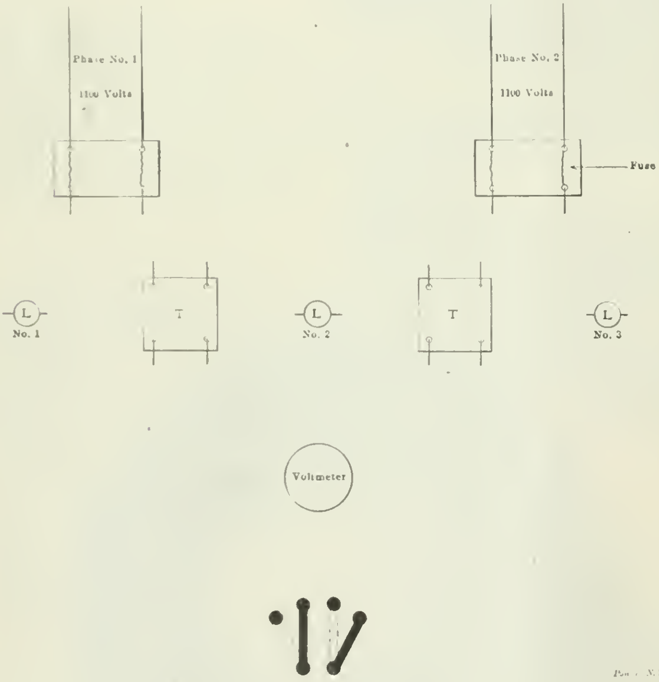


DIAGRAM OF APPARATUS IN VOLTAGE PROBLEM

This was quite an interesting question for some of the station men and will likely be for others. The sketch of the apparatus is submitted with the hope that readers may be able to supply the proper connections to give the foregoing results.

The lamps are indicated at *1*, *2* and *3*, the potential transformers at *T*. The voltmeter is shown, and below the voltmeter is a switch for indicating the voltage of either phase at will.

D. M. GROVE.

Covington, Va.

## Fallacious Reasoning

On page 983, of the June 1 number, C. M. Ripley says that the volatile matter in soft coal amounts to from 30 to 40 per cent., and for this reason it is difficult to get more than from 60 to 65 per cent. boiler efficiency with bituminous coal, while anthracite will give from 70 to 80 per cent.

Up to about 1870, the manufacturers in the East knew nothing about soft coal as fuel for boilers, but in that year there was a strike in the anthracite fields; manufacturers were driven to use soft coal and they had their eyes opened to the fact that one pound of soft coal would do much more work than the same weight of hard coal. Many never went back to anthracite, and the percentage of the latter used is very small.

In my work, anthracite egg showed an evaporation of water from and at 212 degrees of 9.15 per pound of coal. Clearfield, spread even and the fire kept thin, evaporated 9.81 pounds of water per pound coal. Clearfield fired heavy and coked, evaporated 10.63 pounds of water per pound of coal, and Georges Creek, 10.84 pounds.

In those days, nut coal was the smallest size of anthracite and all below was pea and dust, all mixed just as it came from the screens of the coal dealers. This was burned, either with a steam blower, or mixed with soft coal. The price varied from $0.75 to $1.50 per ton according to the demand.

W. E. CRANE.

Broadalbin, N. Y.

## Cost of Cleaning Boilers

In the June 1 number, an editorial suggests that the subject of the cost of cleaning boilers be taken up. It would be interesting and important for those havin experience with machines for purifyin and filtering water to tell us as to th cost of the machines per horsepower an the cost of purifying the water.

As far as lime salts are concerned, the can easily be taken care of within th boiler and at small expense, but the getting rid of the resulting sediment in som types of boiler is laborious and expensive. Magnesia, iron and clay, and als different kinds of vegetable matter, a well as ordinary mud, form quite anothe proposition.

Coke filters will take care of a moderat amount of oil and also general impuritie if the water is heated before entering th filters. When the coke goes to piece look out; for the fine particles close u the passages and shut off the water. Ther is also some sediment.

The cost of cleaning should include a cost for solvents, labor and injury t brickwork from cooling, extra fuel use in heating and the cost for capital fo extra boilers required. On the other side if the water can be made absolutely clea and pure, will such water be a cause o deterioration of the boiler?

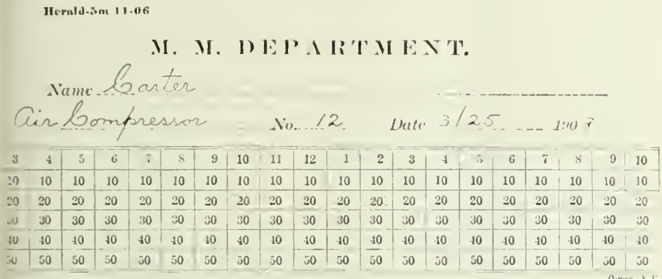
W. E. CRANE.

Broadalbin, N. Y.

## Reducing Cost of Repairs and Maintenance

Having read with interest many descriptions of repair jobs, I will give some rules which I have used to reduce cost of repairs and maintenance.

First, one should secure job cards, Fig. 1, and a loose-leaf record, Fig. 2. The cards may be of good paper put up in blocks of 100, on which are printed the date line, machine number, nature of the repairs and the repairman's name. There are also cross lines, with hours in the upper ow and ten-minute spaces directly under each hour, the time of commencing and nishing the job to be indicated by a cross. The record leaves contain at the top a blank space for the name and number f the machine; there is a marginal line down the left side for the date, and three sets of dollar and cent lines are on the right side, the first set to be used for workmen's wages, the second for the cost f material and the third for the total cost. The workman states on the back f each card the kind and quantity of ma- ial used. At the end of each day he ears off all the cards for the day, and lips them into a box, from which they re taken each morning, assorted as to the achine number, and entered in the ecord, when the cards are destroyed.



Herald-5m 11-06

M. M. DEPARTMENT.

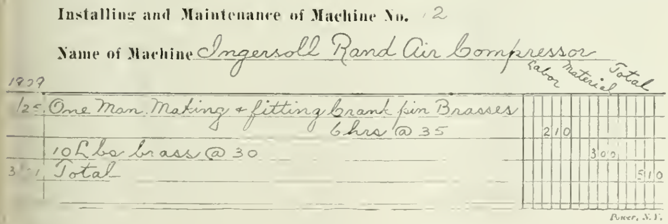
Name Carter

Air Compressor No. 12 Date 3/25 1907

| 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |

Power, N.Y.

FIG. 1



Installing and Maintenance of Machine No. 12

Name of Machine Ingersoll Rand Air Compressor

| 1907 | | Labor | Material | Total |
|---|---|---|---|---|
| /25 | One Man Making + fitting Crank pin Brasses 6 hrs @ 35 | 2 10 | | |
| | 10 Lbs brass @ 30 | | 3 00 | |
| 3/1 | Total | | | 5 10 |

Power, N.Y.

FIG. 2

For locating and determining when re-airs are needed, a perforated tab of cratch paper, placed in a substantial ather binder, is almost a necessity. In is, notes should be made of every de-ect noted in going the rounds, noting but ne machine on a leaf and giving the ame, number and nature of the repair needed; these, unless demanding immediate attention, to be placed on files in the machine or repair shop, the files indicating when work should be attended to.

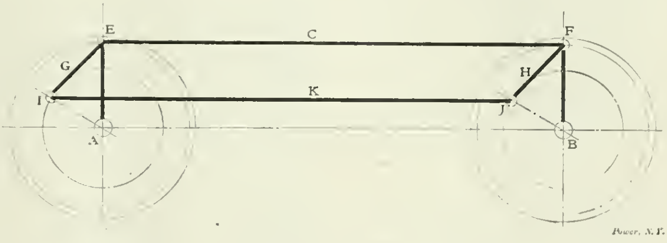
T. J. BLOSS.

Chattanooga, Tenn.

## A Problem In Power

The accompanying sketch refers to J. A. Carruther's problem which appeared in the April 6 number.

The end view of the shafts with the crank disks *A* and *B* are shown. The crank pins *E* and *F* are joined by the main connecting rod *C*. At *G* and *H* are two overhanging cranks rigidly fastened to the disks by the pins *E* and *F* respectively. The pins *I* and *J* of the cranks are connected by the bar *K*, which must be equal and parallel to the connecting rod *C*. The circle scribed by *I* is of the same diameter as the one scribed by *J*, and *G* and *H* may be of any length and turned at any angle, provided they are always equal and parallel and are not the center line of the crank pins and shafts.



MR. ROWLEY'S SUGGESTION

The only function of *K* is to prevent *B* from stopping or reversing its direction of rotation when at the dead center.

FRANK B. ROWLEY.

Minneapolis, Minn.

## Siphon Discussion

Referring to the "A Siphon Discussion" in a recent number, however much nature may dislike the presence of a vacuum, it is a physical impossibility for nature to push water up 40 feet and over the siphon.

"Jimmy the oiler" must remember that nature is the only force acting in this case to raise the water; and a column of water but 34 feet high could be supported even if we had a perfect vacuum at the neck of the siphon, since this force is the pressure of the atmosphere on the surface of water in the reservoir. The long down leg exerts no positive force to lift the water in the short leg. If the siphon were filled with water and released simultaneously at the two ends, the water would break at the neck and flow down each leg.

But how far would the water descend? If there were no possible manner in which air could enter, or be present, we should have an "almost perfect vacuum," as the "Chief" remarked. Although the water might rush completely out of the tube, due to the high head, it would return in the pipe and be vaporized until the vacuum decreased to a pressure equivalent to the temperature of the water. This pressure corresponding to a given temperature may be found in any handbook among the properties of saturated steam. Thus, if the water temperature were 60 degrees, and could remain at that temperature, it would be vaporized until the pressure increased to 0.52 inch of mercury, absolute, at which point vaporization would cease, and the water would stand at a hight of 33.3 feet; assuming a 30-inch barometer, and the lower reservoir at sea level. The hight of water in the short leg would be approximately one foot less, due to the difference in elevation.

The foregoing action as stated is entirely theoretical, however, and we would have far from a perfect vacuum in any [illegible] pass. In such a length of pipe there would be considerable air leak, to say nothing of air carried in by the water. All water contains an amount of air in solution and this may be as great as 5 per cent. This air would be released from the water and prevent any high degree of vacuum. The water would rush down the pipe at a velocity of over 200 feet per second, and the hight to which the level would rise and settle itself would depend upon the amount of air originally contained in the water and that taken in through the pipe joints. In any practical case this hight may be very small and would probably decrease to the level of water in the two reservoirs.

R. R. Peart.

Bridgeport, Conn.

## What Ails the Diagrams?

I [illegible] Wise & Ferry Company's diagram printed in the May 11 number, page 847. The diagram is taken from the crank end, and the trouble is that the string which operates the indicator drum is slipping in some of its fastenings, or the reducing motion is allowing the string to gain in some manner.

The crosshead draws the drum to the point where the offset starts in the compression line or admission, whichever it may be, and at this point the string gains the additional length, and the spring in the drum causes the drum to jump ahead of the crosshead, making the offset, and also moving the diagram.

I find that in the five revolutions shown the diagram has moved just $\frac{1}{4}$ inch in the direction that the expansion line runs.

E. R. Teer.

Anderson, Ind.

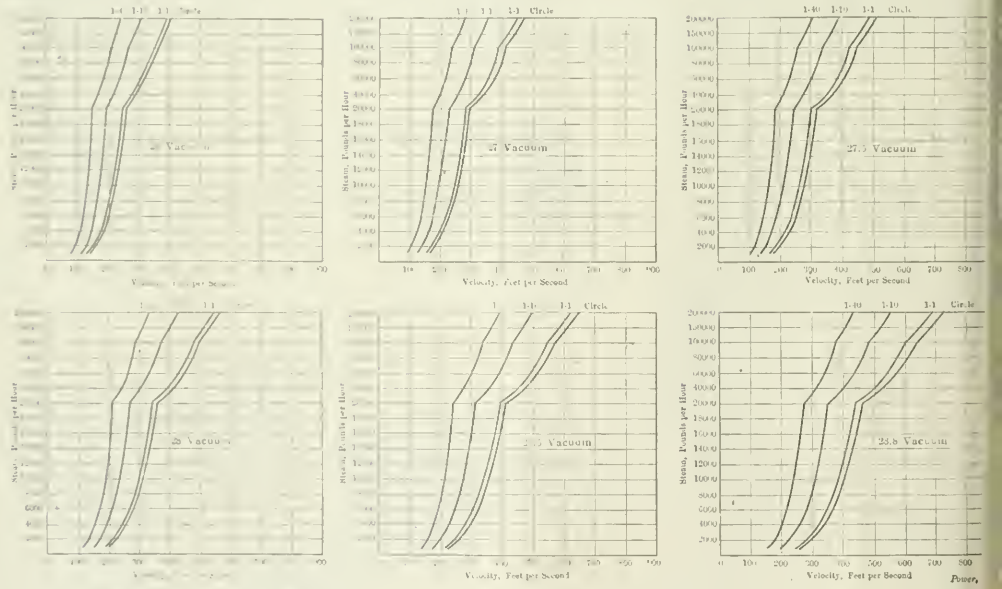


FIG. 2. CURVES SHOWING PERMISSIBLE VELOCITY OF STEAM AT DIFFERENT VACUA THROUGH EXHAUST-STEAM PIPES AND PASSAG BASED ON CROSS-SECTIONAL AREA OF CIRCULAR AND RECTANGULAR SHAPES. CURVES 1-1, 1-10, 1-40 BEING FOR RECTANGULAR PASSAGES WHOSE SIDES ARE IN THAT RATIO

## Engine Room Kinks

In the June 1 number, Milton Heglin shows a kink for using water under a valve tongue to make it possible to enter a boiler. As I have seen this tried with poor results, costing [illegible] the firm a new valve and the engineer several burns, I think care should be used.

In the case mentioned, repairs to the boilers were to be made, and the 6-inch main valve leaked badly. The boiler maker wanted to plug it off in the usual way with a couple of pieces of board, with sheet packing between held in place with bolt and nut. As the valve was connected at the bottom to a trap, the engineer said it would be a simple matter to connect this pipe to the deep-well pump. After doing so and getting a fair stream of water, he went on top of the boiler to look inside and see how things were, when the bottom of the valve came off, scalding him and tying the plant up. I believe the valve was fractured by running the cold water in such a large quantity as to cause water hammer, as there was 125 pounds pressure on one side of the valve at the time.

D. F. Crowther.

Boston, Mass.

## Curves for Condenser Design

The accompanying curve charts, Fi 1 and 2, show curves for use in co denser design.

They have just been completed fr actual experience in the designing of large number of condensers of si capable of handling various quantities steam, ranging from 1000 pounds p hour up to 150,000 pounds per hour; t vacua ranging from 26 inches up

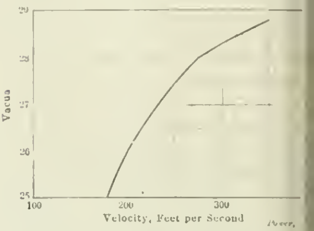


FIG. 1

29 inches, with the barometer at 30 inc

The condensers having their st ports, passages, etc., designed in cordance with the velocity given in curves, have, in all cases, come u their guaranteed results. These cu are submitted, trusting that they wil of interest and value to readers. drawings are self-explanatory and more particulars need be furnished.

Table 1 gives the properties of st at all vacua from 0 inch up to 29.9 inc

TABLE 1. PROPERTIES OF STEAM

| Vacuum Inches-Mercury Barometer 30 Ins. | Percentage Vacuum | Absolute Pressure Lbs. □" | Temperature Fahr.° | Temperature Cent° | Volume Cubic Feet/Lb. | Latent Heat B.T.U's/Lb. | Vacuum Inches-Mercury Barometer 30 Ins. | Percentage Vacuum | Absolute Pressure Lbs. □" | Temperature Fahr.° | Temperature Cent° | Volume Cubic Feet/Lb. | Latent Heat B.T.U's/Lb. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30.0 | 100 | 0.0 | | | | | 23.8 | 79⅓ | 3.045 | 142.0 | 61.1 | 116.0 | 1015 |
| 29.9 | 99⅔ | 0.0491 | | | | | .6 | 78⅔ | 3.143 | 143.0 | 61.6 | 113.0 | 1014 |
| .8 | 99⅓ | 0.0982 | 36.0 | 2.2 | 3430 | 1089 | .4 | 78 | 3.242 | 144.0 | 62.2 | 111.0 | 1014 |
| .7 | 99 | 0.1474 | 46.0 | 7.7 | 2054 | 1082 | .2 | 77⅓ | 3.340 | 115.0 | 62.7 | 108.0 | 1013 |
| .6 | 98⅔ | 0.1965 | 53.5 | 12.0 | 1540 | 1076 | 23.0 | 76⅔ | 3.438 | 146.0 | 63.3 | 105.0 | 1012 |
| .5 | 98⅓ | 0.2456 | 60.0 | 15.5 | 1220 | 1072 | 22.5 | 75 | 3.684 | 149.0 | 65.0 | 98.4 | 1010 |
| .4 | 98 | 0.2947 | 65.0 | 18.3 | 1031 | 1069 | 22.0 | 73⅓ | 3.929 | 152.0 | 66.6 | 91.8 | 1008 |
| .3 | 97⅔ | 0.3438 | 69.0 | 20.5 | 901 | 1066 | 21.5 | 71⅔ | 4.175 | 154.0 | 67.7 | 87.7 | 1007 |
| .2 | 97⅓ | 0.3929 | 73.0 | 22.7 | 737 | 1063 | 21.0 | 70 | 4.421 | 157.0 | 69.4 | 81.8 | 1005 |
| .1 | 97 | 0.4421 | 76.0 | 24.4 | 719 | 1061 | 20.5 | 68⅓ | 4.666 | 159.0 | 70.5 | 78.2 | 1003 |
| 29.0 | 96⅔ | 0.4912 | 79.5 | 26.3 | 643 | 1059 | 20.0 | 66⅔ | 4.912 | 161.0 | 71.6 | 74.7 | 1002 |
| 28.9 | 96⅓ | 0.5403 | 82.5 | 28.0 | 587 | 1057 | 19.5 | 65 | 5.157 | 163.0 | 72.7 | 71.5 | 1000 |
| .8 | 96 | 0.5894 | 85.0 | 29.4 | 546 | 1055 | 19.0 | 63⅓ | 5.403 | 165.0 | 73.8 | 68.4 | 999 |
| .7 | 95⅔ | 0.6385 | 87.5 | 30.8 | 505 | 1053 | 18.5 | 61⅔ | 5.648 | 167.0 | 75.0 | 65.5 | 997 |
| .6 | 95⅓ | 0.6876 | 90.0 | 32.2 | 470 | 1051 | 18.0 | 60 | 5.894 | 169.0 | 76.1 | 62.7 | 996 |
| .5 | 95 | 0.7368 | 92.0 | 33.3 | 442 | 1050 | 17.5 | 58⅓ | 6.140 | 171.0 | 77.2 | 60.0 | 995 |
| .4 | 94⅔ | 0.7859 | 94.0 | 34.4 | 417 | 1048 | 17.0 | 56⅔ | 6.385 | 172.5 | 78.05 | 58.1 | 994 |
| .3 | 94⅓ | 0.8350 | 96.0 | 35.5 | 394 | 1047 | 16.5 | 55 | 6.631 | 174.0 | 78.8 | 56.2 | 993 |
| .2 | 94 | 0.8841 | 98.0 | 36.6 | 370 | 1045 | 16.0 | 53⅓ | 6.876 | 176.0 | 80.0 | 53.9 | 991 |
| .1 | 93⅔ | 0.9332 | 100.0 | 37.7 | 350 | 1044 | 15.5 | 51⅔ | 7.122 | 177.5 | 80.8 | 52.3 | 990 |
| 28.0 | 93⅓ | 0.9823 | 101.5 | 38.1 | 336 | 1043 | 15.0 | 50 | 7.368 | 179.0 | 81.6 | 50.6 | 989 |
| 27.9 | 93 | 1.031 | 103.0 | 39.4 | 322 | 1042 | 14.5 | 48⅓ | 7.613 | 180.5 | 82.5 | 49.0 | 988 |
| .8 | 92⅔ | 1.081 | 104.5 | 40.3 | 308 | 1041 | 14.0 | 46⅔ | 7.859 | 182.0 | 83.3 | 47.6 | 987 |
| .7 | 92⅓ | 1.130 | 106.0 | 41.1 | 294 | 1040 | 13.5 | 45 | 8.104 | 183.5 | 84.1 | 46.1 | 986 |
| .6 | 92 | 1.179 | 107.5 | 41.9 | 282 | 1039 | 13.0 | 43⅓ | 8.350 | 185.0 | 85.0 | 44.5 | 985 |
| .5 | 91⅔ | 1.228 | 109.0 | 42.7 | 270 | 1038 | 12.5 | 41⅔ | 8.595 | 186.0 | 85.5 | 43.6 | 984 |
| .4 | 91⅓ | 1.227 | 110.0 | 43.3 | 263 | 1037 | 12.0 | 40 | 8.841 | 187.5 | 86.4 | 42.4 | 983 |
| .3 | 91 | 1.326 | 111.5 | 44.2 | 253 | 1036 | 11.5 | 38⅓ | 9.087 | 189.0 | 87.2 | 41.2 | 982 |
| .2 | 90⅔ | 1.375 | 113.0 | 45.0 | 244 | 1035 | 11.0 | 36⅔ | 9.332 | 190.0 | 87.7 | 40.4 | 981 |
| .1 | 90⅓ | 1.424 | 114.0 | 45.5 | 237 | 1035 | 10.5 | 35 | 9.578 | 191.5 | 88.6 | 39.2 | 980 |
| 27.0 | 90 | 1.474 | 115.0 | 46.1 | 231 | 1034 | 10.0 | 33⅓ | 9.823 | 193.0 | 89.4 | 38.1 | 979 |
| 26.9 | 89⅔ | 1.523 | 116.5 | 47.0 | 222 | 1033 | 9.5 | 31⅔ | 10.07 | 194.0 | 90.0 | 37.4 | 978 |
| .8 | 89⅓ | 1.572 | 117.5 | 47.5 | 216 | 1032 | 9.0 | 30 | 10.31 | 195.0 | 90.5 | 36.7 | 978 |
| .7 | 89 | 1.621 | 119.0 | 48.5 | 207 | 1031 | 8.5 | 28⅓ | 10.56 | 196.0 | 91.1 | 36.0 | 977 |
| .6 | 88⅔ | 1.670 | 120.0 | 48.8 | 202 | 1030 | 8.0 | 26⅔ | 10.81 | 197.0 | 91.6 | 35.3 | 976 |
| .5 | 88⅓ | 1.719 | 121.0 | 49.4 | 197 | 1030 | 7.5 | 25 | 11.05 | 198.0 | 92.2 | 34.6 | 976 |
| .4 | 88 | 1.768 | 122.0 | 50.0 | 192 | 1029 | 7.0 | 23⅓ | 11.30 | 199.0 | 92.7 | 33.9 | 975 |
| .3 | 87⅔ | 1.817 | 123.0 | 50.5 | 187 | 1028 | 6.5 | 21⅔ | 11.54 | 200.0 | 93.3 | 33.3 | 974 |
| .2 | 87⅓ | 1.866 | 124.0 | 51.1 | 183 | 1028 | 6.0 | 20 | 11.79 | 201.0 | 93.8 | 32.7 | 974 |
| .1 | 87 | 1.916 | 125.0 | 51.6 | 178 | 1027 | 5.5 | 18⅓ | 12.03 | 202.0 | 94.4 | 32.1 | 973 |
| 26.0 | 86⅔ | 1.965 | 126.0 | 52.2 | 173 | 1026 | 5.0 | 16⅔ | 12.28 | 203.0 | 95.0 | 31.5 | 972 |
| 25.8 | 86 | 2.063 | 128.0 | 53.3 | 164 | 1025 | 4.5 | 15 | 12.52 | 204.0 | 95.5 | 30.9 | 971 |
| .6 | 85⅓ | 2.161 | 129.0 | 53.8 | 160 | 1024 | 4.0 | 13⅓ | 12.77 | 205.0 | 96.1 | 30.3 | 971 |
| .4 | 84⅔ | 2.259 | 131.0 | 55.0 | 152 | 1023 | 3.5 | 11⅔ | 13.02 | 206.0 | 96.6 | 29.7 | 970 |
| .2 | 84 | 2.358 | 133.0 | 56.1 | 147 | 1022 | 3.0 | 10 | 13.26 | 207.0 | 97.2 | 29.1 | 969 |
| 25.0 | 83⅓ | 2.456 | 134.0 | 56.6 | 141 | 1021 | 2.5 | 8⅓ | 13.51 | 208.0 | 97.7 | 28.5 | 969 |
| 24.8 | 82⅔ | 2.554 | 135.5 | 57.5 | 136 | 1020 | 2.0 | 6⅔ | 13.75 | 209.0 | 98.3 | 27.9 | 968 |
| .6 | 82 | 2.652 | 137.0 | 58.3 | 131 | 1019 | 1.5 | 5 | 14.00 | 210.0 | 98.8 | 27.4 | 967 |
| .4 | 81⅔ | 2.751 | 138.0 | 58.8 | 128 | 1018 | 1.0 | 3⅓ | 14.24 | 210.5 | 99.1 | 27.1 | 967 |
| 2 | 80⅔ | 2.849 | 139.5 | 59.7 | 124 | 1017 | 0.5 | 1⅔ | 14.49 | 211.0 | 99.4 | 26.9 | 967 |
| 24.0 | 80 | 2.947 | 141.0 | 60.5 | 119 | 1016 | 0.0 | 0 | 14.74 | 212.0 | 100.0 | 26.4 | 966 |

*Power, N.Y.*

TABLE 2. BRASS CONDENSER TUBES.

COPPER, 70%; SPELTER, 29%; TIN, 1%.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Diameter, external . . . | in. | ½ | ⅝ | ¾ | ⅞ | 1 | 1⅛ | 1¼ |
| Diameter, external . . . | m/m | 12.7 | 15.9 | 19.0 | 22.2 | 25.4 | 28.6 | 31.7 |
| Thickness . . . . . . . . . | LSG | 19 | 18 | 18 | 18 | 17 | 17 | 16 |
| Thickness . . . . . . . . . | in. | 0.040 | 0.048 | 0.048 | 0.048 | 0.056 | 0.056 | 0.064 |
| Thickness . . . . | m/m | 1.016 | 1.219 | 1.219 | 1.219 | 1.422 | 1.422 | 1.626 |
| Surface, linear feet . . . | sq.in. | 18.85 | 23.56 | 28.26 | 32.99 | 37.69 | 42.4 | 47.12 |
| Surface, linear feet . | sq.ft. | 0.1309 | 0.1636 | 0.1963 | 0.2291 | 0.2618 | 0.2945 | 0.3272 |
| Area bore . . . | sq.in. | 0.1387 | 0.22 | 0.336 | 0.477 | 0.62 | 0.807 | 1.018 |
| Area bore . | sq.ft. | 0.000965 | 0.00153 | 0.00233 | 0.00331 | 0.00431 | 0.0056 | 0.00707 |
| Weight, Linear Feet . . | lb. | 0.226 | 0.328 | 0.399 | 0.46 | 0.62 | 0.812 | 0.9046 |
| $\frac{S}{A} = \frac{\text{Sur. Lin. Ft.}}{\text{Area Bore}}$ . . . . . . . . . . . . | | 135.9 | 107.2 | 84.1 | 69.2 | 60.8 | 52.7 | 46.3 |
| Distance between supports, in. | | 50 | 62 | 75 | 87 | 100 | 112 | 125 |
| Gals. water at 6 ft. per sec. . . | | 130 | 206 | 314 | 443 | 582 | 753 | 955 |

and also shows the relations of temperature, volume, pressure, etc., of saturated steam under vacua.

This table is useful when calculating the area of steam ports, etc. To permit of certain steam velocity being maintained, reference should be made to the table to ascertain the volume of the steam at any particular vacuum.

Table 2 relates to condenser tubes and shows the external diameter, thickness, surface in linear feet, and percentage of copper, spelter and tin forming the composition of the tubes.

W. VINCENT TREEBY.

London, Eng.

## Vibration and Tension

If a stretched rope under tension is set to vibrating, the number of vibrations will be directly proportional to the square root of its tension.

If an elevator car is suspended by two ropes of equal length and size, the rope carrying the greater load will vibrate faster than the other. For instance, if rope No. 1 vibrates four times as fast as rope No. 2, No. 1 is carrying $\sqrt{4} = 2$ times the load No. 2 carries; or, if No. 1 vibrates 1.2 times as fast as No. 2, No. 1 is carrying $\sqrt{1.2} = 1.095$ times as much weight as No. 1 rope.

HOWARD F. MUNSON.

Oakland, Cal.

From most textbooks of physics one can satisfy himself as to the reliability of the equation

$$V = \sqrt{\frac{T}{m}}$$

where $V$ = the velocity of propagation of the wave, or rate of vibration, $T$ = the tension in rope and $m$ = the mass of the rope per unit length.

This shows that the velocity of a transverse wave is equal to the square root of the tension divided by the mass per unit length. The equation may be written in the form

$$T = m\,V^2$$

which shows the relation between the tension and the rate of vibration. The tension varies as the square of the rate of vibration. This, I think, answers the question.

R. E. ANDERSON.

Boston, Mass.

I should say that the relation can be easily proven as follows:

From consideration of the laws of vibrating strings it is found that the frequency $n$ varies inversely as the length $L$, inversely as the square root of the mass $M$ per unit length, and directly as the square root of the tension $T$. Expressed as a formula this would be:

$$n \propto \frac{K}{L}\sqrt{\frac{T}{M}};$$

which may be changed to an equation:

$$n = \frac{K}{L}\sqrt{\frac{T}{M}}.$$

Suppose we apply the formula to two general cases and then find the ratio. We shall then have

$$n_1 = \frac{K}{L_1}\sqrt{\frac{T_1}{M_1}} \text{ and } n_2 = \frac{K}{L_2}\sqrt{\frac{T_2}{M_2}}.$$

Or

$$\frac{n_1}{n_2} = \frac{\frac{K}{L_1}\sqrt{\frac{T_1}{M_1}}}{\frac{K}{L_2}\sqrt{\frac{T_2}{M_2}}} = \frac{L_2}{L_1}\sqrt{\frac{T_1}{T_2} \times \frac{M_2}{M_1}}.$$

But, since in the case given $L_2 = L_1$ and $M_1 = M_2$ the ratio is:

$$n_1 : n_2 = \sqrt{T_1} : \sqrt{T_2}.$$

JOHN G. MINCH.

Monticello, Ill.

As regards the vibration period and tension on cables of the same length and weight, the relation is such that the number of vibrations per second varies directly as the square root of the tension.

If the tension on two cables of the same kind and length is unequal, the total being known they may be found as follows:

$$\frac{\sqrt{\textit{Tension on A}}}{\sqrt{\textit{Tension on B}}} = \frac{\textit{No. of vibrations on A}}{\textit{No. of vibrations on B}}.$$

This reduces to

$$\textit{Tension on A} = \frac{\textit{Weight on both}}{1 + \left(\frac{\textit{No. of vib. B}}{\textit{No. of vib. A}}\right)^2}.$$

A rule derived from the formula would be:

RULE—*Count the vibrations of each cable and divide that of cable B by cable A. Square the result and add one to the square. Divide the total weight on the two by this figure and the result will be the tension on cable A.*

The number of vibrations can be taken for one minute, or longer if necessary to get accurate results, of course counting both for the same length of time.

If there are more than two cables count each one, say for one minute, square the numbers so obtained, then the load on each cable will be divided among them so that each carries a load proportional to these squares.

C. C. SAMPSON.

Chicago, Ill.

The following well known equation will probably answer Mr. Hastings' inquiry:

$$n = \frac{1}{2rl}\sqrt{\frac{Pg}{\pi d}}$$

in which $n$ = the number of vibrations per second, $r$ = the radius of the cord or rope, $d$ = the density, $l$ = the length, $P$ = the tension, $\pi$ = the ratio of the circumference to the diameter and $g$ = the acceleration due to gravity, 32.16 feet, approximately. This equation has been established theoretically and experimentally.

For two ropes of the same size, material and length the only variables would be $n$ and $P$. Separating the constants and variables, for the first rope we have

$$n = \frac{1}{2rl} \times \sqrt{\frac{g}{\pi d}} \times \sqrt{P}.$$

Likewise, for the second:

$$n_1 = \frac{1}{2rl} \times \sqrt{\frac{g}{\pi d}} \times \sqrt{P_1}$$

in which $n_1$ = the number of vibrations per second of the second rope and $P_1$ = the tension.

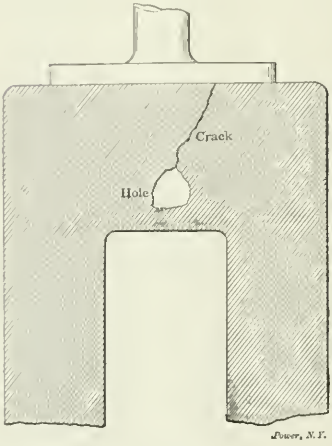


FIG. 1

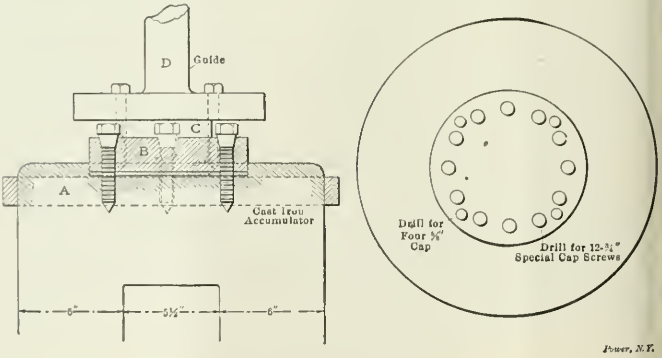


FIG. 2

Dividing the first equation by the second and cancelling, we have

$$\frac{n}{n_1} = \frac{\sqrt{P}}{\sqrt{P_1}}.$$

Squaring both sides we have

$$\frac{n^2}{n_1^2} = \frac{P}{P_1},$$

which is one way of saying that the tension is directly proportional to the square of the number of vibrations in a given time.

The general equation shows in addition that $n$ is inversely proportional to the diameter, length and square root of the density and directly proportional to the square root of the tension. The foregoing is based on the transverse vibration of strings in musical instruments and might require the introduction of constants or other factors to represent accurately the case for elevator suspensions. For all practical purposes the equation

$$\frac{n^2}{n_1^2} = \frac{P}{P_1}$$

would probably answer, if the cords were set in vibration by being struck at the same distance from the car or support.

C. LEE.

Blacksburg, Va.

## A Leaky Accumulator Repaired

An accumulator for maintaining a constant pressure of 4000 pounds per square inch in the high-pressure line to the hydraulic presses in a linseed-oil mill had been in use for about fourteen years. Recently a leak developed due to a crack in the head as shown in Fig. 1.

At first it was thought possible to close up the crack by shrinking on a band as shown in Fig. 2, and this was done, but without result. The accumulator was then put in a lathe and the head turned off about ¼ inch, when the iron showed a very spongy condition. The following scheme seemed to be the only one possible under the circumstances:

A recess was turned in the head about ¾ inch deep, and of a large enough diameter to take up all the spongy and soft metal, and a ½-inch leather packing fitted in. This leather packing was held in place by a steel disk $B$. To make sure that no oil could work up past the cap screws used to hold this disk in place the holes were countersunk, and special ap screws were made with taper should- rs so as to make a fit like a valve on its eat.

The guide rod *D* was held in place by eans of four studs tapped into *B* and assing outside the distance block *C*. This topped the leak.

H. J. Macintire.

Brooklyn, N. Y.

## An Ignition System

Not long ago the batteries on one of y two gas engines gave out and I was ught without renewals on hand. Four ys was the earliest time in which re- wals could be secured and the engine as needed badly. In an hour or so rigged up the device shown in Fig. 1, which *A* is the spark plug, *B* is the duction coil, at *C* are the battery cells, is a double-pole, double-throw switch, and *E* are banks of 16-candlepower hts and *F* are leads running to a 110- lt lighting circuit. This arrangement wered the voltage from 110 volts, which too high, and also gave me any amper- e I wished by turning on and off as any lights as necessary. By the use of e switch *D* I could change from bat- ries to lighting circuit any time I wished. So convenient was this arrangement, d so well did it operate that I at once cided to rig up my other gas engine wise. It was then I ran against some- ng that puzzled me. Fig. 2 shows the angement of the two engines with the and electric connections very much plified. At *A* is the dynamo, *B B B* is 110-volt lighting circuit, *C* and *D* are ks of lamps on No. 1 engine, *E* and *F* similar banks on No. 2 engine. The are electrodes are the movable ones direct contact with the engine frames, while the round electrodes are the stationary ones insulated from the engine frames; *G* and *H* are the gas connections from the engine to the gas main *J*. On completing this arrangement, I found that the two banks of lights, *E* and *C*, remained lighted all the time whether the electrodes were in contact or not. I next found that I could shut off all the lights in bank *C*, and No. 1 engine would still continue to run, but while running this way the bank *E*, instead of remaining continually lighted as formerly, would light up at every contact of each of the two spark plugs. After a little experimenting, I found that the explanation was that a complete circuit had been established as indicated by the dotted line. Simply changing the wires on the electrodes of one of the engines cured the trouble and all went well.

R. Manly Orr.

Brantford, Ont.

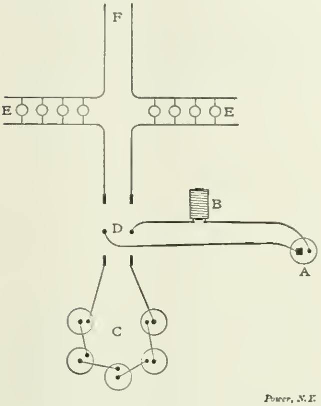


FIG. 1

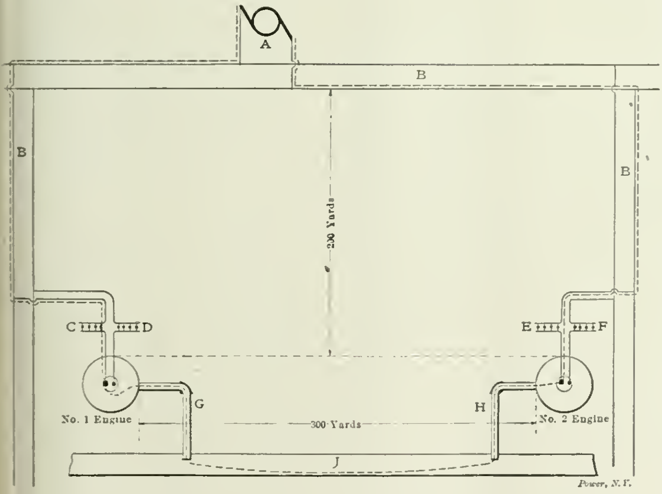


FIG. 2

## Compression

While looking over the letters in the May 18 number, I became interested in the article on "Compression," by E. G. Tilden, also in the diagrams pertaining thereto.

Upon close examination of the letter I find numerous points that appear hard for me to understand. The setting of the valve for the production of the diagram in Fig. 1 is, we are told, by eye, and I don't see any other way of doing the work.

As a slide-valve engine is composed of a single valve, altering any one point alters all other points at the same time. The diagram in Fig. 1 looks to me as if it had no lead or admission until after the crank had passed the center, which would account for the pound on that end, and also a corresponding loss of power. But what is the result on the reverse end of the compromise diagram Fig. 2, which is equally late in admission? It looks to me to be a case of robbing Peter to pay Paul, as the position of the valve is simply reversed, which indicates to me a badly proportioned valve.

Regarding the point of cutoff mentioned, I have failed to discover it as the expansion curve is merged into the admission line. I note that the expansion curve of the two diagrams in Fig. 2 cross each other a little out of the center, but that does not indicate the point of cutoff, as a leaky valve on that end would produce the same effect.

Charles N. Taylor.

Bridgeport, Conn.

## Gas Burns in the Smoke Flue

In the May 18 number, E. A. Adams tells of trouble with the burning of flue gases in the front connection and in the stack of his boiler. He states that the boiler with which he has had the trouble is of the same type as other boilers with which he has had no trouble. Increasing the draft would be a poor expedient for ridding himself of the trouble, even if successful, for the burning of gases after leaving the firebox is evidence of poor combustion in the furnace.

There can be only one reason for this phenomenon and that is lack of air in the fire. Increase of draft might, it is true, draw more air through the grates. However, a very ordinary draft should be sufficient to cause perfect combustion, if there is proper arrangement for admission through the grates. It seems very probable that the grates of his troublesome boiler are of different style than those in the other boilers, and the simplest way out is to vary the size of the grate interstices until it is seen that the gases are being all burned in the furnace. If this does not effect the cure then another expedient, [illegible] will surely have a pronounced effect is to arrange for the admission of air in sufficient quantities through the fire door. He states that the opening of the fire door has stopped his trouble heretofore and I judge that he has a tight-fitting door without draft arrangement. Perhaps this constitutes one of the differences between this boiler and the others. Opening the fire door a little, so that too much cold air is not allowed to enter, will not be harmful to the boiler, and for this purpose the door should be fitted with a variable damper in order that the admission of air may be regulated to correspond to the amount of natural draft. If Mr. Adams succeeds in remedying his difficulty in this manner he will find that he is also economizing in fuel.

L. F. Wilson.

Chicago, Ill.

## Use Cylindrical Flywheels for Safety

In the May 3 number, in the article on flywheels, by A. L. Hodges, there are a number of things to which I take exception. The remarkable thing about the whole subject is the ingenious way in which Mr. Hodges appears to regard the idea of cylindrical flywheels as an entirely new one, and that its general adoption should immediately follow as the result of its suggestion. The fact of the matter is that the flywheel proposition is the most important one that has been before steam-engine designers for almost the last decade, and they have practically gone as far in the adaptation of the cylindrical type as circumstances will warrant. Furthermore, Mr. Hodges has not even touched upon the difficulties which arise in its adaptation, and not only has he ignored them but apparently does not seem to know of their existence.

The danger point in steam-engine operation for a long time had its focus in the construction of the boiler. Modern design and constructive details have resulted in so many improvements, however, that statistics of boiler explosions show a gradual and steady diminution from year to year. Increase in speed and power have so developed the steam-engine type of accident that the chief source of danger lies in the bursting of the flywheel. The number of accidents of this type which are recorded have steadily increased until they have exceeded 150 per cent. increase in a comparatively short time, and from an accident point of view they are a much more significant feature than the ordinary boiler explosion. This has been recognized more or less continuously since the beginning of this change by designers in this field, and all kinds of developments have been attempted, many of them much more complicated and ingenious than the change of form to a more cylindrical type.

As Mr. Hodges states, the kinetic energy of such a wheel and hence its usefulness depend largely upon the moment of inertia of the wheel and this, in turn, depends upon the radius of gyration and the mass. He completely fails, however, to realize that it is the changes in this energy as a proportion of the total energy of the flywheel which is the important point, and that whenever an energy change occurs in either translational or rotational motion a force is created which depends for its size upon the rate of energy change. These forces play the very mischief in the satisfactory operation of the flywheel; and again, the satisfactory operation of an engine, to take care of electric generators where the speed cannot vary even a fraction of what was allowed a short time ago, is dependent upon the ratio of the total energy change in a flywheel to the total kinetic energy in the flywheel. This has to be very small, and since the energy changes themselves are large the total energy bound up in the wheel must often be excessive.

In actual practice it is almost impossible to increase the distance between the bearings of an ordinary flywheel, if the engine is of large power, without disastrous results, at least in regard to the satisfactory and continuous operation of the type. As a simple illustration, the flywheel has to be fastened to the engine by means of the crank shaft. This produces a preponderance of weight on one side which is counterbalanced by a weight attached to the flywheel on the opposite side of the axle. If this is far removed longitudinally, that is, along the axle from the crank shaft, moments are set up which not only distort the wheel, but produce very unequal forces on the bearings and rapidly wear them out. Again, with unequal mass distribution in a flywheel, and high speeds of rotation (and Mr. Hodges seems to think that higher rotational speeds are quite possible if the diameter is cut down), the centrifugal force concentrated at the center of mass produces an unequal pull on the bearings in a radial direction as well. The combination of all of these moments, not only radial but along the axis, is met with in turbine design and operation and the necessity of accurate balancing is immediately apparent to a designer of this type, or even to the operator of such a plant.

A cylindrical flywheel would encounter the same difficulty in the maintenance of the bearings in a satisfactory condition, and the variations in energy which are not apparent in turbine operation would create all kinds of complications in the operation of such a type. In order to understand this, one need merely ask a designer of a turbine installation what would happen to the turbine if it were subject to rapid and alternate variations of kinetic energy, due to the impressio of outside forces at more or less regul intervals, and to what extent variatio in his design would be necessary and i efficiency of construction to allow f such abnormal conditions.

In conclusion it can be said that u doubtedly the author of this paper w not at all familiar with turbine operati or design or any of the practical cond tions which enter in the control and sati factory operation of a large rotati cylindrical mass, operating between bea ings a considerable distance apart.

H. F. Blake.

Philadelphia, Penn.

## Pumping Water for Irrigation

It is a familiar scene in Colorado to s water flowing from a centrifugal pu driven by a 5-horsepower gasolene engi In one case the vertical lift is 22 feet a the discharge is about 300 gallons p minute. This is sufficient for from 20 30 acres of land and if purchased from ditch company would cost about $2 plus the ditch-maintenance tax each ye which tax will exceed the cost for ga lene for this plant. This is an avera size plant and about an average dista to lift water.

The pump is of the submerged type, set about 8 inches from the bottom of t well and is driven at about 600 revo tions per minute by a vertical shaf which the engine is belted; power is tra mitted by a "quarter twist" belt.

The well is an open pit, 7 feet in dia ter, 22 feet deep, curbed with conc blocks and is circular. Water is found a gravel stratum and comes in as fast the pump can handle it. The same pu was used to keep the water out while d ging the well. As the dirt is remo from the inside and drawn out in la buckets the curbing and pump are lowe Concrete blocks make excellent curb for two reasons: it is everlasting and weight makes it settle easily as the ging proceeds. A tripod is used in c nection with a block and tackle for dr ing out the buckets of dirt. The cost operating such a plant would be, about five gallons of gasolene per day 16 cents per gallon, 80 cents for 10 ho It is not necessary to have an attend all that is required is to oil up about times per day, provided the outfit is good make and properly designed and stalled. These plants are not only for pumping from wells, but for rai water from irrigating ditches to hi lands. Sometimes they pump from stre and lakes and occasionally for drai purposes. There are thousands of plants in the arid Western sections, d a great work toward reclaiming land would otherwise be practically worth

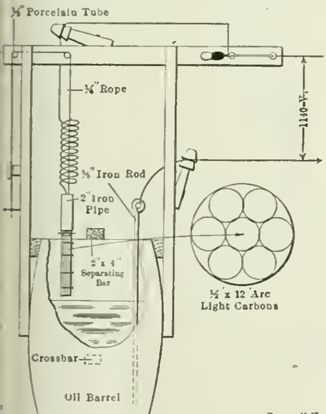
R. B. Whi

Denver, Colo.

## Cheap Water Rheostat

In testing a 75-kilowatt isolated-lighting plant, it was necessary to load the generator on a water barrel, as the lighting load was not sufficient. To make a satisfactory water barrel at once from the materials at hand, one that would work on 1200 volts and absorb from 1 to 25 kilowatts, was a problem. There were no idle transformers in the plant to step the voltage down, and but one barrel could be found, thus eliminating the possibility of putting two in series; and no iron wire was obtainable with which to make a water rheostat.

An old oil barrel was finally found and the head knocked in. Two 2x4-inch wooden pieces, 5 feet long, were nailed to the sides and crossed at the top, with a 3-foot piece of the same material, as shown in the illustration. Two insulators were attached to the frame to carry the conductors and a switch was inserted to open the circuit. In the barrel were nailed two cross bars to prevent the terminals from short-circuiting. A ⅝-inch iron rod was used as one terminal.



*Power, N.Y.*

A CHEAP WATER RHEOSTAT

A flat piece of 4x½-inch iron was tried for the other terminal, but the contact area was so large that 10 kilowatts was the minimum load obtainable. A tapered terminal gave a medium load easily, but the contact area was so small that the very high current density at the point of contact gave an excessive rise in temperature, causing the water to boil violently, giving poor contact and a very fluctuating load.

After several unsuccessful attempts arc-light carbons were tried for the other terminal. First one carbon, then two and finally seven, fastened together, were used as shown. The diameter of each carbon was 5 inches, giving a total cross-section of 1375 square inches. The largest load to be carried by the barrel was about 4 kilowatts, or 20 amperes at 1200 volts, giving a current density of 14.6 amperes per square inch. Carbon conductors will carry from 30 to 35 amperes per square inch, so that the seven carbon conductors were used at about half their maximum density. A rope and two porcelain tubes were arranged so that the carbons could be raised or lowered to get a variation in load and to allow for evaporation of the water. About 18 gallons of water was evaporated every three hours on an average water-barrel load of 19 kilowatts.

This barrel was quickly constructed out of the materials at hand and carried a variable load at 1200 volts without the necessity of using step-down transformers or a series of water barrels.

Louis P. Zimmerman.

Seattle, Wash.

## Cause of Boiler Explosion at Denver

The boiler explosion at Denver has caused considerable comment, and as a suggestion from an engineer on the ground, the writer advances the following as the possible cause of explosion.

Failure occurred at the lower drum which was 84 inches in diameter, constructed of steel plate 11/16 inch thick and having the vertical seam double-strapped and triple-riveted. The shell of the drum was in one sheet having two circular seams, one at the bottom head and one tube sheet, each single-riveted. The seam has rivet holes 1 1/16-inch diameter on a pitch of 2¾ inches. The failure took place at the lower circular seam by tearing the sheet between the rivet holes all the way around the head. The failure of the plate was complete, no rivets being sheared at the seam.

The boiler was about three years old and had been used perhaps twelve months. It was provided with two 4-inch pop safety valves. It had been cut out of commission and had been cleaned, then filled and fired up on the day of the explosion. About 6 p.m., the fireman, with 100 pounds pressure on the other boilers, noted 125 pounds on the damaged boiler by reason of the safety valves blowing. He at once went to the top of the boiler and had the main steam valve wide open when the explosion occurred.

Assuming an average, or above average, load on the unexploded boilers, what else but water hammer, caused by the quick opening of the main steam valve, could have caused the explosion? With a hot fire under the damaged boiler, the safety valve blowing at 125 pounds, and with the other boilers carrying 100 pounds, only what actually occurred is needed to account for the explosion. When the valve was quickly opened, the sudden liberation with reduction in pressure would cause a rapid discharge of the steam from the water, resulting in the water being projected upward against the upper head. The weakest link in a chain will fail under sudden and enormous stress. This boiler, being vertical, was supported at the bottom by lugs or brackets riveted to the shell plate of the lower drum. The brackets rested on suitable foundations in such manner as to provide a pit under the bottom head to get at the blowoff pipe. Grant then a quick reduction in pressure, with the resultant instantaneous liberation of steam in the water space, while water is circulating upward in its usual manner. Under such conditions the disengaged steam in its flight to the surface is expected to carry the water with it, the whole being impelled violently against the upper head. But this head resisted the blow and, of course, the second shock occurred on the lower drum and caused the explosion of the boiler.

The explosion resembles the one occurring at Swift's plant, Union stockyards, Chicago, in 1903. The boiler was the middle one in a battery of five, with seven others in the same room. The type was horiontal tubular, 60 inches diameter. The conditions preceding the explosion were exactly similar to those at Denver. The water lifted, due to difference in pressure coupled with the quick opening of the large steam valve. In this case failure occurred instantaneously on the upper sheets, the fracture extending from head to head. Each head gave way at the top and was bent outward, liberating the tubes which were shot upward at various angles. The entire shell opened outward. The loss of life was appalling and the property loss enormous. The boiler was found in almost its original position after the explosion, proving the fracture from head to head of the shell plates to have been practically instantaneous.

Why this deduction will be asked? For the reason that a boiler under ordinary working condition contains a vast store of explosive energy, varying according to its size and the pressure. If this be liberated by failure, as in the Denver case, the contained energy would project the boiler upward. With a horizontal tubular boiler, should the failure occur at the head, the boiler would be projected in an opposite direction. If at a side or horizontal seam, the boiler would be thrown in a direction opposite from the point of initial rupture. This is self evident. The report of the chief boiler inspector of Chicago, on the Swift explosion attributed the cause to the too sudden opening of the main steam valve.

These two explosions coincide clearly with the theory of that great engineer, Zerah Colburn, who said, "the percussive action exerted by the combined steam and water upon the sudden removal of the pressure must be exerted mainly upward." D. K. Clark says, "The sudden dispersion and projection of the water in the boiler against the bounding surface of the boiler is the great cause of the violence of the results, this dispersion being caused by the momentary generation of the steam throughout the mass of the water and its efforts to escape. It carries the water before it and the combined momentum of the steam and the water carries them like shot through and among the bounding surfaces and deforms or shatters them in a way not to be accounted for by the simple overpressure or by simple momentum of steam."

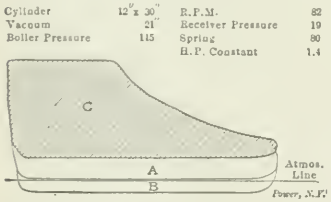
The failure of this boiler, but three years old, constructed by a well known and first-class firm, leads to the inquiry, how shall an explosion of this character be prevented? The result of suddenly opening a large steam valve connecting the boiler with others under less pressure is dangerous. If the intelligence or obedience to orders of the attendant cannot be depended on, be he fireman or engineer, what can be done in the way of devising apparatus that will be fool proof? A 1[illegible]-inch equalizing pipe properly handled would have averted either of these explosions. Common "horse sense" should by this time have taught men the danger of connecting boilers having wide difference in pressure. Is it not really the duty of the engineer in charge to see that the pressures are equal, to personally attend to opening such valves and not leave such important matters to the care of his subordinates?

John Smith.

New York, N. Y.

## Horsepower of Compound Engines

In the issue of April 20, Mr. Harding gives his arguments to show that a compound engine will develop twice the power of a simple engine, saying that diagrams from a compound engine show approximately 100 horsepower for each cylinder, and that if the low-pressure cylinder were removed, it would leave but a 100-horsepower simple engine.



MR. SPRAGUE'S DIAGRAMS

To show that this would not be the condition, I refer to his diagrams of a compound engine which appeared in the January 19 number. The cross-hatched portion of the diagram is a reproduction of his high-pressure cylinder under load. The shaded portion shows a mean effective pressure of 68 pounds and with a horsepower constant of 1.4 would develop 95 horsepower. Suppose the low-pressure cylinder were removed, that would leave an ordinary 12x30-inch simple engine, and with the same cutoff and terminal pressure, and exhausting against 2 pounds back pressure as shown at *A*, the diagram would then show a mean effective pressure of 90 pounds, or 126 horsepower.

The condenser plays an important part in the performance of a compound engine, and if this condenser were connected to the high-pressure cylinder with the usual vacuum, a diagram taken with the same events, as shown at *B*, would show approximately 105 pounds mean effective pressure, or 147 horsepower. A simple engine showing a diagram as at *A* would certainly not be an economical machine. The cutoff is very late and there is also an excessive terminal pressure, but it is developing its 126 horsepower, and by compounding it, it would not be able to develop double the horsepower. If this simple engine were connected to the condenser it would develop, as stated, 147 horsepower, and when compounded would develop a total of about 200 horsepower or 33⅓ per cent. additional power, which is approximately the combined indicated horsepower of Mr. Harding's cards.

G. S. Sprague.

Geneva, Neb.

## Solder Packing

Some time ago one of the pumps on a steamboat on which I was employed, sucked up a quantity of quartz gravel. While this did little damage to the cylinders or valves it seemed to play havoc with the pistons. In a few minutes they were cut in several places to the depth of 1/16 inch or more, and for the full length of the stroke. Several kinds of packing were tried but it would cut out in a few minutes, and it seemed clear that we would have to get new pistons. We could not wait for the repairs that trip, however, and one of the other pumps was pressed into service.

Going to the toolbox a day or two after the accident, I noticed a piece of wire solder several feet long and about ¼ inch in diameter. I thought I would try and experiment, and going over to the disabled pump I packed it with the lead wire, turned on the steam and was surprised to find it worked nicely. The lead filled the cuts in the pistons and from that moment until the boat was laid up in the fall the pump ran 18 hours a day on the average, for three months, without giving us the least trouble.

Since then I have used lead in many instances when other packing was unsatisfactory and always obtained good results.

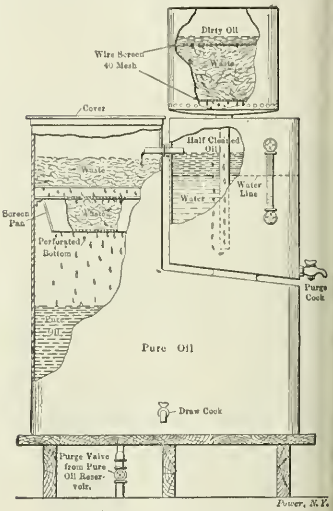
R. C. Demary.

Duluth, Minn.

## Homemade Oil Filter

The filter measures 48x30 inches over all and is constructed of galvanized iron, except the fittings, which are of brass.

The oil is dumped into the auxiliary filter and passes through a 40-mesh wire screen, thence through cotton waste, another 40-mesh wire screen, and down through a tailpipe to within 3 inches of the bottom, the pipe being immersed in water. The oil passes up through the water and over to the main filter through a ½-inch pipe. It then filters through cotton waste, through a shallow galvanized-iron pan, with small holes in the bottom, and through more waste placed in a galvanized-iron trough having a porous bottom.



A HOMEMADE OIL FILTER

This trough is supported on lugs at the side of the filter. The oil then drops to the bottom of the main reservoir, from which it is drawn off through a common cock placed about 3 inches from the bottom. A purge valve is placed on the bottom of the main filter, which does not need purging but twice a year.

A purge cock is connected at the lowest point on the auxiliary filter occasionally to draw off the dirty water and scum The auxiliary filter is made with an inclined bottom and fitted with a glass to ascertain the water level. The main filter also has a gage glass to ascertain the amount of oil.

Edgar G. Schindler.

Roslindale, Mass.

## A Power Plant Layout

If Mr. Wilson has given the dimensions f his pulleys correctly, the 85-horsepower ngine will certainly pull more than its hare of the load. It would give the line haft a speed of 299 revolutions per minte and the 50-horsepower engine 291 evolutions per minute.

The 50-horsepower engine would pull o load unless the 85-horsepower engine ad sufficient overload to bring the line-haft speed down to 291 revolutions per inute, after which the 50-horsepower ngine should carry the additional load.

J. F. Nugent.

Ysleta, Tex.

## Centrifugal Pumps

A. G. Davis brings up a very interest-ig combination in his letter on page 35, of the May 25 number. Assuming ie conditions to be just as stated, I innot understand how he can get all the results which he says he gets. His etch shows connections placed in the rizontal run from the well to the andpipe. The check valve shown is a ing check that would certainly open soon as there was pressure enough. hat it does not open when the 4-inch te valve is open would indicate that the essure at that time was not great ough to overcome the back pressure m the standpipe.

Under working conditions the only actical way to know the power used uld be by using an indicator on the en-ne, and it may be presumed that this done and the power found to be 12 r cent. less when pumping into the indpipe. This being true, it is very ident that more power was used when mping into the sewer. To use more power ien pumping into the sewer and still have pressure less at the check valve than ien pumping into the standpipe, more iter would have to be pumped.

Mr. Davis says that 18 per cent. less ter was pumped, but does not tell how l arrives at this. There is nothing in l article to indicate that it was done h any accuracy, and the results certainly icate that it was not. I will risk a guess: With the pumping discharging into the ndpipe, the engine and pump ran 18 cent. faster than when discharging i the sewer, and Mr. Davis inferred m that that the pump was discharging t much more water. If this guess is not ht I should like to have Mr. Davis tell iow he got his percentages in the results.

n answer to his question: "If it takes re power to pump through the 4-inch e to the sewer, why does it not lift check valve and pump into the stand-pe?" I should say that it is because re is more water going out to the er when pumping that way than goes the standpipe when pumping the other y.

With a centrifugal pump run at a constant speed every change in pressure changes the quantity delivered, whether this change is brought about by changing the head or by manipulating a valve in the discharge line. If the head is increased sufficiently, a point will be reached where there will not be any discharge of water. As the head is lowered the quantity discharged increases, and so does the power that it takes to drive the pump.

W. O. Platt.

Oil City, Penn.

Mr. Davis asks: "If it takes more power to pump through the 4-inch pipe to the sewer, why does not the check valve lift the water flow into the standpipe?"

The power consumed by the pump is not dependent entirely upon the head pumped against, but is a function of the head, capacity and efficiency of the pump.

A pump might be so designed as to deliver more water against a greater head, and yet require less power while operating at the same speed. In the case referred to, it is assumed that the driving engine is running on the governor and the speed is constant.

In a centrifugal pump the best efficiency is obtained only through a comparatively small range of capacity and head. When the 4-inch valve to the sewer is opened, the pressure is relieved; and although the capacity may also be decreased, the efficiency is very greatly decreased; hence more power is required.

The pressure head with the 4-inch valve open must be considerably greater than would appear from the sketch, or an error was made in estimating the relative quantities of water; for it would hardly be expected that a centrifugal pump operating at constant speed under, say, 45-foot head, will deliver 18 per cent. more water at from 160 to 170 feet and require 12 per cent. less power.

R. R. Pratt.

Bridgeport, Conn.

It is a characteristic of the centrifugal pump, when running at uniform speed, to throw more water and require more power to operate it when the pressure against which it is pumping is removed. When Mr. Davis opened the 4-inch gate valve, the pressure was removed from the pump, and consequently a larger quantity of water flowed through the gate valve into the sewer than when pumping direct into the standpipe. That the check valve was not lifted was due to the fact that the pressure from the standpipe was greater than the head against which the pump was working when pumping into the sewer.

The fact that the pump required more power to operate it when running with the gate valve open and discharging into the sewer than when it pumped direct to the standpipe, shows that it was pumping a larger quantity of water than the normal capacity. By partly closing the gate valve he can decrease the load on his engine to some extent.

John B. Sperry.

Aurora, Ill.

Mr. Davis did not state the diameter of his standpipe. Assuming the diameter to be 6 inches and the hight 118 feet, there must be a check-valve pressure of about 53 pounds per square inch. This pressure the pump could overcome, but when the 4 inch gate valve is open, the 4-inch pipe lowers the pressure on the under side of the check valve so that the pressure on top holds it shut.

If Mr. Davis will substitute a 6-inch pipe for his 4-inch pipe, I think he will find it will take less power to pump the water to the sewer, and the pump will also deliver more water. It is not economical to attempt to pump a 6-inch stream of water through a 4-inch pipe.

Henry B. Hicks.

Oriskany Falls, N. Y.

## Filing Clippings

A few years back I hit upon the plan of preserving articles found in mechanical papers, a description of which follows:

I had a case built 19 inches long, 12 inches high and 9 inches deep, outside measurements, made of ¼-inch material and divided into four sections. The outside was nicely finished, so the case might be presentable in any room in the house.

Then I secured some extra-heavy 7¾x10¾-inch envelops, opening at the ends, and lettered them "A," "B," "C," etc.

Next I secured, at a small expense, a 6x15-inch card-index filing case with a set of cards.

Taking a magazine I went through it, carefully selecting all articles of value, clipping them out. If the article was more than one page, I pinned them together, and at the top of the page I wrote the subject. In the upper left-hand corner I put the letter to which the subject belongs; this letter also referred to the envelop in which the article was to be filed. I then took the filing card and indexed the subject and the envelop in which the paper was to be filed. When necessary, it is well to cross-index the subject.

In case the subject is "Valves," say, and formulas are published on one side and on the back of the sheet is an article on "Gas Power Equipment," I would index this under "Valve," "Formula" and "Gas Power," and put in envelop "V."

When an envelop becomes full, I take a second and if it is in the letter "V," I make the second "V1" and mark "V1" on the filing card, thus showing which envelop the subject is filed in.

Elmo N. Owen.

Los Angeles, Cal.

# Some Useful Lessons of Limewater

## Testing for Sulphuric Acid and Its Salts; Value of Such Knowledge to the Practical Man; Action of Sulphuric Acid on Metals

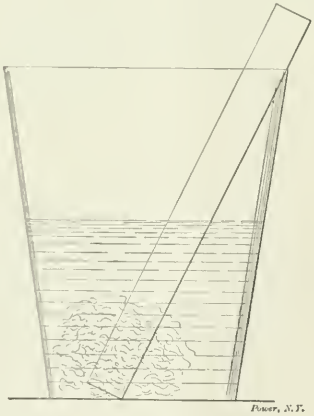
BY CHARLES S. PALMER

The test for sulphuric acid and the salts of sulphuric acid, namely, the sulphates, is the next subject of our attention. We have seen that a solution of barium chloride has been used several times in testing for sulphuric acid or the sulphates, and we note that there follows, in the presence of the said acid or its sulphates, a heavy white precipitation of barium sulphate, $BaSO_4$. Now there are several very interesting matters to be considered in connection with this simple test for this acid. The first thing which you will note is that this white precipitate of barium sulphate, $BaSO_4$, is heavy, and that it comes down quickly; it does not have to be waited for. Again, while most precipitates have some acid, some salt, or some mixture which will dissolve them, yet this white insoluble barium sulphate is insoluble in about everything which is found in the list of reagents. It is insoluble in hydrochloric acid, in nitric acid, and even in a mixture of these acids. To be sure it does dissolve in strong sulphuric acid itself; but that is almost as good as nothing, because we have few filtering materials which can stand sulphuric acid without diluting it with water; and water added to a sulphuric-acid solution of barium sulphate throws down the barium sulphate again. Consequently, it is best to leave the barium sulphate as it is for the present, filtering it off from the rest of the solution to be tested.

There is another point which should be noted, in the use of barium salts to throw down sulphuric acid, and that is that you can use the nitrate to better advantage than the chloride sometimes. The reason for this is that often you will want to test for both sulphuric acid, or the sulphates, and for hydrochloric acid, or the chlorides, in the same solution; and, if you add a chloride to the solution, in the shape of barium chloride as a reagent, of course you are adding that for which the solution must be tested in a moment. Thus we remember that near the close of the last lesson we were discussing the tests for hydrochloric acid and the chlorides, which tests we found very conveniently centered in silver nitrate. Now if you add a drop or two of silver nitrate to barium chloride, of course, you will get the white precipitate of silver chloride, which ilustrates just the point at which we are aiming; but if you add a drop or two of the solution of silver nitrate to barium nitrate, of course there will be no precipitation, and yet barium nitrate will precipitate sulphuric acid or the sulphates just as well as barium chloride. Therefore it is well to use barium nitrate as a reagent for sulphuric acid and the sulphates.

There is another side to the precipitation of any acid or its salts—the analysis of the precipitate. Thus, take silver chloride and perform the experiment shown in Fig. 1. The tumbler contains a little sediment of silver chloride which has been obtained by adding common salt to silver nitrate, according to the following reaction:

| $NaCl$ | + | $AgNO_3$ | = | $AgCl$ | + | $NaNO_3$ |
|---|---|---|---|---|---|---|
| Sodium<br>Chloride<br>Soluble. | | Silver<br>Nitrate<br>Soluble. | | Silver<br>Chloride<br>Insoluble. | | Sodium<br>Nitrate<br>Soluble. |



Power, N.Y.

FIG. 1. SILVER CHLORIDE BEING REDUCED TO METALLIC SILVER BY A STRIP OF ZINC

Put a piece of zinc down into the silver chloride, as shown in Fig. 1, or an iron nail or any similar metal, and a remarkable change will take place in the silver chloride. It will not look so very different from what it was at first, but really it has been changed to metallic silver by a reaction which spreads out gradually from the metal, and which you can trace, as it grows outward, for an hour or two. When the reaction is over, the bit of zinc or the nail will be found to be surrounded by what is really metallic silver, which is readily soluble in nitric acid. Of course, before you dissolve this silver in nitric acid you will separate it from the zinc or iron metal, and you will wash the silver several times to get rid of the salts of zinc or iron; but note that you have followed the metal silver round in a cycle, and that you can precipitate it and redissolve it again.

You can do a similar thing with bariu sulphate, the heavy white insoluble precipitate resulting from the testing of sulphuric acid or the sulphates by bariu chloride or barium nitrate. The method indicated is to boil the heavy insolubl barium sulphate for an hour or tw briskly in a strong solution of sodiu carbonate; in the process of time th barium sulphate will be changed, according to the following reaction, into bariu carbonate, which is still insoluble in wate but is quite soluble in hydrochloric acid

| $BaSO_4$ | + | $Na_2CO_3$ | = | $BaCO_3$ | + | $Na_2SO$ |
|---|---|---|---|---|---|---|
| Barium<br>Sulphate<br>Insoluble. | | Sodium<br>Carbonate<br>Soluble. | | Barium<br>Carbonate<br>Insoluble<br>in water,<br>Soluble in<br>Hydrochloric<br>Acid. | | Sodiu<br>Sulpha<br>Solubl |

Of course, if you should add the hydr chloric acid or the nitric acid to th barium carbonate before the soda sol tion has been drained off, the barium su phate will be reprecipitated, and y would have your trouble of boiling wi sodium carbonate for nothing; but, you filter off the solution, as shown Fig. 2, and then, after washing sever times, treat the barium carbonate wi nitric or hydrochloric acid, you will ha the barium in the original form and sol ble, and the sulphate part will be unit with the soda and will also be solub There are several other metals whi have insoluble sulphates, such as stro tium, calcium and lead, but on the wh solutions of barium make the best te for the sulphates.

Several other new points may come here and you may query: If bari nitrate or chloride is good for the p cipitation of either sulphuric acid or t sulphates, and if one had a mixture sulphuric acid and sulphates, how wo he tell which was which? You can that your old friend litmus will come here. If you have to add considera alkali to the solution before it beco neutral, then there is a good deal of f sulphuric acid present, and of course you measure the alkali you add to br the solution to neutrality, you can c culate the strength of the acid which alkali had to overcome; but, of cou the barium chloride or nitrate will p cipitate the sulphate part just as w (and no better) after precipitation as would before.

Another point may come up here. We have been studying mainly the test for hydrochloric acid and for sulphuric acid, and the question may arise in your mind: What is the test for nitric acid? There is no clean, easy and simple method of precipitating nitric acid and the nitrates in the same way that one can precipitate the chlorides and the sulphates; in other words, all the common nitrates are soluble and we have to use other means for ascertaining whether nitric acid is present, and how much there is of it. We shall consider the special tests for nitric acid in one of the following lessons, as we consider the compounds of nitrogen.

The next thing to be done is to study sulphuric acid itself. Of course, by this time you have learned something of the "feel" of your reagents and you probably could go to the bottles in the dark and pick out the bottle of sulphuric acid from its extra weight. There is also another peculiarity of sulphuric acid which you have learned, and that is the readiness with which it unites with water, and in uniting with water it gives out much heat.

At the risk of being thought a little "cranky," it will pay us to remind ourselves again of the necessity for pouring sulphuric acid into water in diluting it, and never pouring the water into the acid, especially if either is warm, unless the circumstances absolutely require it. But there is another peculiarity of sulphuric acid which you probably have already noticed; that is, when common oil of vitriol is poured into clear and pure water there is considerable white precipitate which soon settles out as a white sediment. You will almost always get this white precipitate from the dilution of crude sulphuric acid or oil of vitriol. It is interesting to know that it is caused by sulphate of lead which the sulphuric acid picks up in its manufacture in lead chambers.

As you read in the books about the manufacture of sulphuric acid you will find that there are two methods of making it; indeed there are three methods. The first consists in the distillation of ferrous (iron) sulphate, or green vitriol. This method results in a very strong sulphuric acid, called Nordhausen or fuming sulphuric acid. The second method of making sulphuric acid, and the one mostly practiced at present, consists in burning the sulphur to the sulphur dioxide stage and then passing these fumes into large rooms of sheet lead in which the sulphur two-oxide or sulphurous sulphur is oxidized to sulphur three-oxide or sulphuric sulphur; and later on the dilute sulphuric acid, which is made in these leaden chambers, is concentrated in leaden pans. In this way the crude sulphuric acid, or oil of vitriol picks up and carries along quite a little lead sulphate which it throws down when it is diluted with water. The third method of making sulphuric acid (and which is mentioned merely for completeness) consists in oxidizing sulphur two-oxide to sulphur three-oxide by means of a platinum sponge. The process results in the production of a very pure acid; but the method is comparatively new and most of the sulphuric acid of commerce is still produced by the second or lead-chamber method.

You will remember that the statement has been made repeatedly that while strong sulphuric acid is a heavy corrosive liquid of intense activity and eating power, especially on organic tissues, which it chars very rapidly on account of its affinity for water, yet at the same time strong sulphuric acid, as long as it is concentrated, is not an acid proper. You can easily prove this by the experiment already mentioned, in which you poured strong sulphuric acid upon zinc, with very little action, and then replaced the strong sulphuric acid by dilute acid, when the action became quicker and violent in forming zinc sulphate and releasing hydrogen.

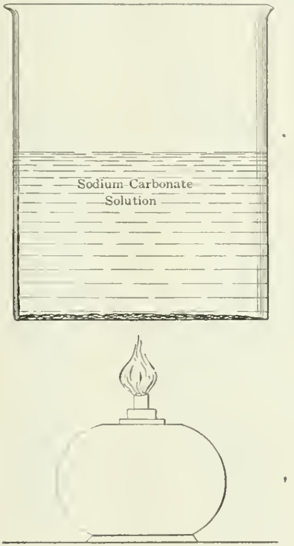


FIG. 2. BARIUM SULPHATE BEING CHANGED TO BARIUM CARBONATE BY BOILING IN A SOLUTION OF SODIUM CARBONATE

The comparative indifference of many metals, such as iron and zinc, to strong sulphuric acid is also in parallel to the fact that strong sulphuric acid does not readily conduct electricity, while dilute sulphuric acid does. The commercial value of all this indifference of metals, like iron, for strong sulphuric acid is well illustrated by the common practice of the railroads in shipping strong sulphuric acid in tank cars. The reason is this (as already explained in a previous lesson) is that the strong sulphuric acid is in a state of inactivity, "association," as it is called; while the diluted sulphuric acid has the parts of the acid in a state ready for activity and in a state of what is called "dissociation." In the tank cars the strong acid is in the neutral or latent state; and as long as it is concentrated it can be kept perfectly safely in the tank cars, which would be quickly chewed to pieces if the acid were diluted.

A more wonderful illustration of this same method of shipping acid is found in the case of so-called "mixed acids;" that is, mixtures of sulphuric and nitric acid which are shipped in iron tanks with perfect safety, simply because both acids contain but little water and are highly concentrated.

The various uses of sulphuric acid have been touched upon, but it will pay you to heat a little common salt (sodium chloride) with sulphuric acid, throwing off the hydrochloride acid, as shown in the following reaction:

| $2\,NaCl$ | $+$ | $H_2SO_4$ | $=$ | $Na_2SO_4$ | $+$ | $2\,HCl$ |
|---|---|---|---|---|---|---|
| Sodium Chloride. | | Sulphuric Acid. | | Sodium Sulphate. | | Hydrochloric Acid. |

In this case the sulphuric acid is mixed with sodium chloride; but if it were mixed with sodium nitrate the reaction would be similar but the side product would of course be nitric acid. In a similar way sulphuric acid can be used to separate scores of other acids from their salts. The commonest soluble sulphates are sodium sulphate or Glover's salt, and magnesium sulphate or Epsom salts; this latter substance is a very common occurrence in the Western plains and is a large ingredient of the so-called "alkali" which gathers on the surface of the soil in the dry climate of the western States.

There is one point here which wants to be noticed before we leave the subject of sulphuric acid; that is, we have often referred to calcium sulphate as an insoluble substance and again we have noticed that it also is soluble enough in water to give it permanent hardness. This variation in the way of looking at the same thing is a good illustration of what practical chemistry must consider. The calcium sulphate is not as insoluble as the sulphates of barium, lead or strontium; it is more insoluble that the sulphates of iron, zinc or copper; but it is soluble enough to make trouble in hard water and we have seen how this hardness may be remedied in part. We shall return to this subject of hard water after considering some of the other acids and salts.

The next topic which naturally comes up for consideration is that of nitrogen and its compounds; a subject which never can be avoided because we always live in an atmosphere which is four-fifths nitrogen.

## A Homemade Prony Brake

By E. S. Frash

The accompanying sketch, Fig. 1, illustrates a prony brake which was built by the writer for his own use and which may be readily constructed by any engineer having moderate mechanical skill. The principal parts of the brake are shown in the drawing. They consist of a cast-iron wheel *A*, a pendulum *B*, also of cast iron, two struts *F* forming the brake beam, two steel straps *D* and 26 brake-shoe blocks *C*; these blocks are of oak and are screwed to the steel straps which are previously bent into circular form to a radius 1½ inches greater than that of the brake wheel. A strong iron support *H* is bolted to the floor and its upper end is slotted to form a guide for the bolt *I*, which passes through the end of the brake beam. Connection between the brake beam and the pendulum is made by means of a flexible strap *J*, preferably of brass, which bears on the half-drum *K* of the pendulum. The pendulum is arranged to turn on the bolt *L* which is set into an iron standard *M*, bolted to the floor. A segmental scale dial *N* is bolted to the support *M* and a wire pointer *O* travels over the scale on the segment *N*. The brake is held in place on the brake wheel by the iron retaining clips *R*.

It will be evident that if the handwheel *Q* is tightened on the bolt *P* while the brake wheel (which is fastened on the engine shaft as close to the flywheel as possible) is turning in the direction of the arrow, the blocks will retard the circular motion of the brake wheel to an extent which may be shown in pounds on the graduated segment *N*. It must be remembered, however, that the brake, not including the pendulum, has weight that must be reckoned with. This weight is allowed for in the following manner: Remove the brake from the brake wheel and detach the pendulum. Allow the brake to hang on a knife edge at *X* and attach weights to the straps at the point *Y* until the circle of brakeshoes hangs plumb. This can be determined by means of a plumb line suspended from the knife edge at *X*; when the opposite edges *Y* and *Z* of the straps *D* are the same distance from the plumb line, the brake is plumb.

The scale *N* is calibrated by pulling up on the strap *J* with a spring balance, the strap being detached from the brake arm. It will be found easier to adjust the pull if the spring balance is suspended from a rope passing over an overhead pulley. The rope is drawn through gradually until the spring balance indicates an exact number of pounds; then a mark is made on the dial opposite the needle, and the number of pounds marked on. This is done for each scale indication desired, throughout the range. One cannot be too careful in calibrating the scale for the value of all results obtained in tests depends on the exactness of the graduated segment. The scale should be given as many divisions as practicable.

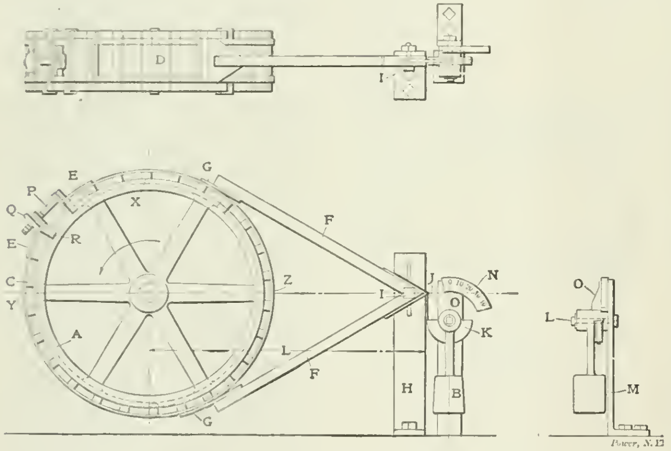


FIG. 1

The brake wheel is usually cooled by water, delivered in a small jet arranged to flow into the rim of the wheel and taken out again by a waste pipe.

Fig. 2 represents a simpler form of brake which gives fairly accurate results in small powers. The brake beam *T* is a wooden plank having a circular segment cut in one edge and blocks notched to fit directly on the rim of the flywheel. A leather belt *U* is fitted with blocks and retaining strips and is fastened to the brake beam by two I-bolts *V V*, one of which is threaded and fitted with a handwheel *Q*. A small spring balance *W* is rigidly supported and is adjusted to read zero when the brake is idle. The brake is compensated for the unbalanced weight of the beam by attaching weights at the rear end *Y* until the beam hangs level on a knife edge at *X*. If ample lubrication is used, this brake serves very well for small work and brief tests. Its use is not advisable when a long test is to be run, because the heat of the brake must be dissipated by the flywheel. In either form of brake, however, the blocks should be well oiled in order to obtain the best results.

It will be found convenient in computing results if the distance *L*, from the center of the brake wheel in Fig. 1, or the motor pulley, Fig. 2, to the registering point of the brake beam can be made exactly 63 1/40 inches; then the horsepower represented by the pull of the brake beam may be computed by the simple formula:

$$H.P. = Pull \times R.p.m. \div 1000.$$

For any other distance *L*, expressed in inches, the formula becomes:

$$H.P. = Distance \times Pull \times R.p.m. \div 63{,}025.$$

Whatever distance of *L* may be adopted, the use of the brake will be greatly facilitated by preparing a table showing the horsepower per revolution (per minute) for different numbers of pounds.

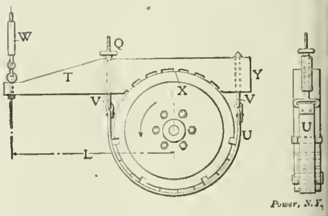


FIG. 2

## Vacuum Ash Conveyer a Patented Device

By W. A. Stadelman

In the June 15 number of Power an The Engineer, there appeared an articl on the vacuum ash conveyer at th Armour Glue Works, by George B. Hess Evidently Mr. Hess did not know tha this system was installed by the Economi Engineering and Construction Company of Chicago, under letters patent whic they own, and later by the Darley En gineering Company, which was incorpor ated and began business May 1, 1908, t operate under these patents.

For the past two months a plant ha been in successful operation handling coa at the works of the Quincy Market Coa Storage and Warehouse Company, o

Boston, Mass. The conveyer is 8 inches in diameter and was put in under a guarantee to handle 300 pounds per minute. It is actually handling 600 pounds per minute and taking the coal wet or dry. Another plant is now being built for the Boston Elevated Railway for handling both ashes and coal.

---

# Useful Members of the Wrench Family

By A. J. Dixon

The construction and special use of nearly every member of the wrench family that is likely to be found in the average steam-power plant, has been pretty thoroughly illustrated and described in a highly interesting article which appeared in the January 5 number of Power and The Engineer. The author of the article in question neglected, however, to give due consideration to one ancient member of the tribe, which, if it does not figure very prominently in stationary power plants, is at least an old standby in locomotive shops, and this is what is known as the crow-foot wrench, a few modifications of which are shown in Fig. 1. This wrench is really a first cousin to the socket wrench; is, in fact, a modified form of the offset socket, and finds its principal utility in restricted places where no form of open-ended wrench could be swung, and where projecting obstacles, as pipe flanges or the like, or insufficient space on all sides of the nut, prevent the socket wrench from taking hold. These conditions are invariably present in steam- and exhaust-pipe work in the front ends of locomotives, and for that matter, may be found in any situation where an elaborate job of piping compels the crowding of flanged joints and similar apparatus into cramped quarters. In such emergencies the crow-foot wrench comes in as handy as the proverbial pocket in a shirt.

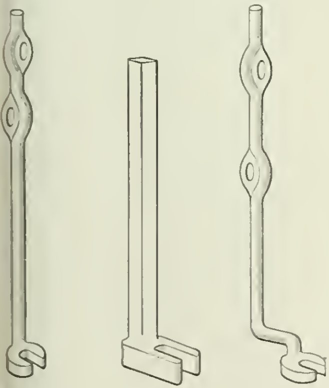
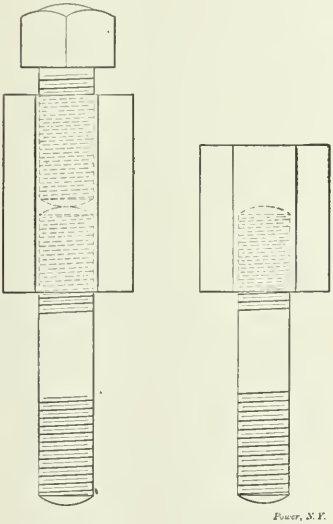

Power, N.Y.

FIG. 1. THE CROW-FOOT WRENCH

With regard to a device for screwing studs into place, the stud nut shown in Fig. 2 might appear to possess some points of superiority over the contrivance described in the aforementioned article, and which is shown here in Fig. 3. Of course, in the matter of providing an effective means for driving a stud home, one device is just as serviceable as the other; for a tightening of the screw in Fig. 2 against the end of the stud will have the effect of locking the nut thereon as securely as jamming the bottom of the nut in Fig. 3 against the end of the stud.

When it comes to loosening the hold of the nut, however, for the purpose of removing it, the contrivance shown in Fig. 3 is clearly at a decided disadvantage when compared with the stud nut shown in Fig. 2. In the case of the latter, removal is accomplished by simply holding the hexagon nut with one wrench and slackening the screw with another, absolutely no effective turning force tending to back the stud out again being present in the operation; whereas in the case of the other device, a quick, jerky twist of a single wrench must be depended upon to relax its hold, and since the nut may be regarded as acting as a clamp to grip the stud—one jaw of the clamp being the bottom of the hole, and the other jaw the side of the thread farthest therefrom—it is plain to be seen that while the hold of this clamp is being broken, a considerable turning force, due to the friction between the surfaces, is exerted in the stud, and if the stud is not very tightly threaded into the hole into which it has been driven, the friction may be sufficient to start it out again.


Power, N.Y.

FIGS. 2 AND 3. SCREWING STUDS INTO PLACE

Concerning the methods in vogue for increasing the leverage of a wrench, it frequently happens in power plants where strong, massive drop-forged double-ended wrenches are furnished with the engine equipment that these wrenches are not long enough to provide the proper leverage in tightening up or slackening off a nut, particularly for sizes above 1 inch, and being double-ended, recourse cannot be had to a piece of pipe, the usual expedient for gaining leverage with a single-ended wrench.

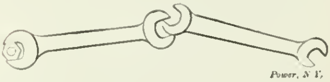

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FIG. 4 INCREASING THE LEVERAGE

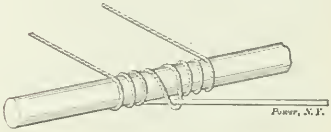
Power, N.Y.

FIG. 5. A FRICTION WRENCH

In Fig. 4 is illustrated a much better plan of getting around this difficulty, provided, of course, that the extra wrench is available, which is usually the case. By hooking the jaws together in the manner shown, the turning effect of the force applied is exactly doubled, while the ample metal section in the jaws and the steadiness of the stress applied, prevent any distortion which might otherwise occur.

An emergency may sometimes arise wherein a cylindrical piece of comparatively large diameter, as a 10-inch pipe or the like, is to be made up into a fitting or revolved for some other purpose, and no chain wrench or other similar device is available for the job. In such cases, or for that matter, in any case where the character and design of the object to be gripped precludes defacement and mutilation of its surface by the sharp teeth of the chain wrench, as in the event of turning a piston or tail rod of ample size into a crosshead, the rigging shown in Fig. 5 affords a very serviceable substitute. The underlying principle of this device is friction pure and simple, and with a man at each free end of the rope exerting just enough force, in holding against a man at the end of the lever, to keep the coils from slipping on the pipe, the turning force applied can be made almost as effective as though the pipe were gripped in the steel jaws of an ordinary wrench.

POWER
AND THE ENGINEER

DEVOTED TO THE GENERATION AND TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.
355 Dearborn Street, Chicago.
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of POWER solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "POWPUB," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During 1908 we printed and circulated 1,836,000 copies of* POWER.

*Our circulation for June, 1909, was (weekly and monthly)* 186,000.

*July 6* . . . . . . 42,000
*July 13* . . . . . . 33,000

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*

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The index of POWER AND THE ENGINEER for the first six months of 1909 is now ready and will be sent to any of our readers who send a postal-card request with name and address.

## Central Service vs. Isolated Plant

There has been a good deal of discussion of the relative merits of central station service and that from one's own plant. Much of it has been so extremely partizan as to lose force and a great deal of it has been entirely irrelevant.

To begin with, there are and always will be conditions under which a central station cannot compete with a private plant without discriminating unfairly against a large number of its customers; and there are also thousands of establishments which can buy power and lights cheaper than they can make them. It is just as foolish to generalize from one or two peculiar cases as it is to apply general standards to an unusual case, and both of these courses have been followed by advocates on opposite sides of the question under discussion. It depends entirely upon local conditions as to whether central service would be cheaper or dearer than operating a private plant. We have known of isolated plants of less than a hundred kilowatts which were operated at less cost than central station service could be bought for, and just as reliably. We have also known of cases where central-station service was far preferable to a private plant in establishments requiring in the neighborhood of a thousand horsepower. There is no hard-and-fast rule, based on either the size of the plant or the relation between power cost and total expenses, which will enable anyone to decide the question correctly without a careful analysis of the individual case in hand, unless the case happens to be near one or the other extreme of the possible range of conditions. It is perfectly obvious that a job printer using three horsepower cannot afford an isolated plant; it is equally obvious that a packing establishment using five thousand horsepower can beat the central-station rate out of sight. Between such extremes as these are thousands of cases which must be intelligently and thoroughly analyzed before one can classify them on one side or the other.

## The Ohio License Law

The discussion which has taken place at State conventions of engineers' associations has revealed an erroneous idea of the conditions existing in Ohio, the assumption being quite general that the Ohio law was declared unconstitutional because it exempted from examination those who had been in successful charge of plants for five years or more.

The act of 1900 was declared unconstitutional in the case of Harman vs. the State, because the examiner is made the exclusive judge as to whether an applicant is trustworthy and competent. No standard is furnished by the General Assembly as to qualification and no specifications as to wherein the applicant shall be trustworthy and competent, but all is left to the opinion, finding and caprice of the examiner. The new act states the subjects in which the applicant must be proficient and provides, as the old did not, that the rules and regulations under which examinations shall be held shall be uniform throughout the State.

> "Surely there is no good reason why one desiring to operate a steam engine shoud have a standard of qualification fixed with more definiteness than one who desires to teach school or practice medicine or law. The statute under consideration is not subject to the criticism in this regard that the statute considered in the case of Harman vs. State was subjected to."

It was claimed by the objectors to the bill that the provision that all persons holding licenses issued to them under the act of 1900 (declared unconstitutional), should not be required to submit to further examination during the period covered by such license first issued, rendered the act unconstitutional.

This is evidently the contention which has led to the conclusion that any attempt to exempt from examination on account of service, to let successful record be the criterion of a man's qualifications, would invalidate a law. But see what the court says of it:

> "Even though this section were held to be unconstitutional, the persons provided for in this section are simply those who at the time the present statute went into effect were holding licenses issued under the former act, and since no such license could extend beyond one year from the time of its issuing, it cannot be supposed that this small period of time for which some were permitted to operate engines after the examination, was an inducing cause for the enactment of the provisions in respect to the examination of those who desire to become engineers. Further than that this act extended the privilege to those who were already licensed under the former act for the short time they would be permitted to operate, it is of too small consequence for the courts to say that it is in controvention of the constitution. In any event this has long ceased to be a practical question, for the present statute went into operation on the first of May, 1902, and all those permitted under the provisions of Section 10, to operate engines, have long since lost that privilege. It is only those who have obtained a license under the present act, who are entitled to a renewal, after examination. It is those who have obtained a license under the present act who may have a renewal.
>
> "It is said in argument that the general interpretation which has been given to this statute by engineers is that those who were permitted by this Section 10 to continue their occupation until the expiration of the time for which their several licenses were issued, were entitled to have such licenses renewed without examination. Whoever has given it this construction has done so in violation of a provision of law expressed in language as plain as any language can well make it, and it behooves all such to take notice now that they were not entitled to a renewal of their licenses under the former act, and it behooves the examiners to take notice that they are not authorized to issue any such renewals. The language of the statute, as has already been said, is so plain that a 'wayfaring man, though a fool, need not err therein.'"

As a consequence of this decision all engineers licensed previous to the passing of the second and constitutional act were required to be reexamined and licensed, but this had no bearing upon the constitutionality of an exemption from examination of those who had by a given term of successful service proven their competency and proficiency as engineers.

## Be Firemen, Not Shovelers

Wages paid to firemen as a rule seem ridiculously low when the nature of the work which they do is taken into consideration. As a worker he is conducting a chemical process by which carbon and hydrogen are changed into carbon monoxide, carbon dioxide and water. Transfer of heat to the water in the boiler is the object sought and for which the process is carried on, and the carbon monoxide, dioxide and water are only byproducts having no market value. But the larger the percentage of carbon dioxide in the total byproduct, the more heat there will be available for transference to the water.

It is not suggested that it is necessary to employ an expert in chemistry in order to get a good fireman. In the manufacture of sulphuric acid or the distillation of spiritous liquors, chemical operations are carried on, but chemists are rarely employed in the work. Men with strength enough for the manual part of the work and with intelligence enough to understand what they are doing only are requisite.

For the making of a good fireman one must be sober, not frequently sober as a certain recommend once read, but sober all of the time, industrious, active and mentally alert; in other words, a man not afraid of work and willing or even anxious to learn all that he can about different coals and their combustion.

Firing is not merely a shoveler's work, yet it is almost always rewarded with shoveler's pay. At no stage in the process of generating and transmitting of power by steam can so much be saved or wasted as in the burning of the fuel. In the plant may be found the very latest in boilers and furnaces, piping protected by the most expensive and efficient covering, engines with lightning cutoff, steam jackets and reheating receivers and condensers that will almost parallel the barometer, but if the fireman does not know his business, and attend to it, all these perfections are useless and any records, except those of which one should be ashamed, are out of the question.

Permanent firemen who are "there with the goods," who do their best all of the time, whether conducting a record-making test that will please the management, or just making the plain everyday run, are not to be had for the wages accepted by hewers of wood and drawers of water, and the sooner plant owners recognize this fact, the sooner will the stockholder's dividends increase.

## 11,000 Volts Run Amuck

The inadvisability of supporting high-tension electric lines on the same poles with other circuits was forcefully and more or less spectacularly demonstrated recently at Greenwich, Conn., where the principal excitement usually consists of counting at the railroad station the new faces amongst the week-end visitors. On the occasion here referred to, an 11,000-volt feeder created unwonted diversion by flashing over to the lightning arrester ground in the wire tower of the power house, with a roar and a fusillade of cannon-like reports which sent two men out of the window and startled the usually imperturbable chief engineer into the suddenest and most extensive activity that he has ever manifested.

The wire tower and high-tension switchboard are at one end of the station, which is steam-driven during the light-load hours and is reinforced during heavy loads by a 400-kilowatt motor-generator taking current from a feeder at 11,000 volts and 25 cycles and delivering current to the local primary circuits at 2300 volts and 60 cycles. The feeder is only about half a mile long, extending from the railroad station to the power house, and was equipped with an automatic circuit-breaker at the railroad station end. The current, from some cause not positively determined, "went to ground" on an iron frame above the high-tension switchboard almost immediately after the circuit had been closed and while the chief engineer and two other men were standing at the switchboard. The circuit-breaker at the railroad station went out, but the attendant there closed it, and when it went out the second time he closed it again and *held it closed!* Then, of course, things happened. The safety devices at the station let go, the two men near the chief engineer found urgent business calling them elsewhere, and the chief ran around shutting down his engines.

The feeder parted between the station and the main high-tension line and the ends fell across the 2300-volt lines, arc-light circuits and telephone wires beneath them on the same poles. This, of course, put 11,000 volts on the other circuits and burned up a considerable number of telephones and transformers. The safety devices on the 2300-volt lines let go and saved those generators, but the lightning arresters and several transformers on those circuits were destroyed. The lightning arresters on the 11,000-volt feeder were reduced to the consistency of a welsh rarebit but none of the high-tension apparatus inside the station was injured at all, the short circuit having occurred beyond the switchboard and the local circuit breakers having opened at the first rush.

It was rumored also that the fire-alarm system of the town was crossed and crippled by the falling of the high-tension feeder, but we were unable to verify this report. Fortunately no loss of life resulted from the accident, but that was due to pure good luck; the feeder broke and fell at an hour in the evening when the street was practically clear of people. Had the feeder been located on a much used thoroughfare, the chances are about ninety-nine to one that loss of life would have resulted, even though the accident occurred just at the hour when most people are at dinner or supper. High tension overhead lines should never be allowed on poles carrying any other class of circuit whatever—not even a private telephone or signal line owned by the same company, and certainly not any circuit of a general service character.

## The Scout Cruisers Said to Have Reversed Their Records

The following item is going the rounds of the daily press:

The scout cruiser "Salem" has arrived from the Madeiras with something entirely new in the line of sea mysteries. When the story her officers have to tell reaches the Navy Department some of the old wiseacres there will probably have to scratch their heads a good while before they solve the puzzle.

The great marine mystery developed when the new scout cruisers "Salem," "Chester" and "Birmingham" were steaming side by side across the Atlantic from the Madeiras on their official engine test. Some time ago, when the three boats were put through their coal-consumption test at 15 knots speed, the "Salem" averaged 107 tons a day, the "Chester" 85 and the "Birmingham" 71.

These figures were strangely reversed on the present cruise. On the first day out from Madeira, at 13.4 knots speed, the "Salem" burned only 84 tons, the "Birmingham" 93 and the "Chester," to everybody's astonishment, burned 110. On the fourth day the "Salem" consumed 94 tons, the "Birmingham" 111 and the "Chester" 144. The average daily consumption of the "Salem" was 95 tons, of the "Birmingham" 110 tons and of the "Chester" 130 tons.

Why the crack warships reversed their form in this strange and unexpected way, nobody on the cruise, or since, has publicly offered to explain. What is the good of a Government test in the face of such queer results as this in actual open sea cruising? This is the question Uncle Sam's naval sharps hereabouts are asking.

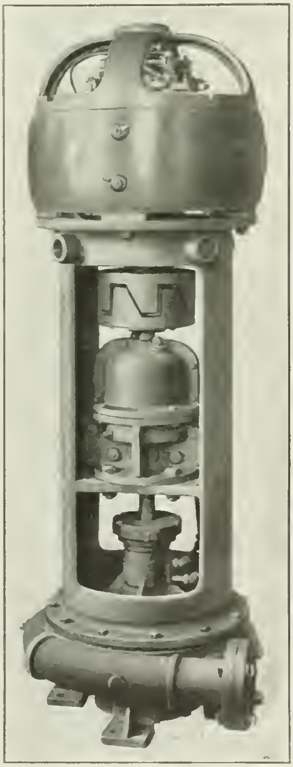
# Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

## Vertical Motor Driven Centrifugal Pump

The illustration herewith shows a pump used to withdraw the water from the hotwell of a surface condenser against a vacuum of 28 inches on the suction side. The pump is placed lower than the hotwell, and for this reason water flows by gravity to the pump, notwithstanding that there is a vacuum on the suction.



VERTICAL MOTOR-DRIVEN CENTRIFUGAL PUMP

The pump is a 3-inch Class A centrifugal type, manufactured by the Buffalo Steam Pump Company, Buffalo, N. Y., and is driven by a 10-horsepower vertical-shaft 600-volt motor operating at a speed of 1260 revolutions per minute. It has a normal capacity of 215 gallons per minute against a total head of 78 feet, which includes a discharge lift against which the pump handles the water.

Upon the lower flange end of the main frame is bolted the pump casing in which runs a brass impeller machined all over. The brass impeller withstands the extra strains imposed by the hot water. At the top of the main frame is mounted the motor which drives the vertical shaft through a flexible coupling. About midway of the main frame the removable thrust-bearing housing is suspended from a heavy rib cast integral with the main frame.

This pump is fitted with a ball-bearing type of thrust and a five-jaw flexible coupling, but can be furnished with any type of ball,- roller- or disk-thrust bearing and the flange style coupling with rubber-incased driving pins. The thrust bearing suspends the weight of impeller shaft and one-half of the flexible coupling. The stuffing box on the pump-shaft bearing is sealed against the vacuum which the pump is working against by water pressure through the small pipe shown, the other small pipe providing grease for the bearing.

It is an exceedingly simple design, affording access to every part without seriously disturbing the other parts. Owing to the design and machining of the runner there is said to be very little loss by slippage.

## Automatic Lubricating System

A new system of automatic lubrication has just been brought out by the Trenton Engine Company, Parker and Randolph avenues, Trenton, N. J. This system is for the purpose of thoroughly and automatically oiling main bearings and crosshead pins of steam engines of both the horizontal and vertical types.

The oil is circulated by means of a positively driven valveless oil pump, which is made of hardened gears, set in a small, compact casing, and driven by means of bronze and iron worm gears, the larger being attached to the engine shaft; the other to the shaft extending from the pump casing, which is attached to the engine frame at the base. The oil as it comes from the bearing passes through a filter and separator which separates such water as may have come in contact with it. The oil is then drawn up through the gear pump and forced into the main bearing or crosshead pin, as the case may be.

In Fig. 1 is shown a view of the method of lubricating a main bearing. It will be seem that the surface between the shaft and the upper side of the bearing is lubricated by means of a patent oil cup used in connection with this system. In order that the oil may get in between the bearing and the shaft on both the out-

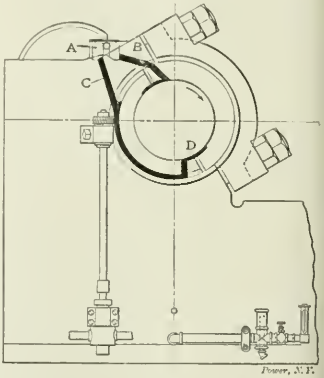


FIG. 1. METHOD OF OILING MAIN BEARINGS

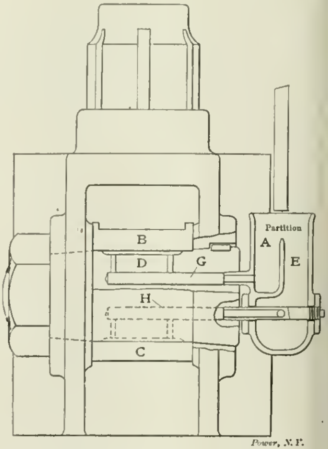


FIG. 2. METHOD OF OILING CROSSHEAD PIN AND BEARING

ward and inward strokes, a portion of the metal is cut away, as indicated by the dark line, on both sides, at the top and bottom of the bearing. Oil then flows from the oil cup *A* into this space, and as the engine is pulling from the crank end the shaft is drawn, owing to the slight amount of play present, toward the head end of the engine, thus permitting the oil to be carried around the shaft and thoroughly lubricating the shaft surface between it and the bearing on the outer side of the bearing cup. As the engine works on the outward stroke, the shaft is shoved toward the outer bearing cap, allowing the oil from the oil passage *C* to flow down into the space *D*, from which point it is carried around between the shaft and the inner side of the bearing, thus thoroughly lubricating it at this point. The oil is then permitted to flow to the lter connected with the oiling system, when it is used over again.

There is no necessity for the engineer to bother about shutting off the oiling system, as it works automatically, starting and stopping as the engine is started and stopped, and if excess oil should flow nt the oil cup *A* it is bypassed back into the oil reservoir in the base of the ngine, thus automatically taking care of ll excessive oil flow.

In Fig. 2 is shown the method of lubriating the crosshead pin of a vertical engine. It will be seen that the surface between the crosshead pin *D* and the top earing *B* is lubricated by means of the il cup *A*. When the pressure is off this art of the bearing, *B* or *C*, a flow of oil s introduced between these parts.

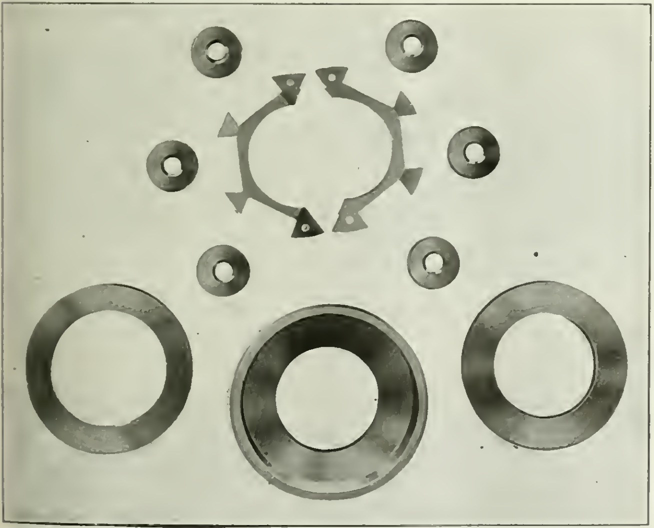


FIG. 2. PARTS OF BEARING

The oil cup shown at *A* has a partition, as indicated at *E*, for the purpose of making a positive lubrication for both sides of the crosshead pin. In order that the crosshead pin may be lubricated, three holes are drilled in the end; one for the purpose of attaching the oil cup *A*, the other two for the purpose of carrying the oil from the oil cup to the respective oilways in the pin. This is shown by the full lines on the upper side and the dotted lines on the lower side of the pin. Thus it will be seen that as the oil enters through the pipe over the oil cup *A*, both partitions are filled, one supplying the oil passage *G*, the other the oil passage *H*. As the space indicated is always filled with oil, it is quite evident that this portion of the engine is thoroughly lubricated at all times.

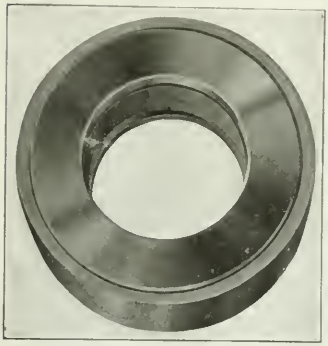


FIG. 1. ASSEMBLED BEARING

## A New Roller Thrust Bearing

The Reeves Pulley Company, of Columbus, Ind., has perfected a new roller thrust bearing which is illustrated herewith, Fig. 1 showing the assembled bearing.

The bearings are so constructed that the rollers are held true at all times, both when the bearing is new and after wearing has occurred.

Fig. 2 illustrates the bearing parts. The hardened-steel rollers are spherical at one end, to conform to the circle of the cast cup, which holds the rollers perfectly true at all times. The rollers continually change their position in the cup, thus preventing the cup from wearing out of true even should it wear larger. The spacing cage is made of bronze, and has no other function than to separate the steel rollers.

There are two hardened-steel raceways which fit into the cast cup and against which the rollers run. One of these raceways is bored large so it will not come in contact with the shaft and cut it. The other raceway and the cast cup revolve with the shaft and have therefore no tendency to cut it, and as these are bored to fit the shaft snugly, they hold the entire bearing central. Fig. 3 shows a bearing with one raceway removed.

To assemble the bearing the raceway with the large bore is placed in the cast cup first, then the spacing cage is put in place and the rollers inserted with the spherical end next to the cast cup, after which the other raceway is put on and the bearing is ready for service.

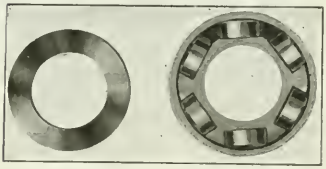
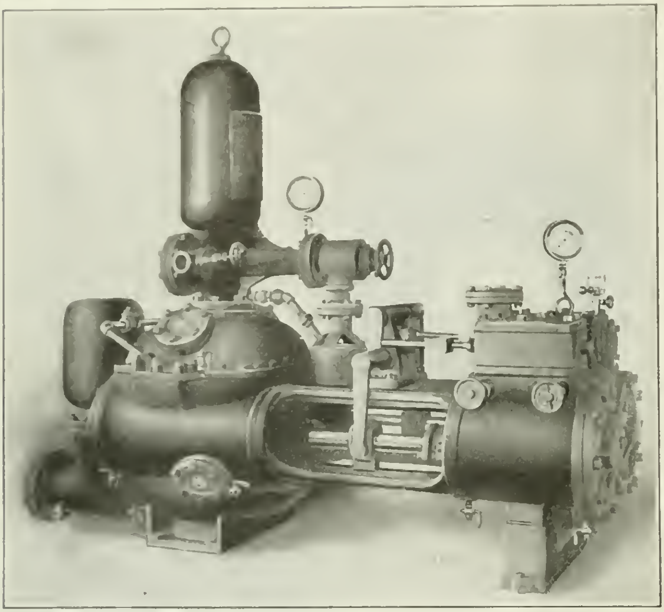


FIG. 3. BEARING WITH RACEWAY REMOVED

## "Canton" Underwriter Fire Pump

The accompanying illustration is that of one of the first underwriter fire pumps built by the Canton-Hughes Pump Company, Canton, O.

Steam fire pumps are ordinarily expected to run at double the piston speed of pumps for boiler feed, or ordinary water supply, and do not usually receive the care that the balance of the steam equipment does around a power plant, they being constantly subjected to dampness, because of condensed steam, and the parts are subject to rust if the pump is not run regularly, and after a period of disuse, a fire pump should be capable of being instantly started and run at full



"CANTON" UNDERWRITER FIRE PUMP

speed by a man who may be excited and perhaps unskilful. Consequently, such a pump needs more strength, better workmanship and better protection against rust than a pump for boiler feeding or other miscellaneous work, and the high speed at which it is expected to work demands large suction-valve area and unusually large steam-valve ports.

This underwriter pump has brass plungers instead of cast-iron plungers, wrought-iron side levers instead of cast iron, bronze piston rods and valve rods instead of iron or steel, and brass-lined stuffing boxes instead of cast iron. The rocker shafts are brass-bushed. The water-valve area and steam-exhaust passages are from 25 to 50 per cent. greater than would be the case were it designed for another purpose. The suction-pipe connections are also larger; the air chamber is larger, and the pump in its entirety is made especially strong.

The special fittings as required by the underwriters are as follows:

Capacity plate, stroke gage, vacuum chamber, two best quality pressure gages, water-relief valve of large capacity, relief-valve discharge cone, set of brass priming pipes and special priming valves, from two to six hose valves, sight-feed cylinder lubricator and a one-pint hand oil pump.

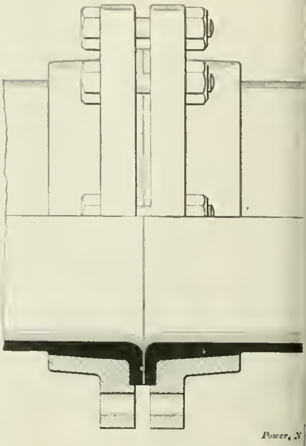
The "Canton" underwriter fire pump is built to conform fully to the underwriter specifications and special care and attention have been paid as to detail of construction. It will be noticed that the water end of the pump, above and below the cylinder, is made round, which adds to the strength of the pump.

---

## Murdock Lap Joint and Welded Steel Header

Due to the increasing demand for high steam pressures and the accompanying superheating, the W. K. Mitchell Company, Incorporated, Philadelphia, Penn., has put on the market an improvement on its lap joint. This is illustrated in Fig. 1. The ends of the pipe have been considerably thickened, so as to give a greater strength at that point, by welding on a collar and flanging the pipe and the collar, which gives a lap or face which, when finished, on the back and front has a thic ness of more than 1½ times the origin thickness of the pipe.

It has been found that the facing the back of the lap is just as importa as that on the face, therefore the coll is trimmed off on a regular taper from tl



Power, N

FIG. 1. MURDOCK LAP JOINT

back of the lap to the end of the hub the flange. The flange is then bored on a corresponding taper and when it drawn up into position makes a snug between the pipe and the flange. T method gives a uniform bearing. T flanges are made in accordance with manufacturers' standard, but the thickn can be increased to suit any requireme Fig. 2 is an illustration of a 16-inch hea with one 14-inch, one 10-inch, two 8-i and one 2½-inch flanged-steel nozz welded thereto.

The advantages of welded piping o older systems include the reduction of number of joints and the elimination heavy fittings of all kinds.

The possibilities of systems construc of welded headers, such as are ma factured by this company, are great, it is well known that any form of p or fitting that can be cast can be weld; that is, in any length that can be ship d by the present methods of transportat

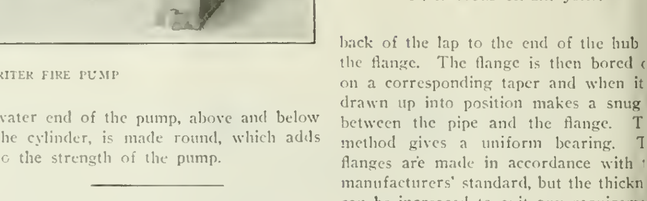


FIG. 2. 16-INCH HEADER WITH WELDED FLANGES

## The "Conkell" Duplex Pump

This new design of pump, which has recently been placed on the market, and is manufactured by the Service Pump Company, Orrville, O., is illustrated and described herewith.

In Fig. 1 is shown a phantom view of the pump which represents the ordinary standard type built by the company. The view of the steam end of the pump shows that there are but two moving parts in each cylinder, the double-headed piston and an ordinary D valve, which registers with the ports at the bottom of the cylinder.

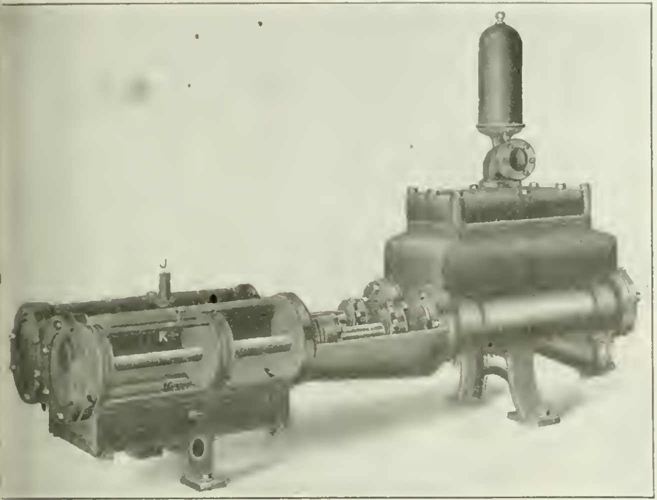


FIG. 1. PHANTOM VIEW OF STEAM CYLINDER

The valve has several lugs attached for the purpose of keeping it properly spaced from the head of the piston when the piston head and valves are at the end of the stroke. When the piston is moving in the opposite direction, the D valve will remain at rest until it is again moved by impact with the opposite head. The steam valve *A*, Fig. 2, is placed between the valve guide *C*, which is brought to the top of the cylinder, and the guide pin, as shown, is introduced through a screw-thread aperture at the top of the cylinder wall. The lower end of the guide pin is then brought into engagement with the side of the slot *C* in the piston, which permits the piston to move longitudinally within the cylinder and at the same time prevents a rotary movement. The distance between the head of the piston with relation to the length of the cylinder, the length of the valve, and the arrangement of the ports in the cylinder is such that when the piston moves to the extreme front position, the head *D* will move the valve into a position to register with the port *E*, bringing the port *F* into communication with the exhaust port *G*.

When the piston moves to its extreme rear position, the head *H* will engage the valve and move it into position to register with the ports *E* and *G*, and when the valve is in this position the port *I* will communicate with that portion of the cylinder between the heads *H* and *D*. At a point equally distant from the front and rear heads of the cylinder, and near the upper portions of the walls of the cylinder, are the steam inlets *K*, which are shown in Fig. 1, these inlets branching from a common steam pipe *J*. Although the double headed piston moves backward and forward within the cylinder, the heads at no time pass the steam inlets *K*, and any steam entering through the pipe *J* will be conducted through that portion of the cylinder. Therefore, the portions of the cylinder between the heads, regardless of what part of the stroke the piston may be, can be regarded as the steam chest of the pump.

The construction of the valve, which is of the D type, is as follows: It has lugs cast in its end for the purpose of engaging the head and to allow a passageway for steam between the head of the piston and valve. The exterior of the valve is semicylindrical, and the inner edges of the valve guides, *B B*, Fig. 2, are so shaped as to conform with the outer surface of the valve.

The upper left-hand figure in Fig. 2, shows the port plate, which is provided with passageways. Between the upper and lower surfaces are the ports, which communicate with the ports of the cylinders and the ducts in the port plates, as well as the exhaust outlet in the port-plate cover. The stop valves *L* are provided for the purpose of limiting the longitudinal movement of the valve and preventing its being displaced and failing to register at all times with the ports. These valves are located at the extreme ports, as shown at *G*, Fig. 2.

The operation of the pump and its steam passage is as follows: When steam is admitted to cylinder, say, No. 1, the port *E* is opened, and the steam will pass through the portway *E*, and enter cylinder No. 2, causing the piston in that cylinder to move to its backward position. The exhaust from the rear end of

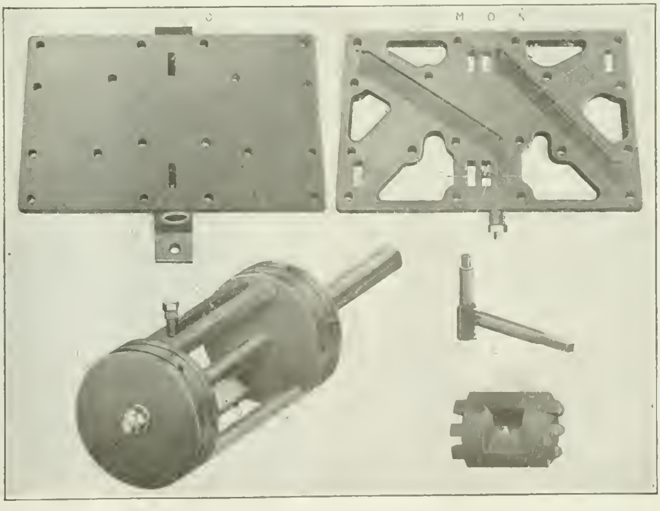


FIG. 2. STEAM VALVE AND PORTS

the cylinder No. 2 will pass through the ports *I* on the interior of the valve in cylinder No. 1 and out through the exhaust port *G*. When the piston in cylinder No. 2 nears the end of its backward stroke, the head of the piston will move the valve backward so that it registers with port *M*. The position of the valve in cylinder No. 2 having thus been changed, steam enters the open port *M*, which will move the piston in cylinder No. 1 to its forward position, and the exhaust will pass out through port *M* on the interior of the valve, and out through the exhaust outlet *O*. As the piston in cylinder No. 1 nears the end of its forward stroke, the head *H* will engage the valve and move it so as to register with the port *E*. Steam will then pass through the port *E* and will enter cylinder No. 2, causing the piston in this cylinder to move to its forward position. The exhaust from cylinder No. 2 then passes out through port *F*, on the interior of the valve, into cylinder No. 1, and exhausts through the port *G*. As the piston in cylinder No. 2 nears the end of its forward stroke, the head will engage the valve in that cylinder and move it to register with port *N*, and will also open port *O*. This will return all the ports to the position first noted, when steam was first admitted, and the operation is then repeated.

## "Stickle" Bucket Steam Trap and Discharging Float Trap

The "Stickle" bucket steam trap consists of an annular chamber, outside of the trap proper, which has four openings, B, entering the main chamber at equal points toward the center. The separating baffle ring cast integral with the trap cover and extending downward into the bucket has side extensions or ribs, which prevent bending of the small rod by lateral movement. At the top of the bucket is a space between the exterior of the baffle ring and the inside of the bucket, sufficient to allow a free movement, and also serve the purpose of a separator, as the four ports in the annular chamber B which surround the trap are so located that they are below and between the openings *A*, in the baffle ring; consequently, when the trap is discharging there is a separation of steam and water at that point. Steam enters the ports at *A* and water enters the bucket ahead of the steam.

Water enters this trap at the inlet through an annular chamber just under the flange which forms a part of the flange.

The four ports *B*, are located at the top of the chamber and even with the top of the bucket. This makes it possible to maintain the water that surrounds the bucket at the full hight of the bucket. The discharge into the trap when it is in operation or open is directly across the top of the bucket line. This prevents the water that floats the bucket from being blown out.

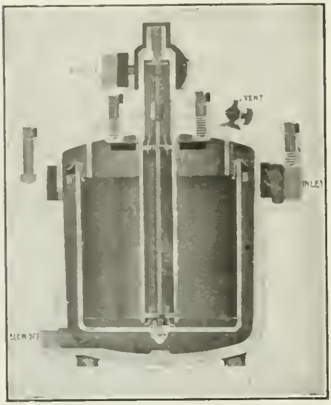


FIG. 1. "STICKLE" BUCKET TRAP

The water and steam entering the trap come in direct contact with the baffle or separating ring, which throws the water downward and the steam upward.

Steam enters the upper ports *A*, and separates the water and steam as they enter the trap when the discharge is taking place. This makes it possible to discharge solid water and not steam and water at the same time.

The water passes out through the large tube extending down into the bucket and leaves sufficient water in the bucket when
the trap closes to form a water seal, an
does not blow steam at the end of th
discharge.

The "Stickle" intermittent balanced floa
trap is so designed and constructed, it i
said, that it will operate for a long tim
without scoring when used in connectio
with steam separators under high pres
sure. The vibration of the cutoff th
waves the water does not unseat th
valve; and the idle slot allows the tra
to fill nearly full before the float exert
any force on the valve. When it do
unseat the valve it drops the length
the slot, throwing the valve wide ope
and it stays open until the water is di
charged from the trap. The float dro
as the water leaves the trap and clos
the valve. The discharge from the tra
is said to be so violent and the entran
to the trap being at the back end,
sweeps all of the accumulated sedime
out at each discharge.

These traps are manufactured by t
Open Coil Heater and Purifier Compan
502 South Pennsylvania street, India
apolis, Ind.

The unit of commercial horsepower d
veloped by a boiler is taken as 34
units of evaporation per hour; that i
34½ pounds of water is evaporated p
hour from a feed-water temperature
212 degrees Fahrenheit, into dry steam
the same temperature. This standard
equivalent to 33,137 B.t.u. per hour. It
also practically equivalent to an evapor
tion of 30 pounds of water from a fee
water temperature of 100 degrees Fahre
heit into steam at 70 pounds gage pre
sure. The unit of evaporation is th
equivalent to 965.7 B.t.u.

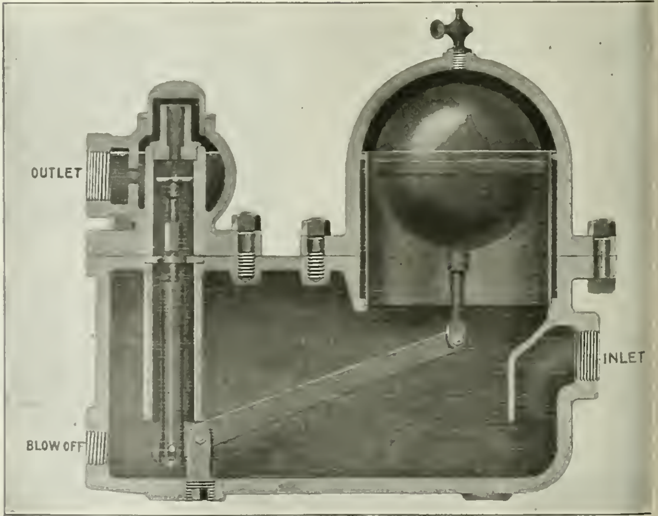


FIG. 2. "STICKLE" INTERMITTENT BALANCED FLOAT TRAP

# Inquiries

*Questions are not answered unless they are of general interest and are accompanied by the name and address of the inquirer.*

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*Weight of Governor Balls and Engine Speed*

Will the speed of an engine be changed by altering the weight of the governor balls?

R. F. D.

Yes. If no part of the governor except the balls had weight it would make no difference, but a change in the weight of the balls would affect their lifting power and at the same hight they would revolve at a different speed.

*Safe Stress on a Shaft*

What is the safe stress to allow on a wrought-iron forging when it is subjected to bending and twisting? What is the elastic limit, and how near to the elastic limit is it safe to work? Authorities seem to be divided upon this point, and while some say it is not safe to work near the elastic limit, others say that as long as the elastic limit is not exceeded, a shaft is safe.

J. T. F.

The best formula for repeated stress, such as that which takes place in revolving shafting, is Weyrauch's based on Wöhler's experiments with alternate compression and tension. Safe load per square inch =

$$f = 10{,}000 \left( 1 - \frac{1}{2}\ \frac{\textit{least max. stress}}{\textit{greatest max. stress}} \right)$$

for Phoenix wrought axle iron.

For shafting, the least maximum stress will equal the greatest maximum stress. Therefore,

$$f = 10{,}000\ (\tfrac{1}{2}) = 5000$$

pounds per square inch.

This is the same result as would be obtained by taking the tensile strength of wrought iron and using a factor of 10.

The elastic limit for wrought iron is nearly one-half the ultimate strength; that is, 25,000 pounds. To anywhere approach this value in shafting would be dangerous. The value as derived above for outside fiber stress is good practice.

To figure the safe load on a shaft to give the fiber stress no higher than 5000 pounds per square inch, use Grashof's formula:

$$f = \frac{r}{I_1} \left( \tfrac{3}{8} M_1 + \tfrac{5}{8} \sqrt{M_1^2 + M_2^2} \right),$$

where

$r$ = Outside radius of shaft,
$I_1$ = Bending moment of inertia,
$M_1$ = Bending moment,
$M_2$ = Twisting moment.

For a solid shaft

$$I_1 = \frac{\pi r^4}{4};$$

for a hollow shaft

$$I_1 = \frac{\pi}{4} \left( r^4 - r_1^4 \right),$$

where $r_1$ = the inside radius of the shaft.

Substitute the conditions of any particular shaft problem in the foregoing equation and if the resultant value of $f$ does not exceed 5000 pounds per square inch the shaft may be considered as not overloaded.

*Horsepower and Steam Consumption*

The accompanying diagrams are from a simple noncondensing engine exhausting into a heater. Will you please state how improvement can be made in the diagrams, and also tell me the mean effective pressure, indicated horsepower and the steam consumption per hour?

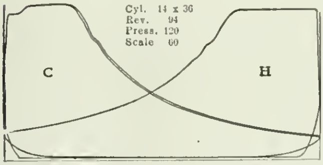
T. J. R.

The formula for steam accounted for per horsepower =

$$\frac{13{,}750}{M.E.P.} (F + C)\,Wf - (X + C)\,Wx,$$

where

$M.E.P.$ = Mean effective pressure,
$F$ = Fraction of stroke completed at point chosen on expansion line,
$C$ = Clearance,
$X$ = Fraction of stroke uncompleted at point chosen on compression line,
$Wf$ = Weight per cubic foot at pressure measured at $F$,
$Wx$ = Weight per cubic foot at pressure measured at $X$.



DIAGRAMS FROM A SIMPLE NONCONDENSING ENGINE EXHAUSTING INTO A HEATER

$$\frac{13{,}750}{52.65} \times (0.25 + 0.03) \times 0.2531 - (0.05 + 0.03) \times 0.04352\ M.E.P.$$

$$261.15859 \times (0.28 \times 0.2531) - (0.08 \times 0.04352).$$

$$261.15859 \times (0.070868 - 0.0034816).$$

$$261.15859 \times 0.0673864 = 17.6.$$

This method of computing the steam used per horsepower-hour is not at all accurate. It only approximates the theoretical amount of dry steam used by the engine and does not take into account the water which goes through the cylinder with the steam, which is seldom less than one-third of the total amount of steam used. In this case the indicator accounts for 17.6 pounds. If this is two-thirds of the steam used the total amount would be 26.4, which would be a fair performance for a simple Corliss engine in good condition working at its rated capacity. The diagrams may be improved by equalizing the cutoff and by getting an earlier exhaust opening. The horsepower developed is 145.

*Down-Draft Gas Producer*

What is the advantage of the down-draft gas producer?

T. M. W.

It will make gas from bituminous coal without making tar, which is important when the gas is used as fuel for an engine.. This is due to the fact that the light tar-making gases distilled from the coal freshly fed to the fire are drawn down through the incandescent fuel and converted into "fixed" gases, which will not condense.

*Effect of Superheating Steam at the Bridgewall*

Will there be any gain by superheating steam at the bridgewall, dissociating the oxygen and hydrogen and discharging them over and through the fire by means of nozzles? Will the combustion of the hydrogen prevent smoke?

A. T. G.

No. The gases of which water is composed will give up in burning just the amount of heat absorbed in the act of dissociation and there will be an actual loss, depending on the friction of apparatus.

There will be no tendency to reduce smoke, as all of the oxygen of the steam will be needed by the burning hydrogen.

If there should be an excess of air passing through or over the fire, the heat from the burning hydrogen might heat it enough to complete the combustion of the volatile matter of the coal which ordinarily escapes as smoke.

---

Water hammer in some of the large mains of the Detroit water works has been materially reduced by the use of an air chamber, according to the annual report of George H. Fenkell, civil engineer of the water board. The direct-pumping system is used. About half a mile from the pumping station an emergency station has been built and equipped with a 1000 cubic-foot air chamber, an electric motor and air compressor, and other apparatus. This chamber is connected to two 42-inch force mains, and since its employment the pressure gages on a 24-inch connecting main a few miles distant have shown a reduction in the ordinary water hammer from about 12 pounds to 3 pounds, while the hammer on one of the 42-inch mains with which the chamber is directly connected has been reduced from 10 pounds to 4 pounds.

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Small sizes of coal burn with less smoke than large sizes, but develop lower capacities.

## Personals

R. H. [illegible], who, for the past [illegible] years, has been in charge of the condenser engineering work of the Allis-Chalmers Company, has now been made engineer in entire charge of the Corliss engine and condenser departments.

Stevenson Association, No. 44, National Association of Stationary Engineers, of New York City, at its last meeting elected the following officers for the ensuing year: J. D. Taylor, president; C. Meyer, vice president; [illegible] Fellerman, financial secretary; F. [illegible], recording secretary; A. Harkness, corresponding secretary; H. Christensen, treasurer; M. J. Burke, conductor; W. Watts, doorkeeper.

Brooklyn Association, No. 8, National Association of Stationary Engineers, of Brooklyn, N. Y., held an open meeting on Saturday evening, July 3, at which the following newly elected officers were installed: Thomas Carlton, past president; George O. Haley, president; C. J. Pritchard, vice president; John Harper, recording secretary; C. A. Enggren, financial secretary; A. C. Brady, corresponding secretary; Charles Morse, treasurer; J. D. Pohlig, conductor; J. F. Demick, doorkeeper; Thomas Carlson, member of board of trustees. The officers were installed by Charles [illegible], assisted by Harry Marks. During the evening the following gentlemen entertained: Herbert Self, Peerless Rubber Company; William Murray, Jenkins Bros.; Robert Webb, Joseph McKenna and Jack Armour, of Power. At the close of the entertainment, Past President Thomas Carlton was called to the rostrum by W. H. Manning, and was presented with a handsome cut-glass wine service. Short addresses were given by National Vice president W. J. Reynolds, of the National Association of Stationary Engineers, and Timothy Healey, general president of the Eccentric Firemen's Association. Refreshments were generously served.

## New Equipment

Eavenson & Levering, Camden, N. J., are increasing their power plant.

The Lovell Manufacturing Company, Erie, Penn., is building a new power house.

The Fulton (N. Y.) Light, Heat and Power Company will build a new steam plant.

The Ford Automobile Company, Detroit, Mich., will erect a new power house at their plant.

The Binghamton (Tenn.) Light and Power Company is to double boiler and generator capacity.

The Safety Car Heating and Lighting Company, Jersey City, N. J., will increase the capacity of its power plant.

The Illinois Soldiers' and Sailors' Home, Quincy, Ill., is in the market for equipment for an electric-light plant.

The city of Quincy, Fla., proposes to expend $36,000 for water-works extension and $9,000 for electric-light improvement.

The citizens of Seneca Falls, N. Y., voted to issue $240,000 bonds for the construction of a municipal water-works plant.

Bids will be received until July 19 for construction of municipal water-works at Madeira, Cal. F. E. Smith, town engineer.

The American Ice Company, Philadelphia, Penn., is having a new ice-making plant and storage building erected to cost $70,000.

Bids will be received by Capt. Louis F. Garrard, Jr. Q. M., U. S. A., Ft. St. Philip, La., until August 2, for constructing water-works and sewer system.

The Suffolk Light Company, Suffolk, Va., has been incorporated to construct a light and power plant. Capital, $250,000. Incorporators, W. L. Williams, R. B. Tunstall, etc.

The Sacramento (Cal.) Ice and Cold Storage Company has been organized. Capital, $150,000; George J. Bryte, D. W. Carmichael, S. E. Ennis and others are on the board of directors.

Chairman Fred H. Sanders, of the public light committee, Canton, Ohio, is receiving propositions for installing a municipal lighting plant at the water-works pumping station.

J. M. Greer, of Livingston, Tex., has organized a company with $100,000 capital for the purpose of putting in, at Sinton, Tex., a 10-ton ice plant. An electric-light system will also be operated in connection with the plant.

Bids will be received until July 20 by the Board of Water Supply, 299 Broadway, New York, for furnishing and installing two 12,500,000-gallon steam turbo-turbine pumps, two 225-horsepower water-tube boilers and accessories for the Jerome avenue pumping station.

## New Catalogs

The Goulds Manufacturing Company, Seneca Falls, N. Y. Catalog. Power pumps. Illustrated, 192 pages, 7x8 inches.

The Ball & Wood Company, Elizabethport, N. J. Catalog. Rateau-Smoot turbines and generators. Illustrated, 5x9 inches.

The Diamond Rubber Company, Akron, Ohio. Catalog. Belting, gaskets, hose, packing, valves, etc. Illustrated, 128 pages, 5x7 inches.

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# A Visit to an Anthracite Coal Mine

## Tells What a Coal Mine Is Like and How Coal Is Mined. Importance of Air Supply. How a Mine Is Timbered; Difficulties to Be Overcome

### BY WARREN O. ROGERS

It was the writer's good fortune to obtain permission from F. M. Zerbey, general manager of the Kingston Coal Company, to visit the Edwardsville, No. 4, mine of the company. The descent was made in company with the mine superintendent Thomas H. Williams, Master Mechanic Erskin L. Solomon and Mine Foreman Thomas Martin. The first stop was made at the 350-foot level.

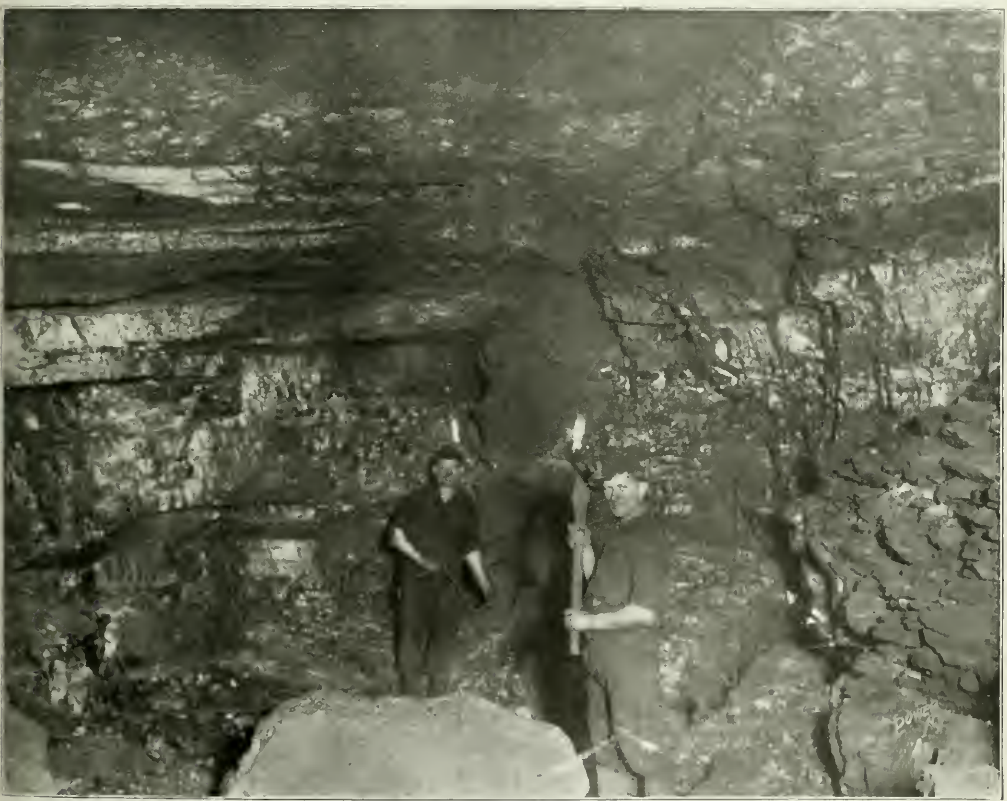

FIG. 1. FACE WORKING OF A COAL SEAM

One unaccustomed to the skill with which the hoisting engineer handles his engines cannot fail to note the accuracy with which the cage is stopped at each level for the loading and unloading of coal cars hundreds of feet below the surface of the earth. In Fig. 2 is shown a cage with miners ready to be hoisted to the surface after a day's work in the mine.

One would naturally expect that at such a depth considerable water would be encountered, but such was not the case. The miners can tell, however, in the upper veins within a few hours that a rain storm has set in, by noting the water trickling down the side walls of the gangways of the levels upon which they are working. This water is taken care of by directing it to the sump from, which it is pumped to the surface, or if the pump is located at an extreme depth, the water is delivered to a pump placed on a higher level, which in turn delivers the water to the surface. In Fig. 3 is shown a large duplex pump located 1000 feet below the surface. The pump is placed in a pump room hewn out of solid slate and coal formation, which is as "dry as a bone." These pumps are scattered through the mine, and on different levels, the steam being piped to them from a boiler plant above ground, and the steam pipes led to the underground working down the shaft.

Close to the shaft is located the hospital where the injured men are taken, to receive first aid there from the ambulance locker containing such simple appliances as will be required under ordinary circumstances, after which the sufferer is hoisted to the surface where an ambulance is waiting to convey him to the hospital. The ambulance is always nearby, the law compelling every mine to have one stationed within 500 feet of the mine shaft.

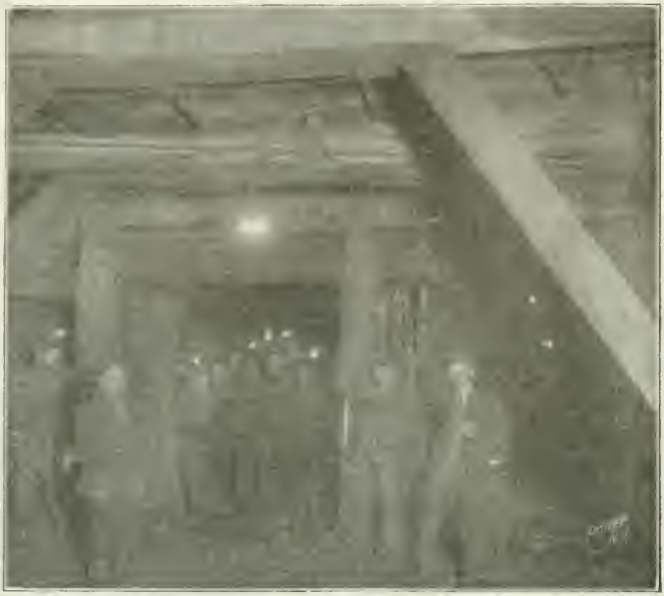

FIG. 2. MINERS READY TO BE HOISTED TO THE SURFACE

Before starting out into the workings of a level, a report sheet is inspected. This report sheet has a record showing the gaseous condition of the workings, stating whether each is clear or not, and if not, to what extent gas is present, or at what time it was cleared.

### Ventilation

An average man requires about 900 cubic inches of air per minute when at rest, and 1500 cubic inches when exerting himself under ordinary conditions. Coal mining is a far more strenuous exercise than walking, and the amount of air required for a miner is therefore greater, or about 1728 cubic inches per minute. Thus it is important that a mine be thoroughly ventilated, even if the matter of safety were eliminated altogether. Owing to the varying amount of gas found in a mine, the problem of calculating the quantity of air necessary to keep the mine in a safe condition is most difficult. It has been found that 100 cubic feet of air per minute per man employed in a mine which is free from gas is sufficient. If the mine is moderately gaseous, 250 cubic feet of air per minute is required, and if the mine is considerably gaseous, from 450 (minimum allowed by law) to 500 cubic feet per minute per man employed.

Gas is detected by the effect it has on the safety lamp carried by the inspector. Owing to its lightness, it is always found in the highest part of the mine, and is not easily detected in all cases. If gas is present in small quantities the flame of the safety lamp will flicker slightly vertically, in larger quantities the flame will become enlarged and considerably longer and a blue halo will surround it; it requires considerable skill to detect small amounts of gas.

The method of disposing of the gas is by proper ventilation. This is accomplished by forcing sufficient air into the mine by means of fans, so that the gases are diffused and the workings put in a proper condition for the miners.

As we made our passage along a level on the way to a face working, or where the miners were working at the extreme end of an excavation, cutting coal, doors were encountered which completely shut off a portion of the passage in order t force air to the face of the drift. These doors hung so that they would swing shut without aid, thus forming an automatic protection against the carelessness of any workman should he forget to shut a door after passing through. These doors were necessary, as without them the air current would naturally take the shortest cut to the upcast and, consequently, the workings farthest from the down-cast shaft, where the air is forced into the mine, would suffer from lack o proper ventilation.

As the face of the working was neared a canvas cloth was found hanging across

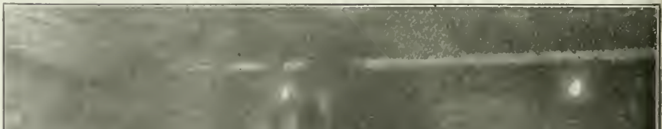

FIG. 3. MINE PUMP IN PUMP ROOM HEWN OUT OF SOLID ROCK AND COAL SEAMS

the air passage. This was because a blast had just been fired, and as the air current was rather weak at that particular place the canvas helped to conduct the air to the face, created a slightly increased draft, and so cleared the working of smoke and gas.

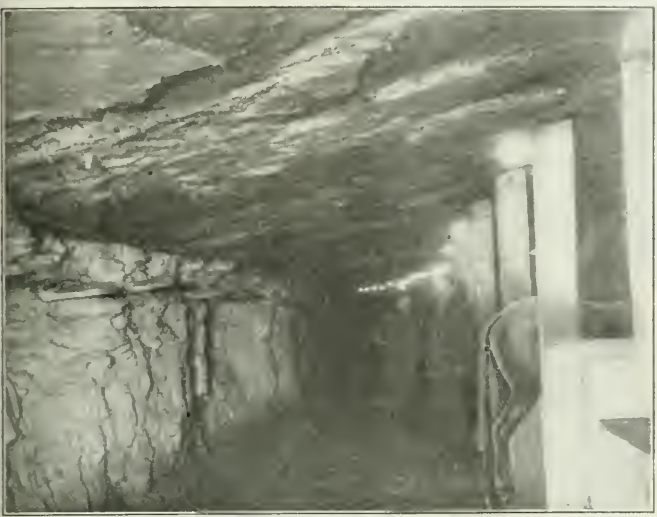

FIG. 4 STABLE 1000 FEET UNDERGROUND

In Fig. 1 is shown a face working; one miner being in the act of boring a hole for a new shot, while the laborer is about to break up the large lump of coal, shown in the foreground, and make it ready for loading into the mine car.

Passing from the face working, a visit was made to the stables, 1000 feet underground, Fig. 4. Here the mine mules were stabled, and contrary to what one would naturally expect, the place was kept as clean and as sweet as most stables found on the surface. This is accomplished by the free use of whitewash and the fact that the partitions between the stalls are made of sheet iron; which is not only a sanitary arrangement but also a safeguard against fire.

### Timbering

Slightly more than 1 per cent. of the men employed in or about the mines in the United States are either killed or injured each year; and as more are injured and killed due to falling slate and the caving-in of the sides of the chambers than are hurt and killed by explosions, it is evident that the matter of timbering a mine is of great importance. In Fig. 5 is shown an example of good timbering, the photograph being taken by the writer in the Kingston company's No. 4 mine.

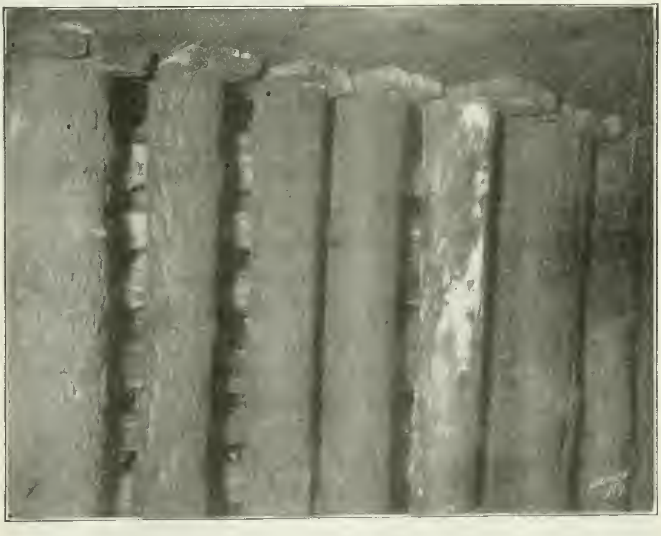

FIG. 5. AN EXAMPLE OF GOOD TIMBERING

Drives follow the inclination of the coal seams, the roof being supported by timbering of some kind. This is not only to support the roof when it is in bad condition, but to keep a good roof sound. In the working places timbering is set at stated intervals. The props used in the side timbering are subjected to a compression strain, and their length being about 10 or 12 times their diameter, a prop so proportioned will support about 1½ tons per square inch; a prop 12 inches in diameter has an area of

$$12 \times 12 \times 0.7854 = 113$$

square inches and a breaking strain of

$$113 \times 1.5 = 169$$

tons. It would seem that such a crushing strain would not be exerted on any one timber, yet the writer recently saw a large number of southern pine timbering, ranging from 10 to 24 inches in diameter, broken, and shattered similar to those shown in Fig. 6. In one instance, a timber of southern pine, all of 24 inches in diameter, was splintered at the top by the enormous weight of roof, which, according to the figures given, must have been in excess of 338 tons exerted as a crushing strain. This timbering had been in place less than three months, and was used in reinforcing the roof supports overtaxed by a squeeze. Fig. 7 shows the result of a squeeze in its final stage.

Before a squeeze occurs, warning is generally given by various noises which, if heard, enable the mine foreman to place new timbering to support the roof and sides. Frequently, however, the pressure on the old timbering becomes so great that the squeeze occurs despite the skilful efforts on the part of those in charge. When this occurs, it means that the débris must be removed and new timbering put in place before that section of the mine can be worked again.

In No. 4 mine, southern-pine timber is used exclusively, it being considered the best timbering wood procurable. In some instances the largest timber measured over 24 inches in diameter and the others very close to 20 inches, such as shown in Fig. 5. Another example of good timbering in No. 4 mine is shown in Fig. 9. This is at the junction of two electric-car tracks. The roof is supported by as

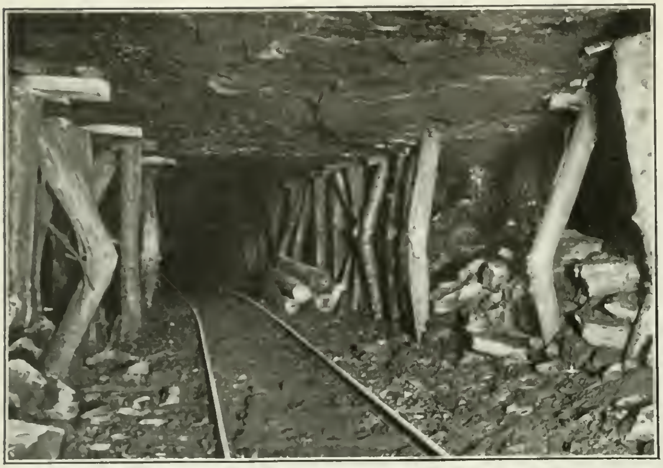

FIG. 6. SQUEEZE IN A COAL MINE

fine a piece of work as is seen in a coal mine. The illustration also shows one of the electric locomotives.

Timbering a mine is an expensive item. If southern pine is used for the purpose, the cost and treatment will amount to about 11 cents per cubic foot of coal mined. Wood timbering is treacherous, as oak, beech and similar hardwoods, while having great strength, will suddenly fail without warning, while yellow pine such as is used in the mine mentioned falls more slowly, as indicated in Fig. 6.

A new departure in timbering mines that is rapidly taking the place of wood in many of the newer mines, is the use of steel. In 1878, attempts were made in France to use old rails as head pieces, and in the United States rails have been used for some years. Today special steel sections are made expressly for mine timbering, an example of which is shown in Fig. 8.

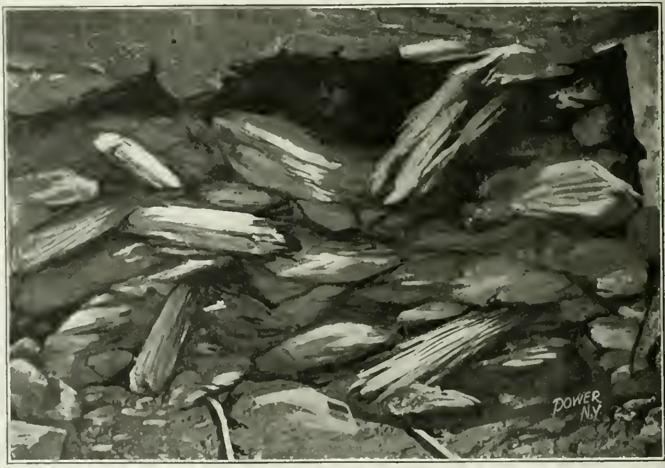

FIG. 7. REPRESENTING THE FINAL STAGE OF A BAD SQUEEZE

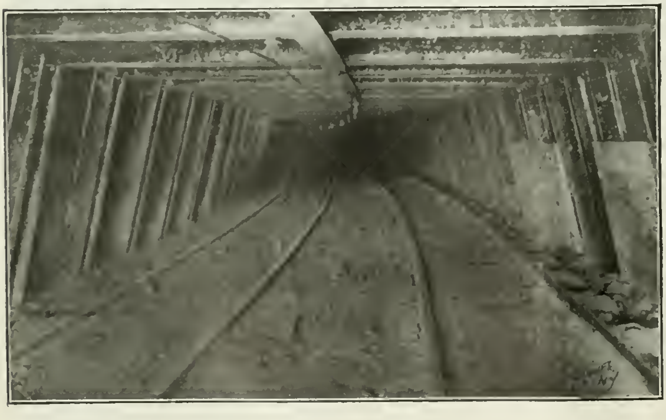

FIG. 8. STEEL TIMBERING

# Operation of Steam Condensers

By Samuel K. Patteson

In the last few years steam condensers have undergone remarkable changes in design and constructive details, with great increases in efficiency, and the question of the relative merits of the different types of condenser now on the market, with a clear understanding of their methods of operation, are matters of the greatest importance to the average operating engineer, who may at any time be called upon to assist in the selection and erection of one of these devices and take charge of its operation. The theory of steam condensation and the advantages to be obtained by it in increased efficiency in the operation of the steam engine are extremely simple in practice to understand, but involve in their actual operation principles extending into hydraulics and thermodynamics and other phases of engineering theory to such an extent that their actual operation is rather complicated and a clear understanding of the mechanism and the duties performed by it is difficult to attain. Ordinary steam condensers usually may be divided into two types, jet condensers and surface condensers. When the mechanism, however, for supplying the steam and providing the water and removing it after use, together with the devices for the removal of the air, are considered, the types become much more numerous and a classification is of not very much advantage.

In regard to the theory of condensers little need be said. The ordinary pressure read on the average pressure gage is pressure in pounds to the square inch above the atmosphere, and the actual pressure exerted by the steam is that read on the gage plus 15 pounds. Thus 80 pounds on the steam gage means that this is the difference in pressure between that exerted by the steam on one side of the piston and that exerted by the air on the other. In reality the absolute pressure of the steam is 95 pounds to the square inch, and if the air is removed from the other side the force obtained from this pressure is at once available. This explains the theoretical advantages to be obtained in the use of the condenser and the reasons for its wide development. In the actual operation of a steam engine, of course, steam is on both sides of the piston, but that on one side is always connected to the exhaust, and hence to the atmosphere, and the atmosphere pressure is transmitted through it very much as hydraulic pressure is transmitted through a liquid.

FIG. 9. SUBSTANTIAL SIDE AND OVERHEAD TIMBERING

### Atmosphere Eliminated in Practice

Now, in actual practice in a condensing engine the atmosphere is eliminated. The steam rushes from the exhaust into a box or receptacle, which is practically a vacuum and has no connection with the outside air. It would rapidly fill this up and exert its own pressure in a reverse direction if it were not, in the ordinary condenser, condensed as fast as introduced. In the act of condensation it gives out its latent heat of vaporization and heats any agent which is used for condensing, such as cold water, so that this rapidly becomes hot and useless for cooling purposes and requires constant renewal. In order, therefore, to supply a constant agent for the production of condensation, cold water must be circulated through the condenser and removed as fast as it becomes hot, and this requires pipes leading into it filled with water and subject to atmospheric pressure. This pressure is balanced by a weight of water in a pipe, generally 30 feet high in practice, because a perfect vacuum cannot be attained and the steam always exerts a pressure of from 1 to 2 pounds. The principle of this column can be readily seen by the action of a barometer. In the latter a tube, closed at one end, is filled with mercury and inverted in a basin also filled with mercury. The mercury stays in a closed tube supported by the air and its surface is 30 inches above that in the basin, and a vacuum very nearly complete exists above the mercury surface in the tube.

If water were used in place of mercury the length of the column of water between levels would be about 34 feet. This is what is meant by balancing the air pressure by a column of water. If a pump is put in this column and pushes the water downward, the level of the water in the column will fall to within a few feet of the outside level and still maintain a vacuum, and in this case the atmospheric pressure is balanced by the action of the pump exerting a force in practice of from 10 to 11 pounds to the square inch on the water and forcing it out against atmospheric pressure when there is a suitable circulation provided and the force is greater.

This column explains the reason for the standpipe or well in ordinary condenser installations. The level of the water in the vacuum chamber and in the outside drain must be 30 feet apart in actual practice unless a pump is installed to overcome this difference in pressure. If water not in contact with outside air pressure or raised a distance of 30 feet, and hence exerting this back pressure, is turned into the vacuum chamber it will at once flow out the lower end of the standpipe, thus maintaining a constant level in the condenser and producing a water circulation as well. In actual practice water must be raised this 30 feet and injected into the condenser chamber, or it must be pumped out of the well a distance of 30 feet in order to maintain the difference of level constant and fixed in the condenser proper when this water circulation is going on. A condenser with a hotwell and a pump for pumping water from it is identical to a condenser with a standpipe and a pump pumping water into the top of it. There exists merely a difference in level of the operating mechanism above and below the surface of the ground, and a different position for the pump in the circulating system.

This cold water circulating through the condenser is sufficient to produce condensation of the steam turned into it, provided the water is sufficiently cold and delivered in sufficiently large amount. In order to get the maximum effect out of the cold water this water is injected into the condenser in the form of a series of jets, in the type known as the jet condenser, or is allowed to run in a thin sheet over a large amount of surface, this latter being known technically as a surface condenser. Air always exists in water injected into a boiler. With the application of heat and the production of steam in this latter device the air is evolved from the water with the steam and goes through the engine into the condenser.

### Removal of Air a Serious Difficulty

The air is not absorbed by the water at anywhere near the rate the steam is condensed and hence the condenser gradually fills with air and destroys the extra back pressure for which the condenser was devised. Therefore, the removal of the air in the condenser presents a serious difficulty. It is removed in two different ways: A vacuum pump is often connected to the condenser chamber and maintains the vacuum by the removal of the air after the action of an ordinary pump. Again, this air may be removed by what is known as the injector or aspirator principle. The device operates after the manner of an ordinary steam injector or aspirator for the removal of air. The jets of water driven quickly into a funnel and expelled through this entangle the bubbles of air and carry it along with the water. This procedure involves a certain speed of water circulation and unless the condenser is properly constructed is apt to prove a serious difficulty on steam or air overloads. The best practice today undoubtedly uses the vac-one pump and separate the jet tubes of the condenser.

The old types combined the different elements and are very satisfactory if several conditions are maintained. The tendency, however, to separate the two units with the elimination of the stand pipe in favor of a pump for the maintenance of the vacuum is becoming more general. It results in a diminution in the water consumption and the power formerly required for the water circulation can now be more advantageously and efficiently supplied in the operation of the two pumps. All of the types of condenser, however, herein mentioned are in common and daily use in a large number of installations and it would be a mistake to say that any one type of those mentioned is rapidly becoming obsolete. The question of relative advantages is still an open one and subject to considerable discussion.

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# Chart for Direct Current Circuits

By H. P. Liversidge

The accompanying chart has been designed for the calculation of problems in direct-current circuits, in which the transmission losses are expressed directly in terms of volts drop. The factors used are expressed in terms of energy transmitted, distance of transmission, number of conductors, size of conductors, generator voltage and drop in volts. For convenience the energy transmitted is plotted in terms of 16-candlepower lamps, motor horsepower and kilowatts, assuming 50 watts per 16-candlepower lamp and 800 watts per horsepower of motor.

The relation existing between the different factors enumerated is expressed in the following general equation.

$$A = \frac{2 \times D \times 10.8 \times P \times W \times K}{V \times E},$$

where

$A$ = Area of conductor in circular mils,
$D$ = Distance of transmission in feet,
10.8 = Resistance per mil foot of copper,
$P$ = Energy supplied to the circuit,
$W$ = System used (2-, 3- or 4-wire),
$K$ = Constant,
$V$ = Volts loss in the circuit,
$E$ = Pressure at generator end.

In order to show the method of using the chart the following problems have been assumed and the solutions explained in detail:

### Problem No. 1

Required the kilowatts that can be carried by a given size of conductor, the known factors being as follows:

| | |
|---|---|
| Distance of transmission, feet | 1050 |
| Volts drop | 13 |
| Generator voltage | 200 |
| Number of wires | 2 |
| Size of wire, circular mils | 350,000 |

In the explanatory diagram the different values given in this problem have been plotted to correspond roughly to the large chart, the remaining unnecessary values being eliminated so that the method of solution may be more clearly shown.

The sequence of factors used in the calculations is printed at the right of the chart as follows: "Feet — Drop — Voltage — Wires — Constant — Wire Size — Load." Referring to the small diagram, starting from the point marked 1050 feet, the first factor in the sequence just stated, follows the vertical line *a* until it intersects the radial line marked 13 volts "drop," the second factor in the sequence. By construction, each successive value must be taken at right angles to the preceding motion, so that the next value in the sequence, voltage, is reached by following the horizontal line *b*, at right angles to the previous line *a*, until it intersects the line marked 200 volts. At right angles to this line, follows the vertical line *c* until it intersects the radial line marked with the value of the next factor: "2 Wire." The next path is along the horizontal line *d* to the radial line marked "Curve Constant." At right angles to this line, follow the vertical line *e* to the intersection of the curve marked 350,000 circular mils—the "wire size." The last value in the sequence, kilowatts, is reached by following the horizontal line *f* drawn from the last point of intersection to the load line, where the load value, 40 kilowatts, is found.

### Problem No. 2

Required the distance of transmission the other factors being as follows:

| | |
|---|---|
| Size of wire, circular mils | 350,000 |
| Number of wires | 2 |
| Generator voltage | 200 |
| Drop in volts | 13 |
| Kilowatts | 40 |

For the purpose of comparison, th same values are assumed in this problem that were used in the first one, referenc being again made to Fig. 1. In this cas however, the first factor of the sequenc feet, is unknown so that the solution mus be started with the load for the first fac tor and the sequence of values followe in reverse order to that previously followed.

Starting at the point marked 40 kilo watts, the different tracings are followe as indicated by the lettered lines, the las line *a* cutting the distance line at 105 feet, the value desired.

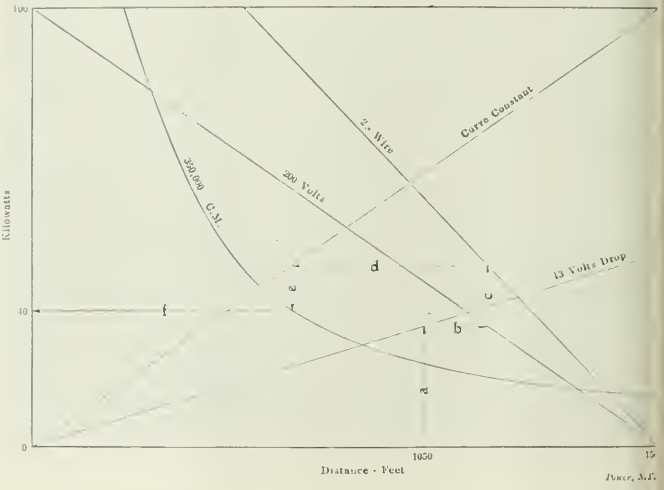


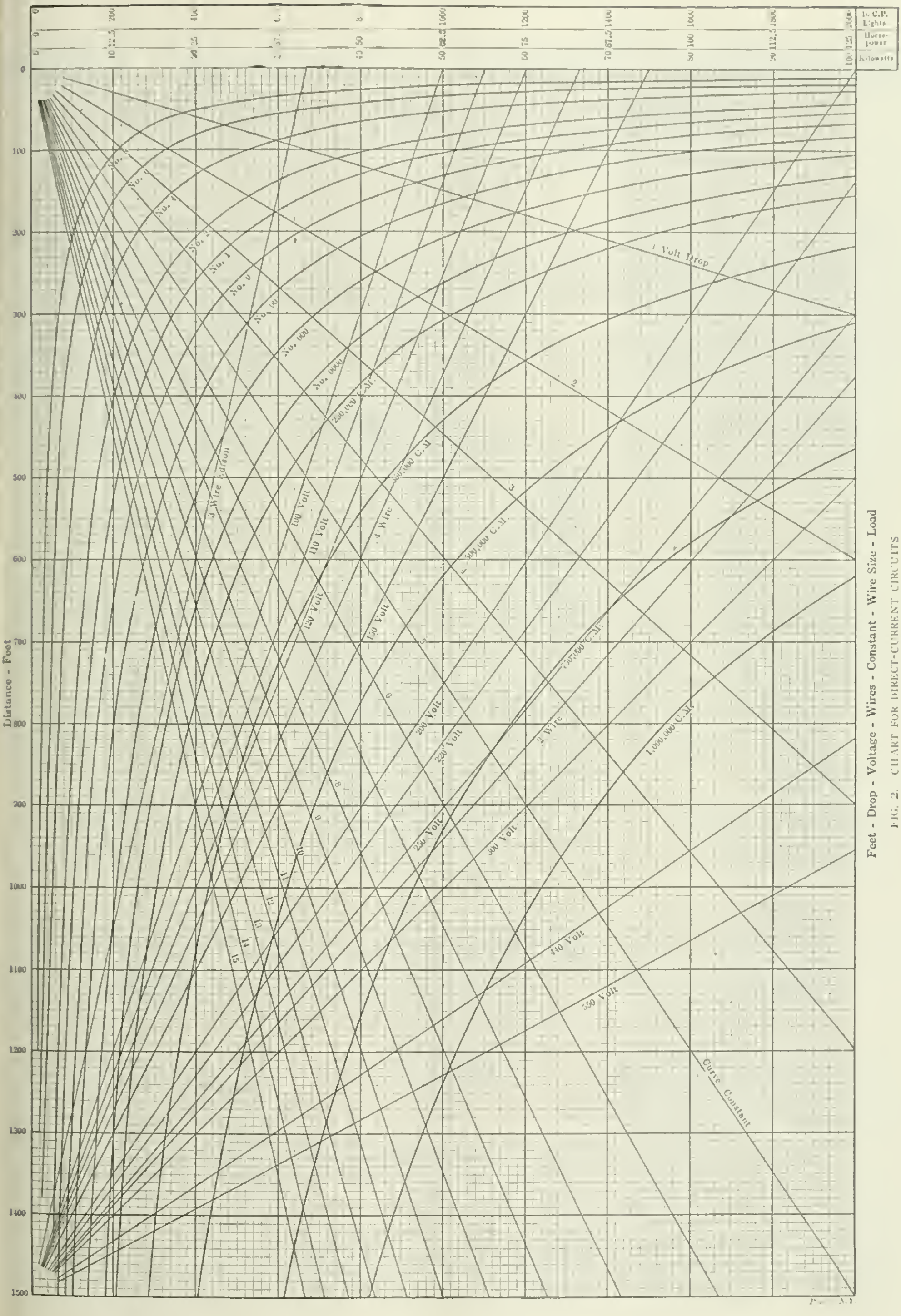
FIG. 1. EXPLANATORY DIAGRAM

### Problem No. 3

Required the drop in a three-wire 11 volt Edison system, the load, distance, etc being known:

| | |
|---|---|
| 16-c.p. lamps | 800 |
| Size of wire, circular mils | 250,000 |
| Number of wires | 3 |
| Voltage (each side of neutral) | 110 |
| Distance, feet | 770 |

Referring to the chart for the solutio of this problem, and starting with th value 800 lamps for the first factor in th sequence, follow the different values give in the order of progression noted, unt the point of intersection with the voltag line is reached. The right-angle line traced from this point until it intersects vertical line drawn from the value 77 feet. The last point of intersection li on the radial line which indicates 6 vol drop, which is the value desired.



Feet - Drop - Voltage - Wires - Constant - Wire Size - Load

FIG. 2. CHART FOR DIRECT-CURRENT CIRCUITS

# Methods of Priming Centrifugal Pumps

## Practical Descriptions of Some of the More Common Systems in Use, with Plain and Explicit Directions for the Proper Handling of Each

### BY JOHN B. SPERRY

Despite the wide application and increasing popularity of the centrifugal pump, fully fifty per cent. of the users of this pump know little if anything about the different systems or methods of priming it, and when they fail to prime it they usually blame the pump. The main thing to bear in mind is that before any centrifugal pump can be made to throw water, or whatever liquid it is to pump, the suction pipe and pump casing must be filled, from the suction level to the discharge mouth of the pump, with the liquid to be handled, which in this article we will suppose to be water. The reason for this can be traced to the fact that when a machine of this character is working as a fan it cannot create a sufficient vacuum to raise the water in the suction pipe within reach of the runner.

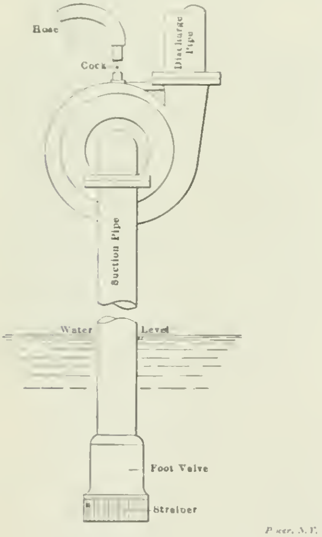


FIG. 1

In many cases the pump will be so installed that the liquid will flow into the pump casing under outside pressure. This is necessary when pumping hot water, as the steam will cause the pump to lose its priming and cease pumping. If the pump is not submerged, or so erected that the water flows into it, the operation of priming or filling the pump with water becomes necessary. The hight above the water level at which a pump can be set varies with the altitude and is shown by the accompanying table

BAROMETRIC PRESSURE AT DIFFERENT ALTITUDES, WITH EQUIVALENT HEAD OF WATER AND THE VERTICAL SUCTION LIFT OF PUMPS.

| Altitude. | Barometric Pressure, Pounds Per Sq. In. | Equivalent Head of Water, Feet. | Practical Suction Lift, Feet. |
|---|---|---|---|
| Sea level. | 14.70 | 33.95 | 25 |
| ¼ mile (1,320 ft.) above sea | 14.02 | 32.38 | 24 |
| ½ mile (2,640 ft.) above sea | 13.33 | 30.79 | 23 |
| ¾ mile (3,960 ft.) above sea | 12.66 | 29.24 | 21 |
| 1 mile (5,280 ft.) above sea | 12.02 | 27.76 | 20 |
| 1¼ miles (6,600 ft.) above sea | 11.42 | 26.38 | 19 |
| 1½ miles (7,920 ft.) above sea | 10.88 | 25.13 | 18 |
| 2 miles (10,560 ft.) above sea | 9.88 | 22.82 | 17 |

### PRIMING METHODS IN GENERAL USE

There are two general schemes of priming in use; that of creating a vacuum in the casing and suction pipe by some kind of air pump, and causing the water to rise up into the casing, and that of displacing the air in the pump by pumping water into it. There are numerous devices that embody these two methods and a description of the most common of these in use will be given. Local conditions and conveniences, such as steam, compressed air, city water, etc., will determine which of these methods should be used to accomplish the desired result.

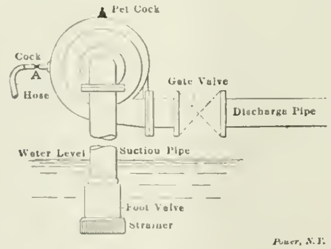


FIG. 2

Fig. 1 shows the simplest method of priming a pump. A foot valve is located at the submerged end of the suction pipe, which enables the pump and suction pipe to be filled with water from above. Before starting the pump, a sufficient quantity of water is admitted, generally through
hole at the top of the volute, to fill it con
pletely. In this case city water was t
be had and the pump was filled by con
necting it with the mains by a hose. Car
must always be taken to make the volut
air-tight before starting, but it is not nec
essary to close the cock through which th
priming water is admitted until after th
pump is pumping in good shape. Wit
this method, as long as the foot valv
remains tight a single priming is enougl
and pumping will begin immediately whenever the pump is started.

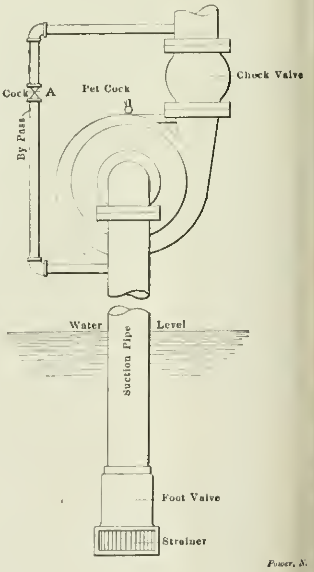
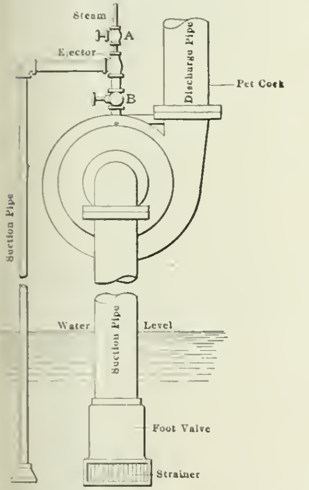


FIG. 3

Fig. 2 shows a pump set up to operat
on the siphon principle. The method
priming is similar to that of Fig. 1.
foot valve is placed at the foot of tl
suction pipe, and a gate valve in the di
charge pipe close to the volute, and at tl
highest part of the volute a pet cock
fitted to allow the air to escape whe
priming. The volute is connected with tl
city water mains at the side by a hos
as shown. Before turning on the ci
water, shut the gate valve and open tl
pet cock. When water flows out of tl
pet cock, start up the pump, shut off tl

ity water with the cock *A*, close the pet ock and then slowly open the gate valve in the discharge pipe. With this method, i the gate valve is closed before shutting lown the pump, and if the foot valve, ate valve and all connections are tight, single priming is sufficient; otherwise, he pump must be primed every time it s started.

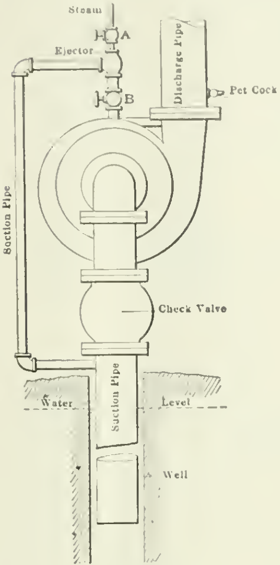
When the head pumped against exceeds 30 feet a check valve is generally placed n the discharge pipe to relieve the pump asing from any water ram caused by udden checking of the water column in he discharge pipe when the pump stops. nder these conditions an arrangement imilar to that shown in Fig. 3 is sometimes used. As will be seen the suction ipe ends with a foot valve, and a bypass onnects the discharge pipe with the suction pipe. The pump is primed in the irst place by the method described in Fig. 1, or by filling the discharge pipe from above and letting the water flow through the bypass into the pump; then, if the foot valve leaks when the pump is shut down, open the pet cock at the top of the volute and the cock at *A*. This will allow water to flow from the discharge pipe into the pump chamber and drive the air out through the pet ock.



Power, N.Y.

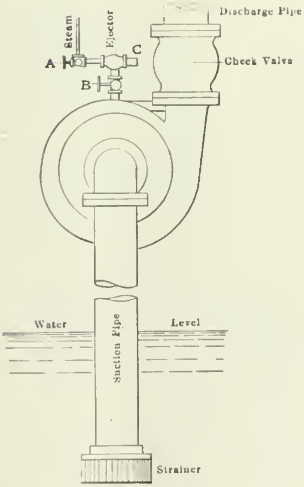
FIG. 4

Fig. 4 shows an arrangement for steam-driven centrifugal pumps, or those that have steam or compressed air within easy reach. The suction pipe is fitted with a foot valve and strainer, and water is pumped for priming with an ejector. In this system care should be taken that the ejector suction is not placed too far above the water level for practical working. To prime the pump open the valve *B*, then the valve *A*, and blow out all of the water in the steam pipe. Next shut the valve *A* and reopen it a little at a time. Use as little steam as possible. When the water flows out at the pet cock in the discharge pipe, shut off *A* and *B* and start up the pump.



Power, N.Y.

FIG. 5



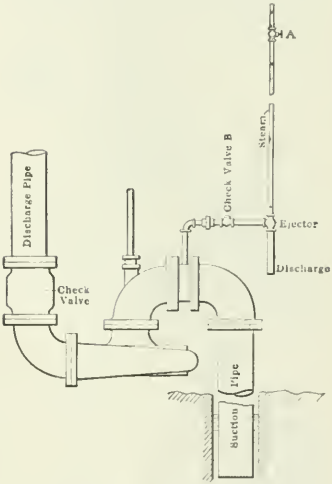
Power, N.Y.

FIG. 6

### Priming without a Foot Valve

When pumping water from a well it is often impossible to insert the ordinary foot valve in the well casing. In that case the pump is often connected up, as shown in Fig. 5, with a check valve just above the well, in the suction pipe. The operation of priming this apparatus is similar to that in Fig. 4. Open the valves *B* and *A*, clear out the steam pipe, close *A* and reopen slowly, using as little steam as possible. When the water reaches the pet cock, close *A* and *B* and start up the pump. The operator should remember that the apparatus here illustrated cannot be primed by filling the pump, by turning water from a hose or anything else, into the discharge pipe; for between the water level and the check valve there is a pocket of air, and when the pump is started up this air is drawn into the pump and pumping ceases.

Fig. 6 is another method of priming a pump without a foot valve. A check valve is placed in the discharge line to prevent the inflow of air when using the ejector in priming. To prime this apparatus, open the valve *A* and blow out the water in the steam pipe so that dry steam can be had; then shut it off for a moment and open the valve *B*, after which turn on the steam at *A* until the ejector works, using as little steam as possible; for it will be found that the ejector will work better on a little steam than it will when the valve is wide open. When the water flows from *C*, start the pump and shut off *B*, then *A*. With this type of priming apparatus it is generally necessary to prime each time the pump is stopped and restarted. Compressed air can be used in place of steam, if desired.



Power, N.Y.

FIG. 7

### To Prime a Top-suction Vertical Pump

In Fig. 7 we again have the ejector, which this time is fitted to prime a vertical pump of the top-suction type. The pump is shown pumping from a well and has no foot valve; instead, a check valve is fitted in the discharge line. The ejector suction pipe is fitted to the highest part of the ejector suction pipe of the pump. A check valve is placed in the ejector suction pipe to prevent the water escaping as air through the ejector. The impellers of vertical pumps are generally [illegible] [illegible] [illegible] [illegible]. The priming is accomplished much the same as in Fig. 7. In this case the check valve *B* takes the place of the valve *C* and is closed [illegible] automatically. The operator [illegible] the ejector valve *A* and when water flows from the discharge *E* he starts the pump.

Fig. 8 illustrates a method that is often used on large motor-driven pumps when the engine runs condensing. The top of the volute is connected to the air pump of the condenser and this creates a sufficient vacuum to prime the pump. There is no foot valve, but a check valve must be placed in the discharge pipe to prevent the inflow of air when priming. A water glass is fitted to the pump shell at *B* and *C*. When the water glass shows sufficient water for priming, the valve *A* is closed and the pump started.

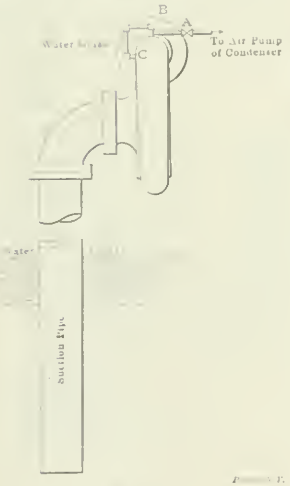


FIG. 8

For small pumps, ranging in size from 1½ to 6 inches, the primer shown in Fig. 9 is often used. It is a fitting that is substituted for the elbow in the suction line. When the operator wishes to prime the pump, he primes water up through the suction pipe with the plunger pump shown at *F B*. This pump works similar to the common bicycle pump. The water is drawn into the pump cylinder through the port *E* and the check valve *A*, and is forced out through *D* into the pump shell. When water flows from the pet cock *G*, start the pump.

The great drawback to this type of primer is the resistance it offers to the passage of the water. This resistance is caused by the irregular shape it is necessary to give the primer and to the check valve *C*. The foot valve shown is not necessary.

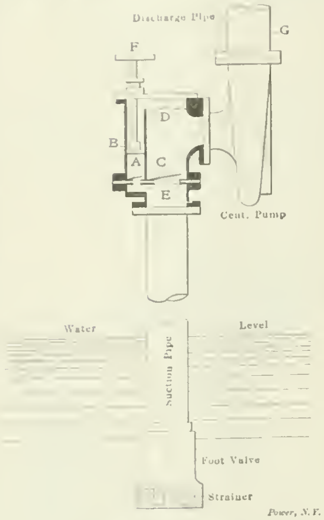


FIG. 9

### WHERE CITY WATER IS NOT AVAILABLE

Fig. 10 represents a type of primer similar to that shown in Fig. 9, but which avoids the objectionable features of the latter. This primer is used where city water is not available. The primer pump is made of a piece of steel tubing screwed into bottom and top castings. The bottom casting contains the check valve *A* and is held to the elbow by bolts *C*. The primer discharge connects the suction elbow of the pump with the top casting. The plunger *E B* is similar to that found in an ordinary cistern pump. The cock shown at *D* is placed there merely to prevent any chance for the air to leak into the pump through the primer. In this apparatus the foot valve is necessary to hold the water in the pump when priming. A pet cock is placed in the discharge pipe for noting when the pump is primed. If the foot valve is tight the primer will have to be used only when the pump has not been running for some time.

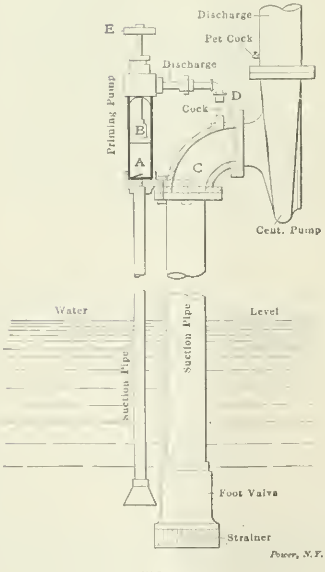


FIG. 10

Another primer that avoids the losses of Fig. 9 is shown in Fig. 11. The ai pump is placed in the discharge pipe. Th foot valve on the suction pipe can b omitted if desired. When priming, clos the gate valve in the discharge pipe, ope the cock at *E* and pump out the air. Whe water flows from *C*, close the cock *E* start up the pump and open the gate valv slowly. When pumping from a well, th foot valve can be omitted.

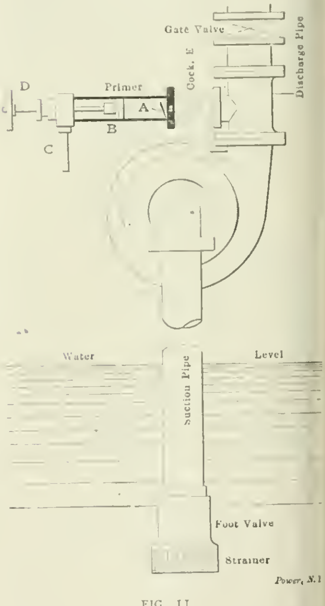


FIG. 11

### PRIMING MULTISTAGE PUMPS

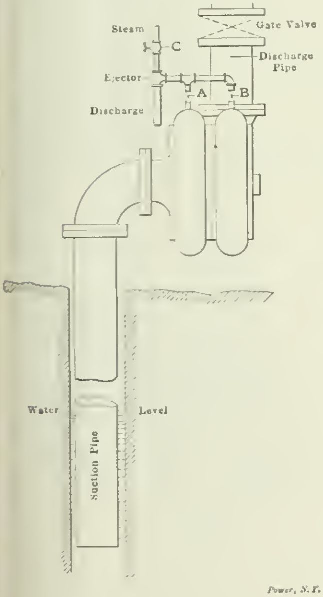
Fig. 12 illustrates a method of primin multistage centrifugal, or turbine pump by means of an ejector, when pumpin from a well where a foot valve cannot b used. The ejector suction is connecte to the highest part of each pump chambe with cocks at *A* and *B*. These cocks ar necessary to prevent the back flow o water from the high-pressure to the low pressure chamber when pumping. T prime the pump, close the gate valve in the discharge pipe, blow out the steam pipe, then shut off the steam for a minute, open the cocks *A* and *B*, and then turn on the steam again, taking care to remember all the precautions mentioned regarding the use of the ejector. When water flows from the ejector discharge, start up the pump, shut off *A* and *B*, and then *C*. When the pump gets up to speed open the gate valve slowly.

When a multistage pump uses a foot valve it can be primed with an ejector by the arrangement shown in Fig. 13. The ejector raises the water through an independent suction pipe and forces it into the first-stage pump chamber. The air escapes through the discharge pipe and pet cock *C*. To prime the pump, open the cock at *A* and turn on the steam, and have the pet cock *C* open. When water issues from *C*, close *B* and *A*, and start the pump, after which *C* can be closed.

### SPECIAL PRIMING DEVICES

To the foregoing it might be interesting to add the descriptions of some special priming apparatus. Fig. 14 shows an electric driven centrifugal pump that is automatically primed. As will be seen, the priming part consists of a rotary pump driven by the motor. The suction of the rotary pump is connected to the suction elbows of the centrifugal pump. Before starting the motor, open the valves *C* and *D*. Then start the motor. The rotary pump pumps the air out of the suction pipe of the centrifugal pump, and when it has created a sufficient vacuum, so the water can be seen in the water glass, the pump is primed, and the valves *C* and *D*, can be shut. A check valve in the discharge pipe prevents the inflow of air when priming.

Fig. 15 shows an arrangement that can be attached to a pump placed some distance above the water, which gives it all the advantages of one submerged. Should the water level lower and allow air to enter the pump and prevent its working, this device automatically recharges it. The automatic recharging of the pump is effected by means of the pipe *A*, in which is a valve *B*. When *B* rises it allows water to flow into the suction pipe *C* from *A*, which is connected to the tank into which the pump discharges, or it may be connected to the discharge pipe. The cock *D* would not be needed then, but this arrangement would not allow the pump to be primed when first starting. It will be seen that the pipe *A* discharges into the suction pipe above the foot valve. When the pump is working steadily *B* is closed, but should the pump cease pumping, or even diminish its discharge, *B* opens and allows a larger or smaller amount of water to flow, so that air contained in the pump is driven out.



Power, N.Y.

FIG. 12

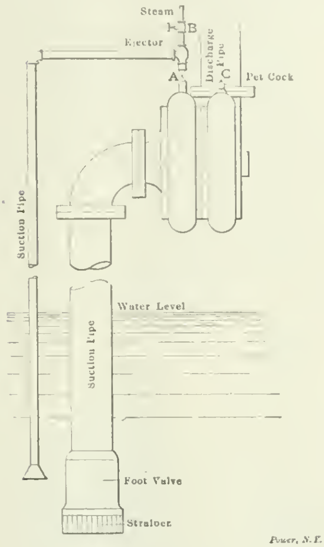


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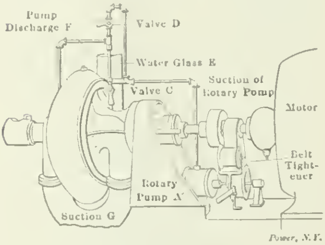
FIG. 13

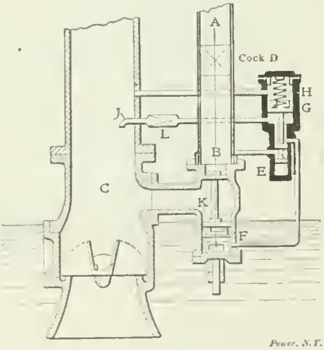
The opening and closing of the valve *B* is automatically caused by the valve *E* and the pistons *F* and *G*, the spring *H* and the Pitot tube *J*. The piston *F* works in the cylinder *K* and can be put in communication with either the suction pipe *C* or the pipe *A* by means of the valve *E*; when it is down it is connected with the former and when up the latter. The piston *G* is kept up by the pressure produced by means of the Pitot tube *J*, which faces the current, so that the pressure is proportional to the square of the velocity of the current. If the quantity of water flowing in the suction pipe decreases, the pressure drops and *G* is forced down by the spring *H*, thus allowing the pressure in the suction pipe *C* to come under the piston *F*, which is in turn pressed down by the greater pressure in the pipe *A*, so that *B* remains open until the pump is recharged. On the other hand, if the pump is working properly, *G* is kept up by the pressure due to the Pitot tube. At *L* is a screen filter that prevents dirt getting into the valve *E*. When the pump is not working the cock *D* should be closed. The quantity of water discharged by the valve *B* can be governed by regulating the spring *H*.

If the distance from the water level, when pumping does not exceed that shown in the table, and the suction pipe and pump casing are air-tight and filled with water, as described in this article, it will be impossible for a centrifugal pump not to start pumping when primed, provided, of course, that it is speeded correctly for the working head and there is a sufficient supply of water.



Power, N.Y.

FIG. 14



Power, N.Y.

FIG. 15

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Where no facilities are provided to prevent the feed pipe inside of the boiler becoming lined with hard scale, it should be put together with unions instead of couplings, to save a hard, hot job when the pipe must eventually be taken out.

# Power Cost Production in a Small Central Station

By H. S. Knowlton

Detailed study of central-station costs through a series of years is always useful whether the capacity of the plant be large or small. The same general conditions bearing upon station efficiency are present in all capacities of similar equipment. The following data suggest the causes of high and low power cost in a steam-electric plant of about 600 kilowatt rating, for the years 1905 to 1908 inclusive. Unlike many steam plants of moderate size this station succeeded in reducing its manufacturing cost per kilowatt-hour progressively from year to year, the cost in 1905 being 2.78 cents, and in 1908, 1.8 cents.

TABLE 1. TOTAL ANNUAL COSTS OF MANUFACTURING POWER

| | 1905. | 1906. | 1907. | 1908. |
|---|---|---|---|---|
| K.w.-hrs. m'f'd | 420,520 | 481,119 | 636,486 | 730,458 |
| Fuel cost | $6,386 | $6,805 | $7,974 | $6,751 |
| Oil and waste | 517 | 157 | 135 | 149 |
| Water. | 212 | 212 | 212 | 105 |
| Wages at station | 3,752 | 3,726 | 3,845 | 5,017 |
| Station repairs Blg. | . | 126 | 223 | . . . |
| Steam plant repairs | 643 | 904 | 849 | 804 |
| Elec. plant repairs | 125 | 189 | 91 | 26 |
| Total | $11,665 | $12,419 | $13,629 | $13,152 |

The equipment of the plant underwent little change during the four years. In 1905 the boiler plant consisted of one Strothers & Wells 150-horsepower unit with 136 three-inch tubes, and two Babcock & Wilcox units rated at 200 horsepower each and having individually ninety 4-inch tubes. The total boiler-plant rating was 550 horsepower, and this installation remained the same throughout the four years.

The engine equipment of the station consisted of McIntosh & Seymour engines as follows: One 15x23x17-inch tandem-compound condensing engine, one 10x17x14-inch cross-compound condensing engine and one 13x22x18-inch cross-compound condensing engine. The capacities of these engines at normal load were, respectively, 250, 125 and 250 horsepower, and the speeds of operation, 208, 250 and 230 revolutions per minute. The total engine rating was 625 horsepower. No changes in the engine equipment were made during the four years covered by the figures to follow. The electrical department of the plant operated 450 kilowatts in dynamos, alternating- and direct-current machines being in service. A few slight changes were made in the number of dynamos used during the time reviewed, giving in 1908 a total generator capacity of 630 kilowatts. During the first three of the years tabulated the plant was operated by two engineers and two firemen. In 1908 three engineers and three firemen were employed. Table 1 gives the kilowatt-hours produced and delivered at the switchboard of the station, and the total manufacturing costs for the four years, with cents omitted.

These figures show that the generated electrical energy of the plant increased about 71 per cent in the four years. The total cost of production increased only about 13 per cent. The company's power sales for motor service increased from 108,000 kilowatt-hours in 1905 to 220,544 kilowatt hours in 1906. In 1907 the motor load demanded 241,000 kilowatt-hours at the consumers' meters, while in 1908, probably on account of the business depression, the power sales dropped to 230,293 kilowatt-hours. The total sales of electrical energy for the four years, the amount of coal burned and the cost per ton are shown in Table 2, the coal being of the bituminous variety, and the cost per ton the average expense of purchase and delivery at the plant.

TABLE 2. TOTAL SALES OF ELECTRICAL ENERGY, TONS OF COAL USED AND COST.

| | 1905. | 1906. | 1907. | 1908. |
|---|---|---|---|---|
| K.w.-hr. sold | 409,730 | 447,660 | 466,941 | 549,620 |
| Tons coal used | 1,570 | 1,665 | 1,845 | 1,629 |
| Av. cost coal per ton... | $4.05 | $4.07 | $4.31 | $4.15 |

The station was fortunate in not being obliged to meet sweeping advances in the cost of coal per ton. The cost for 1906 was practically the same as for 1905, and while there was a troublesome increase in 1907, there was a reduction in 1908 sufficient to bring the total fuel cost for that year below the 1907 figure. It speaks well for the intelligence with which the station was operated that the total fuel cost for 1908 was less than in 1906 and 1907, and only about 6 per cent. greater than in 1905, despite the large increase in energy sales and plant production. The figures indicate that the owners and operators must have watched closely for all the incidental sources of waste, and the steam-plant repair costs, averaging reasonably near the same level for three of the four years, combined with steadily diminishing electrical-equipment repair costs, show that the apparatus as a whole was well maintained. It might be feasible for a year or two to neglect the proper steam-plant repairs somewhat in order to make a better showing in the total cost of power production; but such a practice could scarcely be prolonged without resulting in an abnormal expenditure in some early year following for equipment maintenance.

Difficult as it is to operate a plant steadily year in and year out without incurring sudden variations in the items composing maintenance charges, the even flow of these expenditures hints here at a fortunate absence of accidents and consequent breakdown involving abnormal expenditures. The regularity of the steam-plant repair costs as a whole implies that they were assigned mainly to the replacements of equipment parts necessary ir the ordinary service of he station. Th equipment must have been handled witl special efforts to produce electricity under the most favorable conditions of efficiency in individual generating units; ii other words, the plant was evidently operated at as near the most efficient outputs of its machines as could be reached, anc in this practice the attendants were undoubtedly aided by the substantial gain in energy required for motors from yea to year. Even in a small station the effec of an expanding day load is bound to b beneficial to economy, if the apparatus i well handled.

In the three years 1905, 6 and 7 th total labor costs held about the same ii the face of heavier and heavier demand upon the station. The increasing of th operating force in 1908, however, wa a wise step. While it increased the tota labor cost by about $1200 compared witl 1907, the unit labor cost, as shown ii Table 3, was increased in a far smalle ratio. Table 3 gives the manufacturin cost per kilowatt-hour expressed in term of fuel, labor, miscellaneous and total for the four years.

TABLE 3. COSTS IN CENTS PER KILC WATT-HOUR.

| | 1905. | 1906. | 1907. | 1908. |
|---|---|---|---|---|
| Fuel... | 1.52 | 1.41 | 1.25 | 0.92 |
| Labor... | 0.89 | 0.77 | 0.605 | 0.6 |
| Miscellaneous..... | 0.37 | 0.39 | 0.285 | 0.29 |
| Total..... | 2.78 | 2.57 | 2.14 | 1.90 |

# Economy in Condensing Plant

It sometimes occurs that the sourc from which the water used for coolin condensers at power stations is drawn, i at a level considerably below that of th condensing plant. It is then necessar of course, to use a pump to force th water up to the condenser, and a larg amount of power may be absorbed i this way. The water in returning to th original level, however, can be made t perform useful work. This fact has bee taken advantage of by W. H. Allen, So & Co., in the installation of condensin plants at the Newcastle tramway powe station and at the Penrikyber collier In both these cases the condensers a considerably higher than the water supply. An electric motor is used to driv the pump which raises the water, and turbine, coupled on to the same shaf utilizes the returning water to furnis some of the driving power. In the ca of the Nawcastle installation, 2500 gallons of water have to be raised 120 fe per minute, but the total amount of powe used is only 52 kilowatts, or about ha that required if the turbine arrangeme were not employed. The Penrikyb plant has given even better results tha this.—*The Standard*, London.

# Running a Westinghouse Steam Turbine

## How to Care for the Turbine While Running, Instructions for Shutting Down and Inspection. Details of Construction and Operation

On the right-hand end of the main shaft in Fig. 2 of the article of last week there will be seen a worm gear driving the governor. This is shown on a larger scale at *A*, Fig. 1. At the left of the worm gear is a bevel gear driving the spindle *D* of the governor and at the right an eccentric which gives a vibratory motion to the lever *F*. The crank *C* upon the end of the shaft operates the oil pump. The speed of the turbine is controlled by admitting the steam in puffs of greater or less duration according to the load. The lever *F*, having its fulcrum in the collar surrounding the shaft, operates with each vibration of the eccentric the pilot valve. The valve is explained in detail later.

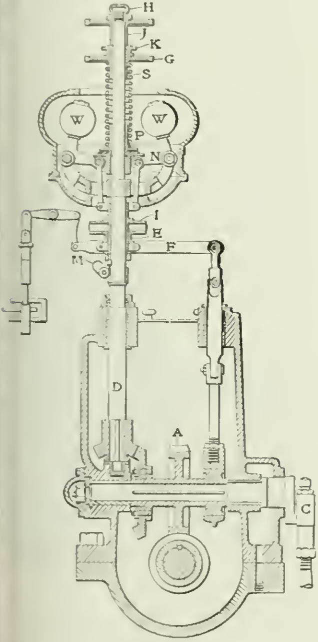


FIG. 1

This form of governor has been superseded by an improved type, but so many have been made that it will be well to describe its construction and adjustment. The two balls *W W*, Fig. 1, are mounted on the ends of bell cranks *N*, which rest on knife edges. The other end of the bell cranks carry rollers upon which rest a plate *P*, which serves as a support for the governor spring *S*. They are also attached by links to a yoke and sleeve *E* which acts as a fulcrum for the lever *F*. The governor is regulated by means of the spring *S* resting on the plate *P* and compressed by a large nut *G* on the upper end of the governor spindle, which nut turns on a threaded quill *J* held in place by the nut *H* on the end of the governor spindle and is held tight by the locknut *K*. To change the compression of the spring and thereby the speed of the turbine the locknut must first be loosened and the hand nut raised to lower the speed, or lowered to raise the speed as the case may be. This operation may be accomplished while the machine is either running or at rest.

The plate *P* rests upon ball bearings so that by simply bringing pressure to bear upon the handwheel which is a part of the quill *J*, the spring and locknut may be held at rest and adjusted while the rest of the turbine remains unaffected. Another lever is mounted upon the yoke *E* on the pin shown at *I*, the other end of which is fastened to the piston of a dashpot so as to dampen the governor against vibration. Under the yoke *E* will be noticed a small trigger *M* which is used to hold the governor in the full-load position when the turbine is at rest. The throwing out of the weights elevates the sleeve carrying with it the collar, which is spanned by the lever *F*.

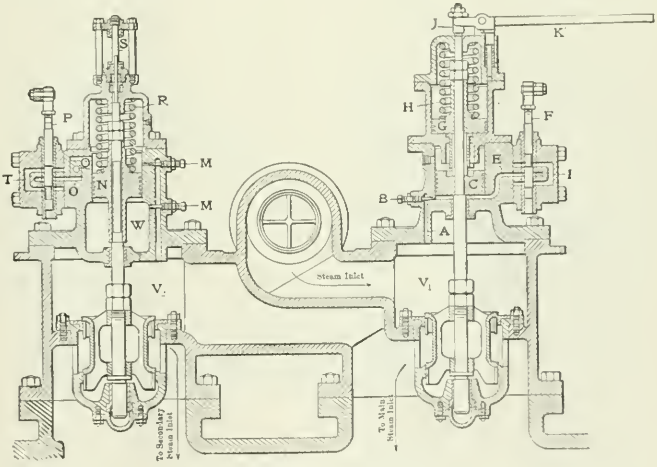


FIG. 2

The later turbines are provided with an improved form of governor operating on the same principle, but embodying several important features. First, the spindle sleeve is integral with the governor yoke, and the whole rotates about a vertical stationary spindle so that two motions are encountered—a rotary motion and an up-and-down motion, according to the position taken by the governor. This spiral motion almost entirely eliminates the effect of friction of rest, and thereby enhances the sensitiveness of the governor. Second, the governor weights move outward on a parallel motion opposed directly by spring thrust, thus relieving the fulcrum entirely of spring thrust. Third, the lay shaft driving the governor oil pump and reciprocator is located underneath the main turbine shaft so that the rotor may be readily removed without in the least disturbing the governor adjustment. The substitution of a motor for handwheel *H* allows the speed of the turbine to be regulated from the switchboard.

### The Valve Gear

The valve gear is shown in section in Fig. 2, the main admission being shown at $V_1$ at the right, and the secondary $V_2$ at the left of the steam inlet. The pilot valve *F* receives a constant reciprocating motion from the eccentric upon the lay-shaft of the turbine through the lever *F* Fig. 1. These reciprocations run from 150 to 180 per minute. The space be-seat, the passage [illegible] in communication with the [illegible] chest, where exists the [illegible] pressure, through the port J, the admission of steam to the piston C being controlled by a needle valve K. The pilot valve connects the port J leading from the space beneath the piston to an exhaust port I.

When the pilot valve is closed, the pressure can accumulate beneath the piston C and raise the main admission valve from its seat. When the pilot valve opens the pressure beneath the piston is relieved and it is seated by the helical spring above. If the fulcrum *E*, Fig. 2, if the lever *F* were fixed the admission would be of an equal and fixed duration. But if the governor raises the fulcrum *E*, the pilot valve *I*, Fig. 2, will be lowered, changing the relations of the openings with the working edges of the ports. The seating of the main admission-valve is cushioned by the dashpot, the piston of which is shown in section at *G*, Fig. 2. The valve may be opened by hand by means of the lever *K*, to see if it is perfectly free.

The secondary valve is somewhat different in its action. Steam is admitted to both sides of its actuating piston through the needle valves *M M* and the chamber from which this steam is taken is connected with the under side of the main admission valve, so that no steam can reach the actuating piston of the secondary valve until it has passed through the primary valve. When the pilot valve is closed, the pressures equalize above and below the piston *N* and the valve remains upon its seat. When the load upon the turbine exceeds its rated capacity, the pilot valve moves upward so as to connect the space above the piston with the exhaust *T*, relieving the pressure upon upper side and allowing the greater pressure below to force the valve open, which admits steam to the secondary stage of the turbine.

It would do no good to admit more steam to the first stage, for at the rated capacity, that stage is taking all the steam for which the blade area will afford a passage. The port connecting the upper side of the piston *N* with the exhaust may be permanently closed by means of the hand valve *O*, to be found on the side of the secondary pilot valve chest, thus cutting the secondary valve entirely out of action. No dashpot is necessary on this valve, the compression of the steam in the chamber *W* by the fall of the piston being sufficient to avoid shock.

The timing of the secondary valve is adjusted by raising or lowering the pilot valve by means of the adjustment provided. It should open soon enough so that there will not be an appreciable drop in speed before the valve comes into play. The economy of the machine w be impaired if the valve is allowed open too soon.

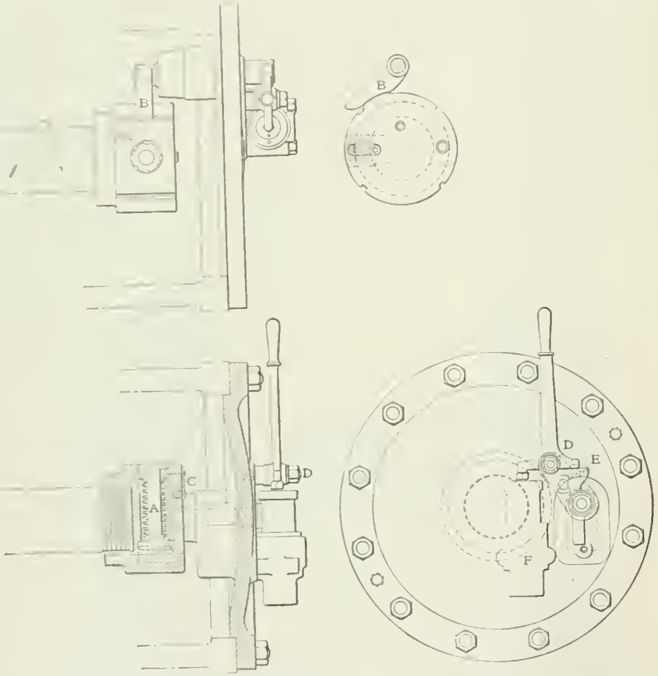


FIG. 3

### Safety Stop Governor

This device is mounted on the govern end of the turbine shaft, as shown in F 3. When the speed beaches a predete mined limit the plunger *A* having its ce of gravity slightly displaced from the ce ter of rotation of the shaft, is throv radially outward and strikes the lever It will easily be understood that when t plunger starts outward, the resistance spring *C* is rapidly overcome, since t centrifugal force increases as the squa of the radius, or in this case the ecce tricity of the center of gravity relative the center of rotation. Hence, the lever struck a sharp blow. This releases t trip *E* on the outside of the governor ca ing and so opens the steam valve *F* whi releases steam from beneath the actuati piston of a quick-closing throttle val located in the steam line. Thus, wit a period of usually less than one seco the steam is entirely shut off from the tu

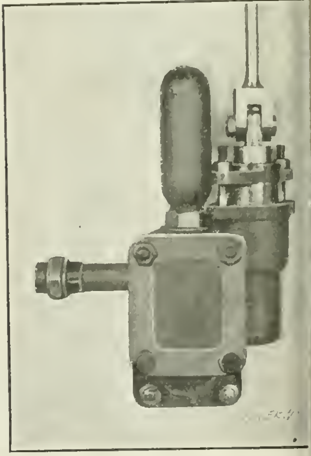


FIG. 4

bine when the speed has exceeded 7 o per cent. of the normal.

### The Oiling System

Mounted on the end of the bedplate the oil pump operated from the m shaft of the turbine as previously stat This may be of the plunger type sho in Fig. 4, or upon the latest turbine, rotary type shown in Fig. 5. Arou the bedplate are located the oil-cool coils, the oil strainer, the oil reserv and the oil piping to the bearings.

The oil reservoir, cooler and piping all outside the machine and easily acc sible for cleaning. Usually a corrugat steel floorplate covers all this appara so that it will not be unsightly and cumulate dirt, particularly when the t ine is installed. Where the turbine is set igher, a casing is usually built around his material so that it can be easily removed and forms a platform alongside he machine.

The oil cooler, shown in Fig. 6, is of he countercurrent type, the water entering at A and leaving at B, oil entering at (opening not shown) and leaving at D. he coils are of seamless drawn copper nd attached to the cover by coupling and ut. The water manifold F is divided nto compartments by transverse ribs, each ompartment connecting the inlet of each oil with the outlet of the preceding coil, hus placing all coils in series. These oils are removable in one piece with the overplate without disturbing the rest of he oil piping.

### Blading

The blades are drawn from a rod conisting of a steel core coated with copper o intimately connected with the other metal that when the bar is drawn to he section required for the blading, the xterior coating drawn with the rest of he bar forms a covering of uniform hickness as shown in Fig. 7. The bar after being drawn through the correct section is cut into suitable lengths punched as at A, Fig. 8, near the top of the blade and has a groove shown at B, Fig. 9, near the root, stamped in its concave face, while the blade is being cut to length and punched. The blades are then set into grooves cut into the rotor drum or the concave surface of the casing, and spacing or packing pieces C, Fig. 9, are placed between them. These spacing pieces are of soft iron and of the form which is desired that the passage between the blades shall take. The groove made upon the inner face of the blade is sufficiently near to the root to be covered by this spacing piece. When the groove has been filled the soft-iron pieces are calked or spread so as to hold the blades firmly in place. A wire of comma section, as shown at A, Fig. 8, is then strung through the punches near the outer ends of the blades and upset or turned over as shown at the right in Fig. 8. This upsetting is done by a tool which shears the tail of the comma at the proper width between the blades. The bent-down portion on either side of the blade holds it rigidly in position and the portion retained within the width of the blade would retain the blade in its radial position should it become loosened or broken off at the root. This comma lashing, as it is called, takes up a small proportion only of the blade length or projection and makes a job which is surprisingly stiff and rigid, and yet which yields in case of serious disturbance rather than to maintain a contact which would result in its own fusing or the destruction of some more important member.

### Starting up the Turbine

When starting up the turbine for the first time, or after any extended period of idleness, special care must be taken to see that everything is in good condition and that all parts of the machine are clean and free from injury. The oil piping should be thoroughly inspected and cleaned out if there is any accumulation of dirt. The oil reservoirs must be very carefully wiped out and minutely examined for the presence of any grit. Avoid using cotton waste for this, as a considerably quantity of lint is almost sure to be left behind and this will clog up the oil passages in the bearings and strainer.

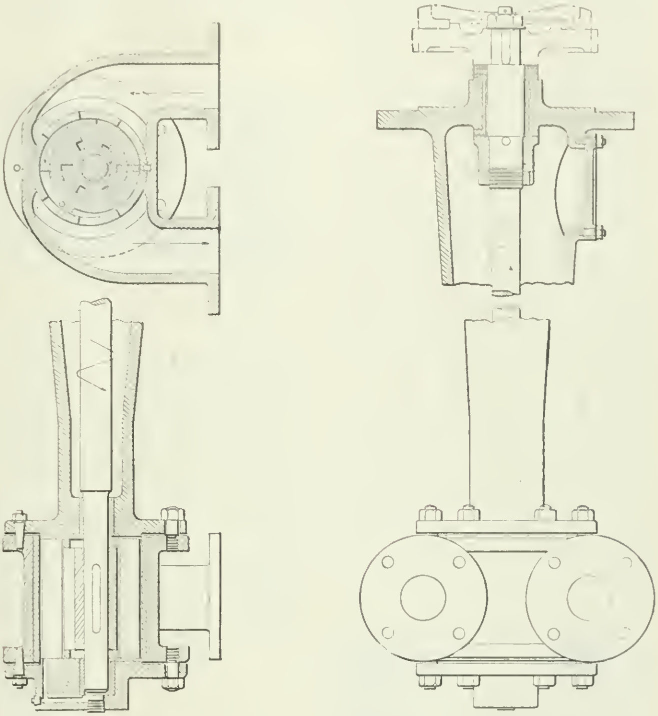


FIG. 5

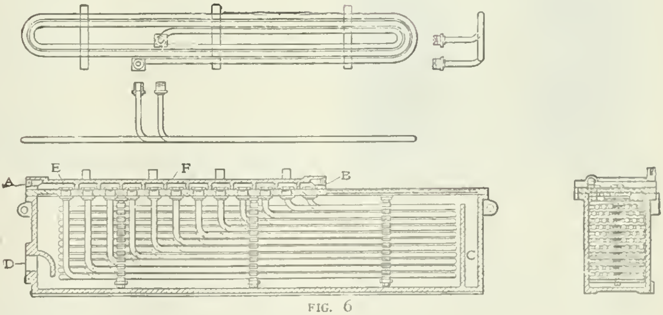


FIG. 6

The pilot valves should be removed from the barrel and wiped off, and the barrels themselves cleaned out by pushing a soft cloth through them with a piece of wood. In no case should any metal be used.

If the turbine has been in a place where there was dirt or where there has been much dust blowing around, the bearings should be removed from the spindle and taken apart and thoroughly cleaned. With care this can be done without removing the spindle from the cylinder, by taking off the bearing covers and very carefully lifting the weight of the spindle off the bearings, then sliding back the bearings. It is best to lift the spindle by means of jacks and a rope sling, as, if a crane is used, there is great danger of lifting the spindle too high and thereby straining it or injuring the blades. After all the parts have been carefully gone over and cleaned, the oil for the bearing lubrication should be put into the reservoirs by pouring it into the governor gear case. Enough oil should be put in so that when the governor gear case and all the bearing supply pipes are full, the supply to the oil pump is well assured.

Special care should be taken so that no grit gets into the oil when pouring it into the machine. Considerable trouble may be saved in this respect by pouring the oil through cloth.

A very careful inspection of the steam piping is necessary before the turbine is run. If possible it should be blown out by steam from the boilers before it is finally connected to the turbine. Considerable annoyance may result by neglecting this precaution from particles of scale, red lead, gasket, etc., out of the steam pipe closing up the passages of the guide blades.

When starting up, always begin to revolve the spindle without vacuum being on the turbine. After the spindle is turning slowly, bring the vacuum up. The reason for this is, that when the turbine is standing still, the glands do not pack and air in considerable quantity will rush through the glands and down through the exhaust pipe. This sometimes has the effect of unequal cooling. In case the turbine is used in conjunction with its own separate condenser, the circulating pump may be started up, then the turbine revolved, and afterward the air pump put in operation; then, last, put the turbine up to speed. In cases, however, where the turbine exhausts into the same condenser with other machinery and the condenser is therefore already in operation, the valve between the turbine and the condenser system should be kept closed until after the turbine is revolved, the turbine in the meantime exhausting through the relief valve to atmosphere.

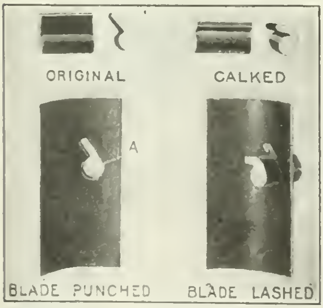


FIG. 8

Care must always be taken to see that the turbine is properly warmed up before being caused to revolve, but in cases where high superheat is employed always revolve the turbine just as soon as it is moderately hot and before it has time to become exposed to superheat.

In the case of highly superheated steam, it is not undesirable to provide a connection in the steam line by means of which the turbine may be started up with saturated steam and the superheat gradually applied after the shaft has been permitted to revolve.

FIG. 7

For warming up, it is usual practice to set the governor on the trigger (see Fig. 1) and open the throttle valve to allow the entrance of a small amount of steam.

It is always well to let the turbine operate at a reduced speed for a time, until there is assurance that the condenser and auxiliaries are in proper working order, that the oil pump is working properly, and that there is no sticking in the governor or the valve gear.

After the turbine is up to speed and on the governor, it is well to count the speed by counting the strokes of the pump rod, as it is possible that the adjustment of the governor may have become changed while the machine has been idle. It is well at this time, while there is no load on the turbine, to be sure that the governor controls the machine with the throttle wide open. It might be that the main poppet valve has sustained some injury not evident on inspection, or was leaking badly. Should there be some such defect, steps should be taken to regrind the valve to its seat at the first opportunity.

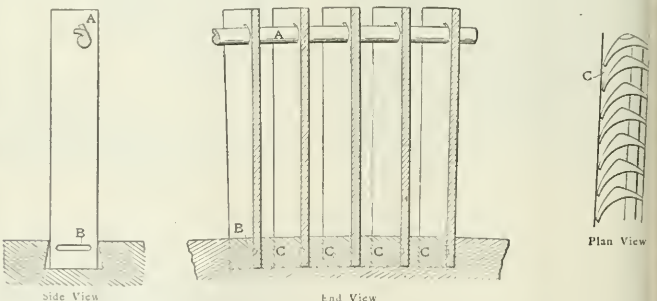
On the larger machines an auxiliary oil pump is always furnished. This should be used before starting up, so as to establish the oil circulation before the turbine is revolved. After the turbine has reached speed, and the main oil pump is found to be working properly, it should be possible to take this pump out of service, and start it again only when the turbine is about to be shut down.

If possible, the load should be thrown on gradually to obviate a sudden, heavy demand upon the boiler, with its sometimes attendant priming and rush of water into the steam pipe, which is very apt to take place if the load is thrown on too suddenly. A slug of water will have the effect of slowing down the turbine to a considerable extent, causing some annoyance. There is not likely to be the danger of the damage that is almost sure to occur in the reciprocating engine, but at the same time it is well to avoid this as much as possible. A slug of water is obviously more dangerous when superheated steam is being employed, owing to the extreme temperature changes possible.

## RUNNING

While the turbine is running, it should have a certain amount of careful attention. This, of course, does not mean that the engineer must stand over it every minute of the day, but he must frequently inspect such parts as the lubricators, the oiling system, the water supply to the glands and the oil-cooling coil, the pilot valve, etc. He must see that the oil is up in the reservoir and showing in the gage glass provided for that purpose, and that the oil is flowing freely through the bearings, by opening the pet cocks in the top of the bearing covers. An ample supply of oil should always be in the machine to keep the suction in the tank covered.

Care must be taken that the pump does not draw too much air. This can usually be discovered by the bubbling up of the air in the governor case, when more oil should be added.



Side View

End View

Plan View

FIG. 9

It is well to note from time to time he temperature of the bearings, but no larm need be occasioned because they eel warm to the touch; in fact, a bearing is all right as long as the hand can be borne upon it even momentarily. . The oil coming from the bearings should be preferably about 120 degrees Fahrenheit and never exceed 160 degrees.

It should generally be seen that the oil-cooling coil is effective in keeping the oil cool. Sometimes the cooling water deposits mud on the cooling surface, as well as the oil depositing a vaseline-like ubstance, which interferes with the cooling effect. The bearing may become unduly heated because of this, when the coil should be taken out at the first opportunity and cleaned on the outside and blown out by steam on the inside, if this atter is possible. If this does not reduce the temperature, either the oil has been in use too long without being filtered, or the quality of the oil is not good.

Should a bearing give trouble, the first symptom will be burning oil which will smoke and give off dense white fumes which can be very readily seen and smelled. However, trouble with the bearings is one of the most unlikely things to be encountered, and, if it occurs, it is due to some radical cause, such as the bearings being pinched by their caps, or grit and foreign matter being allowed to get into the oil.

If a bearing gets hot, be assured that there is some very radical cause for it which should be immediately discovered and removed. Never, under any circumstances, imagine that you can nurse a bearing, that has heated, into good behavior. Turbine bearings are either all right or all wrong. There are no halfway measures.

The oil strainer should also be occasionally taken apart and thoroughly cleaned, which operation may be performed, if necessary, while the turbine is in operation. The screens should be cleaned by being removed from their case and thoroughly blown out with steam. In the case of a new machine, this may have to be done every two or three hours. In course of time, this need only be repeated perhaps once a week. The amount of dirt found will be an indication of the frequency with which this cleaning is necessary.

The proper water pressure, about five pounds per square inch, must be maintained at the glands. Any failure of this will mean that there is some big leak in the piping, or that the water is not flowing properly.

The pilot valve must be working freely, causing but little kick on the governor, and should be lubricated from time to time with good oil.

Should it become necessary, while operating, to shut down the condenser and change over to noncondensing operation, particular care should be observed that the change is not made too suddenly to noncondensing, as all the low-pressure sections of the turbine must be raised to a much higher temperature While this may not cause an accident, it is well to avoid the stresses which necessarily result from the sudden change of temperature. The same reasons, of course, do not hold good in changing from noncondensing to condensing

### SHUTTING DOWN

When shutting down the turbine the load may be taken off before closing the throttle; or, as in the case of a generator operating on an independent load, the throttle may be closed first, allowing the load to act as a brake, bringing the turbine to rest quickly. In most cases, however, the former method will have to be used, as the turbine generally will have been operating in parallel with one or more other generators. When this is the case, partially close the throttle just before the load is to be thrown off, and if the turbine is to run without load for some time, shut off the steam almost entirely in order to prevent any chance of the turbine running away. There is no danger of this unless the main valve has been damaged by the water when wet steam has been used, or held open by some foreign substance, when, in either case, there may be sufficient leakage to run the turbine above speed while running light. At the same time, danger is well guarded against by the automatic stop valve, but it is always well to avoid a possible danger.

As soon as the throttle is shut, stop the condenser, or, in the case where one condenser is used for two or more turbines, close the valve between the turbine and the condenser. Also open the drains from the steam strainer, etc. This will considerably reduce the time the turbine requires to come to rest. Still more time may be saved by leaving the field current on the generator.

Care should be taken, when the vacuum falls and the turbine slows down, to see that the water is shut off from the glands for fear it may leak out to such an extent as to let the water into the bearings and impair the lubricating qualities of the oil.

### INSPECTION

At regular intervals thorough inspection should be made of all parts of the turbine. As often as it appears necessary from the temperature of the oil, depending on the quality of the oil and the use of the turbine, remove the oil-cooling coil and clean it both on the inside and outside as previously directed; also clean out the chamber in which it is kept. Put in a fresh supply of oil. This need not necessarily be new, but may be oil that has been in use before but has been filtered. We recommend that an oil filter be kept for this purpose. Entirely new oil need only be put into the turbine when the old oil shows marked deterioration. With a first-class oil this will probably be a very infrequent necessity, as some new oil has to be put in from time to time to make up the losses from leakage and waste.

Clean out the oil strainer, blowing steam through the wire gauze to remove any accumulation of dirt. Every six months to a year take off the bearing covers, remove the bearings, and take them apart and clean out thoroughly. Even the best oil will deposit more or less solid matter upon hot surfaces in time, which will tend to prevent the free circulation of the oil through the bearings and effectively stop the cushioning effect on the bearings. Take apart the main and secondary valves and clean thoroughly, seeing that all parts are in good working order. Clean and inspect the governor and the valve gear, wiping out any accumulation of oil and dirt that may appear. Be sure to clean out the drains from the glands so that any water that may pass out of them will run off freely and will not get into the bearings.

At the end of the first three months, and after that about once a year, take off the cylinder cover and remove the spindle. When the turbine is first started up, there is very apt to be considerable foreign matter come over in the steam, such as balls of red lead or small pieces of gasket too small to be stopped by the strainer. These get into the guide blades in the cylinder and quite effectively stop them up. Therefore, the blades should be gone over very carefully, and any such additional accumulation removed. Examine the glands and equilibrium ports for any dirt or broken parts. Particularly examine the glands for any deposit of scale. All the scale should be chipped off the gland parts, as, besides preventing the glands from properly packing, this accumulation will cause mechanical contact and perhaps cause vibration of the machine due to lack of freedom of the parts. The amount of scale found after the first few inspections will be an indication of how frequently the cleaning should be done. As is discussed later, any water that is unsuitable for boiler feed should not be used in the glands.

In re-assembling the spindle and cover, very great care must be taken that no blades are damaged and that nothing gets into the blades. Nearly all the damage that has been done to blades has resulted from carelessness in this respect; in fact it is impossible to be too careful. Particular care is also to be taken in assembling all the parts and in handling them, as slight injury may cause serious trouble [illegible] damaged part be put back until the injury has been repaired.

If for any reason damaged blades can not be replaced at the time they can be easily removed and the turbine run again without them until it is convenient to put in new ones. In fact, machines have been run at full load with only three quarters of the total number of blades. In such an event remove the corresponding stationary blades as well as the moving blades, so as not to disturb the balance of the end thrust.

### Conditions Conducive to Successful Operation

In the operation of the turbine the conditions of the steam, both live and exhaust, play a very important part. It has been found by expensive experimenting that moisture in the steam has a very decided effect on the economy of operation; or considerably more so than in the case of the reciprocating engine. In the latter engine, 2 per cent. of moisture will mean very close to 2 per cent. increase in the amount of water supplied to the engine for a given power. On the other hand, in the turbine 2 per cent moisture will cause an addition of more nearly 4 per cent. It is therefore readily seen that the drier the entering steam, the better will be the appearance of the coal bill.

By judicious use of first-class separators in connection with a suitable draining system, such as the Holly system which returns the moisture separated from the steam, back to the boilers, a high degree of quality may be obtained at the turbine with practically no extra expense during operation. Frequent attention should be given the separators and traps to insure their proper operation. The quality of the steam may be determined from time to time by the use of a throttling calorimeter. Dry steam, to a great extent, depends upon the good and judicious design of steam piping.

Superheated steam is of great value where it can be produced economically, as even a slight degree insures the benefits to be derived from the use of dry steam. The higher superheats have been found to increase the economy to a considerable extent.

When superheat of a high degree (100 degrees Fahrenheit or above) is used special care must be exercised to prevent a sudden rise of the superheat of any amount. The greatest source of trouble in this respect is when a sudden demand is made for a large increase in the amount of steam used by the engine, as when the turbine is started up and the superheater has been in operation for some time before, the full load is suddenly thrown on. It will be readily seen that with the turbine running light and the superheater operating, there is a very small amount of steam passing through; in fact, practically none, and this may become very highly heated in the superheater, but loses nearly all its superheat in passing slowly to the turbine; then when a sudden demand is made, this very high temperature steam is drawn into the turbine. This may usually be guarded against, where a separately fired superheater is used, by keeping the fire low until the load comes on, or in the case where the superheater is part of the boiler by either not starting up the superheater until after load comes on or else keeping the superheat down by mixing saturated steam with that which has been superheated. After the plant has been started up there is little danger from this source, but such precautions should be taken as seem best in the particular cases.

Taking up the exhaust end of the turbine, we have a much more striking departure from the conditions familiar in the reciprocating engine. Due to the limits imposed upon the volume of the cylinder of the engine, any increase in the vacuum over 23 or 24 inches, in the case, for instance, of a compound-condensing engine, has very little, if any, effect on the economy of the engine. With the turbine, on the other hand, any increase of vacuum, even up to the highest limits, increases the economy to a very considerable extent and, moreover, the higher the vacuum the greater will be the increase in the economy for a given addition to the vacuum. Thus, raising the vacuum from 27 to 28 inches has a greater effect than from 23 to 24 inches. For this reason the engineer will readily perceive the great desirability of maintaining the vacuum at the highest possible point consistent with the satisfactory and economical operation of the condenser.

The exhaust pipe should always be carried downward to the condenser when possible, to keep the water from backing up from the condenser into the turbine. If the condenser must be located above the turbine, then the pipe should be carried first downward and then upward in a U form, in the manner of the familiar "entrainer," which will be found effectively to prevent water getting back when the turbine is operating.

### Condensers

As has been previously pointed out, the successful and satisfactory operation of the turbine depends very largely on the condenser. With the reciprocating engine, if the condenser will give 25 inches vacuum, it is considered fairly good, and it is allowed to run along by itself until the vacuum drops to somewhere below 20 inches, when it is completely gone over, and in many cases practically rebuilt and the vacuum brought back to the original 25 inches. It has been seen that this sort of practice will never do in the case of the turbine condenser and, unless the vacuum can be regularly maintained at 27 or 28 inches, the condenser is not doing as well as it ought to do, or it is not of the proper type, unless perhaps the temperature and the quantity of cooling water available render a higher vacuum unattainable.

On account of the great purity of the condensed steam from the turbine and its peculiar availability for boiler feed (there being no oil of any kind mixed with it to injure the boilers), the surface condenser is very desirable in connection with the turbine. It further recommends itself by reason of the high vacuum obtainable.

Where a condenser system capable of the highest vacuum is installed, the need of utilizing it to its utmost capacity can hardly be emphasized too strongly. A high vacuum will, of course, mean special care and attention, and continual vigilance for air leaks in the exhaust piping, which will, however, be fully paid for by the great increase in economy.

It must not be inferred that a high vacuum is essential to successful operation of this type of turbine, for excellent performance both in the matter of steam consumption and operation is obtained with inferior vacuum. The choice of a condenser, however, is a matter of special engineering and is hardly within the province of this article.

### Oils

There are several oils on the market that are suitable for the purpose of the turbine oiling system, but great care must be exercised in their selection. In the first place, the oil must be pure mineral, unadulterated with either animal or vegetable oils, and must have been washed free from acid. Certain brands of oil require the use of sulphuric acid in their manufacture and are very apt to contain varying degrees of free acid in the finished product. A sample from one lot may have almost no acid, while that from another lot may contain a dangerous amount.

Mineral oils that have been adulterated, when heated up, will partially decompose, forming acid. These oils may be very good lubricants when first put into use, but after awhile they lose all their good qualities and become very harmful to the machine by eating the journals in which they are used. These oils must be very carefully avoided in the turbine, as the cheapness of their first cost will in no way pay for the damage they may do. A very good and simple way to test for such adulterations is to shake up a quantity of the oil in a test tube with a solution of borax and water. If there is any animal or vegetable adulterant present it will appear as a white milk-like emulsion which will separate out when allowed o stand. The pure mineral oil will appear at the top as a clear liquid and the excess of the borax solution at the bottom, the emulsion being in between. A number of oils also contain a considerable amount of paraffin which is deposited in the oil-cooling coil, preventing the oil from being cooled properly, and in the pipes and bearings, choking the oil passages and preventing the proper circulation of the oil and cushioning effect in the bearing tubes. This is not entirely a prohibitive drawback, the chief objection being that it necessitates quite frequently cleaning the cooling coil, and the oil piping and bearings.

Some high class mineral oils of high viscosity are inclined to emulsify with water, which emulsion appears as a jelly-like substance. It might be added that high-grade oils having a high viscosity might not be the most suitable for turbine use.

Since the consumption of oil in a turbine is so very small, being practically due only to leakage or spilling, the price paid for it should therefore be of secondary importance, the prime consideration being its suitability for the purpose.

In some cases a central gravity system will be employed, instead of the oil system furnished with the turbine, which, of course, will be a special consideration.

For large installations a central gravity oiling system has much to recommend it, but as it performs such an important function in the power plant and its failure would be the cause of so much damage, every detail in connection with it should be most carefully thought out, and designed with a view that under no combination of circumstances would it be possible for the system to become inoperative. One of the great advantages of such a system is that it can be designed to contain very large quantities of oil in the settling tanks; thus the oil will have quite a long rest between the times of its being used in the turbine, which seems to be very helpful in extending the life of the oil. Where the oil can have a long rest for settling, an inferior grade of oil may be used, providing, however, that it is absolutely free of acid.

The immediate lesson to be learned from the Denver explosion is to be particularly vigilant about a boiler which has been laid off, to exercise unusual care when any interruption to usual and ordinary service is in progress and not to open a big valve between a boiler and the main when there is a material difference in the pressure existing between them.

A good stoker or furnace poorly set is of less value than a poor stoker or furnace well set. Good installation of furnace equipment is necessary for smoke prevention.

# Calculating Pipe Lengths

By A. J. Dixon

Pipe fitting stands out quite prominently among the manifold duties of engineers in charge of plants of small or medium capacity, where all the repair and operating functions are usually in the hands of one or two men; and for that matter, it is likewise a job that very frequently concerns the operating engineer in larger plants. A serviceable job of pipe fitting, aside from the proper adaptation of the general layout or design of the work to the purpose in view, is largely a matter of correct measurements in the first place, and good judgment in putting the parts together and making up the joints in the second place. The acquirement of skill in both of these essentials to good workmanship, as in any other mechanical occupation, is primarily a matter of experience and practice.

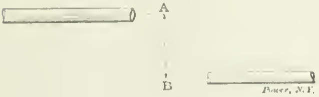


FIG. 1

There is one feature of pipe work, however, that frequently offers a snag to the smooth progress of the engineer engaged in the installation of new apparatus, or the repair or alteration of old pipe lines, and this is the running off of a branch, or lead, from a line at an angle of 45 degrees. Very often the man who has this work to do will endeavor to find the diagonal dimension involved by direct measurement, guessing at the angle as near as he can, with the almost invariable result of an error. Others, again, employ a graphical method. Thus, for example, suppose the length of a diagonal piece to connect the two parallel lines in Fig. 1 is to be ascertained; then by measuring the distance between the parallels, as *A B*, and taking this measurement as the length of each arm of an isosceles right angled triangle, the length of the diagonal will be given accurately by the base. The principal drawback to the convenient use of this method, however, lies in the fact that the diagram must be drawn with great precision, particularly if the dimensions are large, and it may frequently happen that local restrictions or lack of proper facilities will hamper the work and render an accurate layout of the diagram extremely difficult.

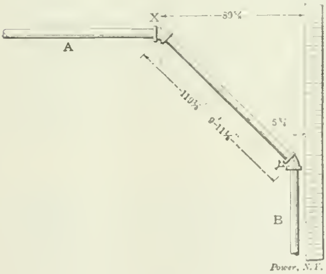


FIG. 2.

In such cases, or for that matter, in any case, the easiest, quickest, and generally the most precise method, is to measure the perpendicular distance between the line from which the diagonal branch is to be run, and the point in which it is to terminate, and then to multiply this distance by 1.42.

For example, suppose it is desired to branch off at an angle of 45 degrees from the point *X* in the line of pipe marked *A* in Fig. 2, and to connect to another pipe line *B*, located at some distance from the point *X* and at right angles to *A*. Here, the problem of finding the length of the diagonal *X Y* is simply a matter of measuring the distance from *X* to the wall running parallel to *B*, deducting therefrom the distance between the axis of pipe *B* and the wall, and multiplying the remainder by 1.42. Thus, if the distance from *X* to the wall is $80\frac{5}{8}$ inches, and the space between the wall and the pipe line *B* is $5\frac{3}{4}$ inches, then the length of the diagonal *X Y* from center to center of the 45-degree elbow is,

$$(80.625 - 5.75) \times 1.42 = 119.1,$$

or say, 9 feet $11\frac{1}{8}$ inches.

Anyone who can manipulate decimals can use this method. The constant 1.42 is an approximation of the secant of 45 degrees, but sufficiently accurate for the ordinary purposes of pipe fitting, where approximations as close as 1/16 inch are usually regarded as the ultimate limit of precise measurement; but if anyone is desirous of ultra refinement in his pipe measurements, here is the value correct to six decimal places, 1.414213.

In Illinois about half the washeries pass their coal over screens with round openings, and size and number it as follows:

No. 1, coal passing through 3-inch screen and over $1\frac{3}{4}$-inch screen.

No. 2, coal passing through $1\frac{3}{4}$-inch screen and over 1 inch screen.

No. 3, coal passing through 1-inch screen and over $\frac{3}{4}$-inch screen.

No. 4, coal passing through $\frac{3}{4}$-inch screen and over $\frac{1}{4}$-inch screen.

No. 5, coal passing through $\frac{1}{4}$-inch screen.

To make an oil chain in a hanger-box run, put a center-punch mark on the shaft where the chain tracks. The chain channel should also be freed from sharp corners and the small ends of the links should point in the direction of rotation.

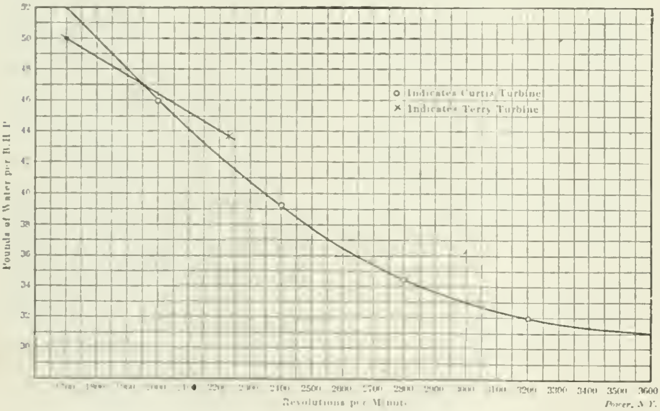
# Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think,
Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

## Terry vs. Curtis Turbine

In the June 20 number of POWER AND THE ENGINEER, was published Mr Burleigh's contribution to the discussion of George A. Orrok's paper on "Small Steam Turbines." In regard to this discussion, Mr Burleigh referred to the Terry curve, Fig. 25, and stated that the steam consumption obtained is 44 pounds per brake horsepower, with a speed of 2350 revolutions per minute. Under the same conditions excepting speed, Fig. 28, the Curtis test is given as 40 pounds, but at 2400 revolutions per minute. The Curtis test is on a wheel 25½ inches in diameter, whereas the Terry has a wheel of 2-feet diameter. Bringing these to the same peripheral velocity, we get the Curtis speed to be 2400 as against the Terry speed of 2210. In the writer's contribution to the discussion on this paper, the accompanying curve was published, which shows that the Curtis turbine is slightly better at 2225 revolutions per minute, but worse at 1700 revolutions per minute. Or, in other words, the difference is so slight as to be negligible.



A COMPARISON OF TESTS REDUCED TO THE SAME WHEEL VELOCITY

Mr. Burleigh goes on to state that the Curtis turbine when run at its designed speed of 3600 revolutions per minute, is 42 per cent. more efficient than the Terry at 2350 revolutions per minute. Assuming all the while that the 2350 revolutions per minute of the Terry were the speed at which maximum efficiency would be obtainable, which, on the face of it, is absurd in the writer's opinion, and the only direct comparison that can be made is under the same working conditions and at the same speed. Moreover, it should be pointed out that the tests carried out on the Terry turbine were made at the works of the Westinghouse Machine Company without any representative of the Terry Company being present, and the figures are without corrections, whereas the Curtis tests specifically state that these tests are "corrected to" the given operating conditions. The Terry turbine in question was not designed for 150 pounds, but designed to operate at 100 pounds, so that the proportions of the machine are not conducive to the maximum possible efficiency.

It is difficult to understand Mr. Burleigh's remark, "With apologies to the public who found it necessary to operate pumps and blowers" by means of the turbine. Why is it that our most uptodate plants at the present time are installing turbines for such purposes as boiler-feed pumps, blowers, etc., when there are still reciprocating engines or motors to be bought?

The Terry turbine is not, as a rule, fitted with an emergency governor. The main governor in the Terry turbine is fitted direct to the turbine shaft in the same position that the emergency governor is fitted to a Curtis turbine, and if the regulating governor of a Terry turbine is likely to go out of order in this position, why is the emergency governor on the Curtis turbine not likely to do the same? The worst that can happen to a governor of this kind is the spring breaking, which would immediately close the valve. If the valve begins to stick during the operation of the machine, this becomes at once apparent as the sticking will be evidenced by the valve remaining closed, as there is no pull back on the governor rod, so that the chances of this valve sticking and this sticking being overlooked by the operating engineer is so remote that in the designer's opinion an emergency governor is an additional complication and unnecessary luxury. Small turbines are operated in the majority of cases by inexperienced engineers and in most cases by unskilled labor, so the less there is on the machine consistent with absolute reliability, the more popular the machine becomes. Incidentally, of the 160 Terry turbines in operation, the manufacturers have yet to have the experience of one going to pieces. In larger machines, and where specifically specified, the emergency governors are fitted, but for the ordinary commercial run of small machines, the writer believes it has yet to be proved a necessity.

W. J. A. LONDON.

## Repairing Pump Rods

The water end of a steam-pump rod is generally the first to show signs of wear, due to grit, pipe scale, or other foreign substance lodging in the rod packing, or to improper use of packing. If the scoring is slight the rod can usually be dressed down, but further wear would probably necessitate renewal.

A worn rod can be restored by turning it down until it will just drive into the nearest-size brass tubing, and the tubing then turned off until it finishes up to the original diameter of the rod. The rod thus finished will really be better than new, as it will be rust-proof and if again scored, the bronze tube can be removed and another piece substituted. The steam end can also be treated in the same way.

LEWIS C. REYNOLDS.

Willard, N. Y.

## Setting Piston Valves

I would like a rule by which the eccentrics and piston valves may be properly adjusted for the indirect motion on a hoisting engine. There are two drums which work together or independtly.

B. Haas.

Beaverdale, Penn.

## Condenser Tube Alterations

I received a letter some time ago stating that the pumps at a certain station were giving a great deal of trouble, and I was asked to go and try to straighten things out. The plant contained two duplex, triple, tandem compound direct-pressure pumping engines of three million gallons capacity per twenty-four hours, pumping against a head of 125 pounds. These pumps were operated condensing, being equipped with the Worthington surface condenser, which forms part of the supply pipe to the water cylinders. At times during the day there would be considerable demand for water, which would increase the speed of the pump sometimes from 30 to 40 per cent. over its rated capacity, when the pump would pound badly at each end of the stroke. Closing the cushion and equalizing or cross-exhaust valves had no effect on the pump's pounding, and after the piston heads found the contact stroke three or four times it would be necessary to throttle the pump down.

It took me some time to find out just where the trouble was, but I finally decided that the pump was not getting enough water and that perhaps the condensing arrangement shown in the sketch had something to do with it. The question that then presented itself to me was how to take out some of the tubes without injuring the condensing ability of the condenser. I tried the temperature of the discharge water from the air pump connected with the pump that was in service, and found that it was very cold, something like 47 degrees Fahrenheit. I figured that by plugging a number of the tubes in the condenser I could increase the temperature of this discharge water to, say, 100 degrees, and still be able to maintain a good vacuum. At the time I was making this alteration there was but 22 inches being maintained in the condenser. I procured some pine plugs and for the first test plugged but 15 of the tubes. This increased the temperature of the discharge water to about 69 degrees Fahrenheit. I then plugged 25 more tubes, which brought the temperature of the discharge water up to 100 degrees Fahrenheit. I calculated that, with the fluctuations of speed of the pump at times, when running at any overload the pump could handle, it would not increase the temperature of the discharge water above 150 degrees, at which temperature 22½ inches of vacuum could easily be maintained. Further to guard against any heating of the condenser, I put a ½ inch water line into the exhaust-steam line leading from the large pump to the condenser (not shown). This proved a great help at all times, especially when the pump was overloaded. After plugging up some 40 of the tubes and running the pump for two or three days, I was convinced that many tubes could be taken out of the condenser without interfering with its working.

I took out the tubes shown at *F*, leaving those remaining shown at *E*. I did not take out as many tubes as I had plugged, allowing for the difference in the temperature of the cooling water passing around the tubes during the different seasons of the year. If I wished to cut out any more from the 31 remaining tubes, I could plug them during the winter. In taking out the tubes I removed those that most directly obstructed the flow of the water through the condenser, and it made a remarkable difference in the working of the pump. After I had taken out the tubes the vacuum maintained was poor, never exceeding 22 inches and most of the time much less, and never constant at any time. When there was condensation enough passing through the air pump to seal its valves, the vacuum would occasionally pull down to 23½ inches, and after remaining there for a few minutes, drop back to 20 or 21 inches, sometimes as low as 18 inches.

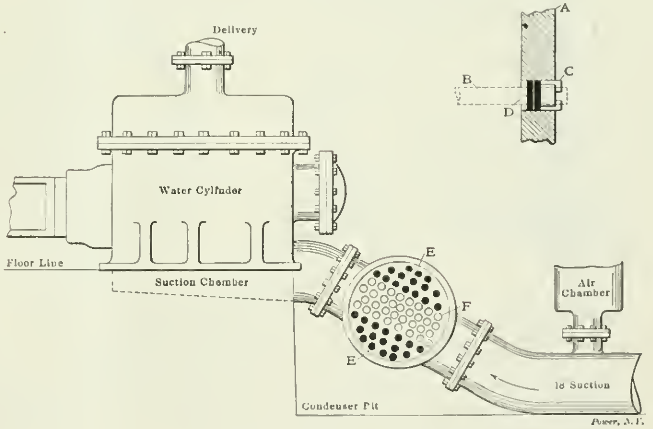
This caused a great unevenness in the regulation of the pump, and also resulted in a very irregular line on the "water-pressure chart. The putting of the ½-inch water line on the exhaust pipe entering the condenser, and with this valve "just cracked," furnished sufficient water to keep the valves in the air pump sealed at all times and under all conditions. The hand of the vacuum gage would not vary ¼ inch for days at a time, no matter what the load was on the large pump, 27 inches and 28 inches being the vacuum maintained.

After I had concluded to take out the tubes, my next move was to figure out some way of filling the holes in the head. Blank washers, made of 3/16-inch thick vulcanized fiber, were made with a solid punch and die. It required two of these washers or blanks, liberally covered with red lead mixed in a good quality of varnish to the consistency of very soft putty. In the sketch at *A*, is shown a sectional view of the head of the condenser, *C* is the gland nut, and at *D* are shown the two fiber washers in position. The dotted lines at *B*, show how the tubes were fitted into the head originally. These alterations not only increased the efficiency of the pump; but by increasing the temperature of the discharge from the air pumps, increased the efficiency of the open heater which had been condemned as of practically no use whatever.

Prior to the change the water entering the supply pipe to the boiler-feed pump had never exceeded a temperature of 152 degrees Fahrenheit, and after the change was made, it was frequently necessary to put cold water into the heater to get the pump to handle the water therefrom, thus proving that the water in the heater reached a temperature of 212 degrees or more. After some few rearrangments of the back-pressure valve on the exhaus line from the auxiliaries to the heate the water in the heater was kept at fro 201 to 208 degrees with no trouble, a the feed pumps would handle it nicely.

C. W. Dunlap.

Depew, N. Y.



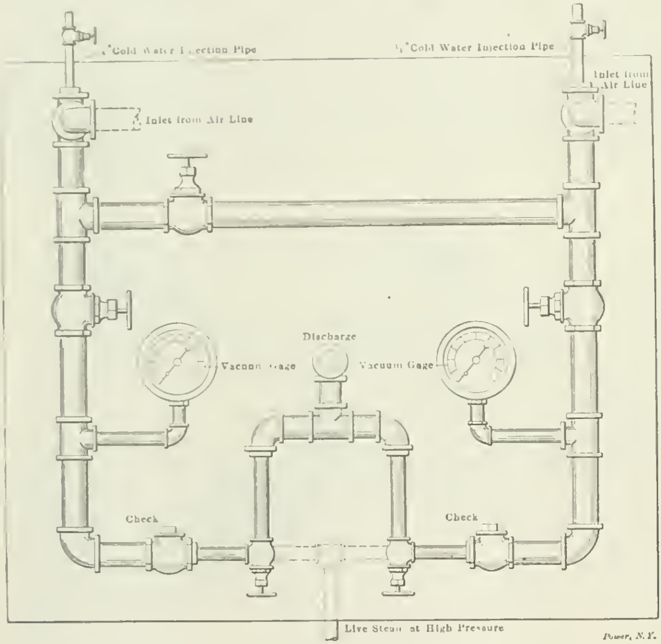
CONDENSER-TUBE ALTERATIONS

## Improving a Paul Heating System

The illustration represents the apparatus used on the Paul system [illegible] circulation for heating and drying. I started in last fall to operate such a system which had got into disrepute. During previous winters it had been necessary to maintain [illegible] pounds pressure to fill the radiators with steam. I found I was unable to get any vacuum on the air lines, due mostly to faulty setting of the air valves and imperfect valves. I put in an order for some new valves and as this is a municipally owned plant they were so long in coming that something had to be done. I put in the two ¼-inch cold-water injection pipes shown at the top of the sketch, with the result that the vacuum immediately went up to 17 inches and we were able all last winter to heat the buildings with 3 pounds pressure.

W. T. MEINZER.

Brooklyn, N. Y.



IMPROVING A PAUL HEATING SYSTEM

## Unscientific Water Softening

In a small electric-lighting station in hich I was employed some years ago a chief engineer the then chief as-tant was a rule-of-thumb man, without y theoretical knowledge whatever.

Having heard of the "Clark" process for ftening water, and its beneficial effects in reducing the amount of deposit in boilers, he set to work to utilize it at our plant.

The principle of Clark's process consists in adding caustic lime to the hard water, and this, absorbing the carbonic-acid gas from the bicarbonate of lime in the water, changes it into the insoluble carbonate, which can then be filtered out or given time to settle to the bottom of the tank, the clear water then being decanted off from the top.

The action stated in the form of a chemical equation is:

$$Ca(HCO_3)_2 + Ca(OH)_2 = 2CaCO_3 + 2H_2O.$$

Calcium bicarbonate + slaked lime = 2 Calcium Carbonate + 2 Water

This method will deal effectively with temporary hardness, whether due to bicarbonate of lime or magnesia, but not with the permanent hardness.

The water in this case contained a large amount of calcium sulphate, which formed a hard scale in the boiler, and this, of course, would not be prevented by the use of caustic lime.

The boilers were 30x8 Lancashires. There were three, two being in use and one reserved for cleaning and repairs.

It was usual to lay off each boiler, after two months' work, for cleaning purposes, and at the time our engineer began his experiments, No. 2 boiler had just been cleaned and put in service, and No. 1 boiler should have been laid off within a week or two.

The station ran noncondensing, and the water supply was taken from the town main, which fed into a large storage tank, from which the water gravitated to the feed pumps.

There was also a small tank in the boiler house, capable of holding about 1000 gallons, and this was used to catch the return water from the steam traps, etc. Water could also be taken from the large tank, and a connection to the feed-pump suction main enabled it to be pumped out when required.

Our expert (?) began operations by getting in a stock of caustic lime, and his *modus operandi* was to order the stoker to put a few buckets of lime into the small tank at intervals and pump it straight into the boilers.

This went on for weeks, and No. 1 boiler, which should have come off for cleaning, was kept steaming as the chief assistant was confident that no more scale was being formed.

The crisis came one Saturday evening, at the time of the heaviest load of the week, when I was on duty with only one stoker and an engine driver.

It was my practice to go into the boiler room frequently and see the water gages blown through, check the hight of water in each boiler and have a general look around. On this particular evening, about a quarter of an hour after I had made a tour of inspection, the stoker came flying into the engine room, with a face as white as a sheet, and said that the furnace crowns of No. 1 boiler were collapsing.

I at once went to investigate, and on opening the furnace door saw a large bulge on each furnace crown. The water was at its proper level in the boiler, and I knew it had not been low during the shift.

I could not possibly take the boiler out until the peak load went off, without putting the town in the dark, and the spare boiler would take some hours to get ready.

I came to the conclusion that the trouble was due to scale, which had allowed the plates to get overheated, and I argued that, the plates having bulged, the scale had cracked away and allowed the water to cool them, and I decided to run on as long as there was no sign of further bulging.

My theory as to the cracking of the scale and the cooling of the plates proved correct, otherwise I should not now be in a position to relate my experience.

The stoker said after it was all over, that he would not face the same thing again, if he lost twenty situations and would rather starve to death than be blown to pieces.

I had the boiler shut down as soon as the peak was over, discharging the storage battery to expedite matters, and the spare boiler was run up in time for the next peak load.

On opening the boiler we found it very badly scaled, and the wonder was that a larger area of the furnace crowns did not collapse. The cause of the trouble was never laid at the door of the chief assistant, but water-softening experiments were discontinued soon after.

A. W. Empson.

London, England.

## Oil for Pump Governor Diaphragm

On taking hold of the job which I now have, I found two fire pumps equipped with governors which did not give satisfaction. In fact, other employees told me that men from the factory had been unable to do anything with them.

After studying a sectional view of the governor, I was not disposed to blame the men. The diaphragm controlling the pilot valve of the regulator is situated over a chamber filled with live steam on its way to the pump and consequently the water intended to convey the pressure to the diaphragm is kept constantly boiling, creating an over pressure and depositing the solids in the water on the diaphragm.

On taking the valve apart, I found the parts referred to baked solid with lime, etc. After thoroughly cleaning, oiling, putting in a new diaphragm and blowing out the pipe leading from the pressure to be regulated, I arranged a trap in the pipe with tees and a filling plug and filled this with cylinder oil, this preventing the water reaching the diaphragm. I turned on the valves and started up and have had no trouble since.

W. T. Meinzer.

Brooklyn, N. Y.

## Piston Packing

I was once called to examine two old engines of the Corliss type, one of 50 horsepower and one of 80 horsepower. They seemed to have an enormous steam consumption, considering the amount of work they were doing. We took off the cylinder head to examine the piston and found that the packing was of the steam-adjustment variety, in which the rings depended upon the pressure of steam to set them out. We also found that both of the cylinders were bell-shaped or larger on the ends than in the center.

This, in my mind, was caused by the action of the rings being set out by the pressure. For instance, suppose an engine is cutting off at one-third stroke and runs this way for quite a long time. When the steam is cut off the pressure in the cylinder naturally reduces as the piston travels toward the end of the stroke, thus reducing the expanding pressure exerted on the packing. This causes the cylinder to wear, as shown in the cut. Now, suppose after a time this same automatic engine is called upon, owing to a reduced load, to cut off at one-fourth stroke or less. The pressure begins to decrease as formerly, but with the exception that the pressure is reduced at an earlier point than before, and the cylinder having worn to suit the old point of cutoff meets with new conditions. The rings are not carried out to the cylinder walls as formerly, which allows the steam to blow through, thus losing a large percentage of the expansion of the steam contained in the cylinder and allowing it to blow over the rings and out through the exhaust. There is a certain amount of expansion to the rings themselves to be followed up, but the amount is limited and owing to wear will gradually grow less. After they have reached this condition it is impossible to do any peening out with these rings, and any attempt to do so would result disastrously, as they are constructed of cast iron; also, owing to the direction of the pressure of the steam, these rings are very liable to wear sidewise, thus in time causing quite a noisy piston, for which there is no remedy except a new junk ring or new steam rings. This is not so with a sectional packing or even the old split-ring variety, as these can be peened out to a certain extent and if loose sidewise the piston can be put in a lathe and faced off until a working fit is obtained. If it is not desirable to face off the piston, the follower plate can be recessed to accomplish the same result.

We calipered the cylinder and found it was 3/16 inch smaller in the center than at each end. We rebored both cylinders and fitted them with a sectional packing, the piston being centered inside of a bull ring which was just a sliding fit in the cylinder.

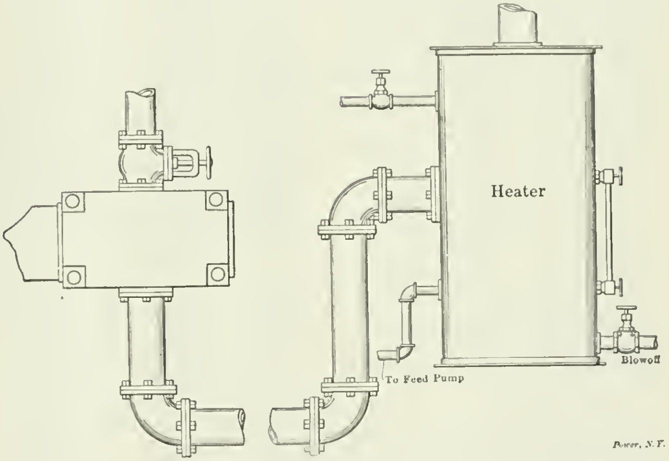
If this bushing was too small it would allow the piston to lift in the cylinder, causing a disagreeable pound. The superiority of this kind of packing lies in the fact that being set out by springs, the pressure is uniform the entire length of the cylinder, thus distributing the wear evenly the entire length of the stroke. Also, the packing is kept constantly in contact with the walls of the cylinder, thus keeping it steam-tight at all times and under all conditions.

Charles H. Taylor.

Bridgeport, Conn.

## An Engine Wreck

On dropping into an engine room the other day I saw the results of a peculiar accident caused by water backing up from an open heater into the engine cylinder.



HOW ENGINE AND HEATER WERE CONNECTED

The engine and heater were connected up as shown in the sketch. The engine was of the high-speed automatic type. At the time of the accident they were adjusting some new machinery in the mill, which made it necessary to start and stop about every five minutes. The last time the engine was started the engineer heard a commotion in the heater, and in looking for the trouble saw that the heater was full of water. He started to open the blowoff valve when the signal was given to shut down. He ran to the throttle and closed it. The engine made about a dozen turns when the water backed up, causing a split cylinder and a bent rod.

There was no float in the heater to regulate the water level. The accident would not have happened had the fireman been paying attention to his business, as he shut down the feed pump and did not shut off the water supply to the heater.

Louis B. Carl.

Marshfield, Wis.

## Glycerin in Sight Glass

One of our boys saw in a copy of POWER, several years ago, that cranky lubricators would work better with glycerin in the sight feed tube. Upon trying it we found that it worked with good results. If the lubricator is filled with water before it becomes entirely empty the glycerin will last some time, but if allowed to remain empty while the engine is running the glycerin soon disappears.

J. R. HAW.

Hampton, Va.

## Novel Pump Installation

In many localities there are small power plants situated on rivers which have a periodical rise and fall; in some cases the difference amounting to 40 feet or more. Evidently some means must be provided so to arrange the pump, which provides the water supply, that at low water the suction head will be reduced to a practical amount.

Various schemes have been used, most of which required a fixed pump located at a point some 20 feet or less above the point of low water. This requires, usually, expensive tunneling and excavation; and while this plan seems the only feasible one where the river is subject to rapid fluctuations without warning, the writer has used the scheme illustrated herewith on slowly fluctuating rivers at a great saving in original cost of construction and with very gratifying results.

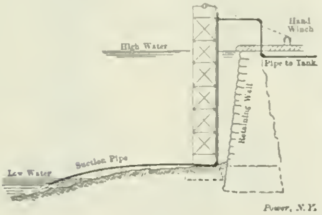


FIG. 1

By referring to Figs. 1 and 2 it will be seen that the plan includes a steel or timber tower which practically constitutes an elevator shaft. In this tower is placed a car which carries the pump, the whole being operated by a hand winch. Adjustable counterweights are provided on each side of the tower by means of which the car and pump may be accurately balanced. The pump is practically located in a bypass to a standpipe secured to the tower, and the lower end of the standpipe extends, on a slight grade, to the point of low water, while the upper end terminates in a pipe line run to the tank which furnishes the supply for use in the plant.

At intervals of some length, which should not be too great for a reliable suction head, say 15 feet, tees are inserted in the standpipe and these tees, except when connected to the pump, are blanked off with covers. Gate valves are placed between these tees and thus it is possible to divide the standpipe into a suction and discharge line by closing the gate between the tees to which the suction and discharge branches of the pump are connected.

By simply unbolting the pump branch connections, the pump may be raised or lowered to any desired position; all water valves, of course, being kept open except that between the pump branches, the unused tees are blanked off.

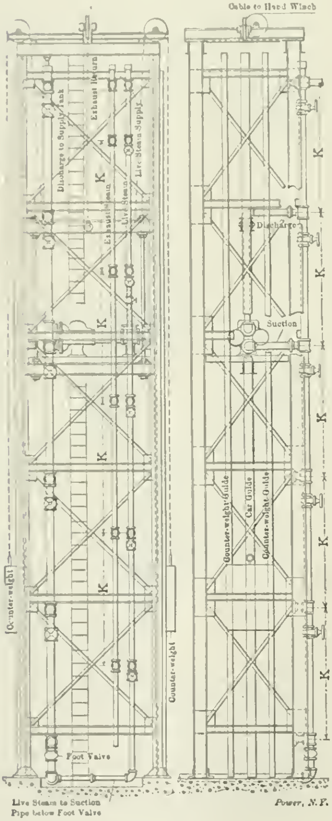


FIG. 2

As the strainer is inaccessible at high water, the writer places a steam connection, as shown, where a steam pump is used, for blowing out the suction pipe. When an electric pump is used, an elevated tank is advocated and the foot valve is dispensed with. Sometimes a check valve is placed in the line above the pump, and should the suction pipe become obstructed at high water it may be cleared by removing the gate from the check valve and opening the gate valve between the pump branches; this allows the water from the elevated tank to flow back through the suction pipe and will quickly clear the strainer; of course, any other means for creating a back pressure, such as a connection from the boiler-feed pump to the pump discharge, would serve as well.

In some cases where sufficient room has been available, and the foot of the river retaining wall is never free from water, the writer has driven piling and installed the pump on a car running on an incline as shown in Fig. 3, the system of piping remaining the same, except that the main pipe lies on the trestle alongside of the rails.

The design of tower shown has been used for the larger size pumps installed, these having a capacity in the neighborhood of 500 gallons per minute.

The vertical columns were constructed of I-beams weighing 55 pounds per foot; the horizontal members of 6x3-inch channels, weighing 10½ pounds per foot and the diagonals of 3x2-inch angle iron, weighing 5 pounds per foot. With 15-foot panels such a tower would be suitable for a pumping outfit (pump and motor) weighing about 6 tons. The whole weight of the outfit, including the tower, counterweights, car, piping, ladder and fittings, would be in the neighborhood of 20 tons for an 80-foot tower, and the cost of car and tower made by any structural-steel shop would be approximately $1000 f.o.b. The whole outfit is very easily erected, the only element requiring good workmanship is to take care that the distance between the centers of the branch tees is absolutely the same for each section.

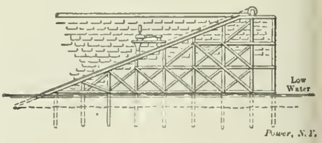


FIG. 3

Where pumps of smaller capacity and weight are used the columns and horizontals may be made of pipe, or a reinforced-concrete construction for the tower might be used.

The writer has installed a number of pumps on lines similiar to those indicated, the largest being an 8x10 Deane triplex pump driven by a 35-horsepower motor, making a load on the car of 5 tons. These pumps take water directly from a tropical river which has flowed a thousand miles through densely vegetated country and the water is full of semi-suspended matter. The only daily inspection these pumps receive is from native talent.

In spite of these disadvantages the op-ration of the pumps has been as reliable s if they were bolted down in the engine room. Several have been in con-inuous use for six years.

CHARLES J. SEIBERT.

Troy, N. Y.

## Saved His Steam Plant

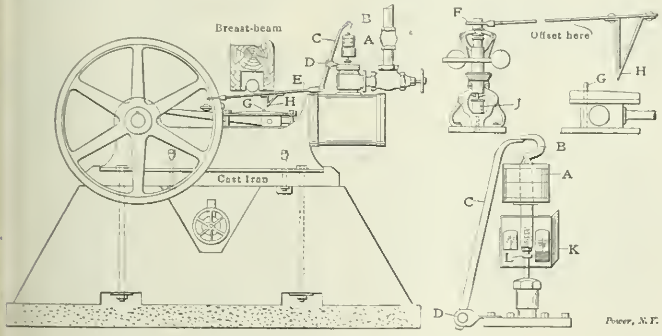
The following is descriptive of a speed imit I saw on a slide-valve engine which, n this case, was direct-connected to large printing, drying and calender-ng machine combined, the speed being and-regulated. When bought, the engine was equipped with a throttling gover-r. When installed, however, owing to ack of space, it was necessary to allow he breast beam of the machine to over-ang the engine, and it came in such a sition as to interfere with the governor elt.

As the machine was direct-connected, ind was to be hand-regulated, it was be-ieved that the governor was not neces-ary and consequently the engine was iped without it. This arrangement was atisfactory until one day the cloth pass-ng through the machine wound round ne of the rollers in such manner as to ree the driving gear on the engine shaft, nd away went the engine. The opera-r (a good printer, maybe, but no engi-ieer) got excited and instead of closing he regulating valve, which was half pen, opened it wide. The engine had een erected on a rough plank-and-beam undation, which collapsed under the naway; the steam pipe broke near a upling, close to where it passed through he wall, and the flywheel found an effi-ient brake in the hardwood flooring.

The manager, a new man, bitterly con-lemned the way the engine had been rected, and declared his intention of utting in a motor to be operated by ower from the electric-light station. This was a blow to the engineer in charge of the plant. He knew that once the electric-light company got a foothold in the mill it would not be long before another engineer would be looking for a job. Putting the right foot forward, he got permission from the manager to erect a concrete foundation, and made such other changes as would put the engine in reasonably safe working order. The illustration shows the style of foundation he built. The gap is necessary to allow access to the under gear of the machine. The cast-iron subbase was made to order.

For a speed-limit device he took the throttling governor that came with the engine and sawed the bracket holding the balls and gears close to the flange, then sawed the governor-valve spindle, and piped the case containing the balanced valve, as shown. He fastened the bracket to a pipe flange, and bolted it to the engine frame on the shaft side of the interfering breast beam, and belted the two governor pulleys.

Then, lengthening the valve spindle so as to support the weights *A*, he placed a hook *B* at the end. The connecting rod *C*, pivoted at *D*, serves to support the weights and leave the governor valve open. Its lower end connects with the latch rod *E*, one end of which rests on top of the spindle of the governor as shown at *F*. Securing the latch *G* to the crosshead, he had a ready means of tripping the lever *C*, whenever the speed of the engine allowed the governor spindle to lower the end *F* so that the nose *H* of the rod *E* connected with *G*. The position of *H* is such that *G* cannot move it any more than is necessary to trip the weights and close the balanced valve. A dashpot *J* was placed on the spindle to prevent the usual jumping of this style of governor.



SHOWING ALTERATIONS TO ENGINE

Another thing on this engine worthy of mention is the mode of throttle control. Different quality of cloths need different lengths of time to pass through the machine, i.e., the engine would be allowed to run faster on light goods than on heavy goods. As the operator, however, was on piecework, the tendency was to run the machine faster than good work could be turned out, and it became necessary to limit the speed at which he could run the engine. It has been previously stated that the balanced-valve spindle was lengthened to form a support for the weights *A*. The connection was made as shown. It will be seen that that part of the spindle that connects with the valve disks can be lengthened, thus throttling the steam to the engine. A small galvanized-iron box *K*, provided with a lock, was placed around this juncture. To the back cover a lined paper was glued, which would indicate the different speeds at which the engine would run with a certain quality of cloth. By bringing the needle pointer *L* to correspond with one of the lines, the speed of the engine was easily and quickly adjusted, and it was this simple device that clinched the engineer's argument in favor of the engine as against the motor.

R. O. RICHARDS.

Framingham, Mass.

## Determining the Deflection of an Engine Crank Shaft

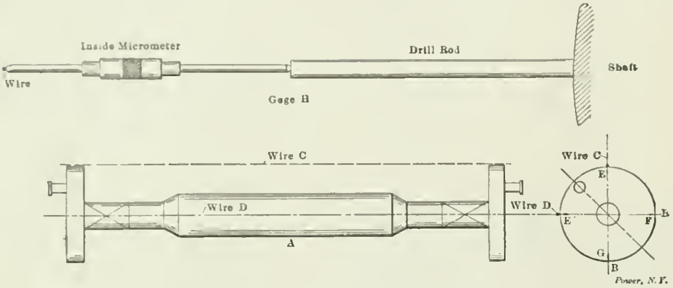
Some time ago I found it necessary to measure the deflection of the crank shaft of a 3000-horsepower cross-compound engine. After giving the matter considerable study, I did it in the following manner: At *A* is shown the plan view of the crank shaft of a horizontal cross-compound engine, and *B* is an elevation of the crank disk. As the force of gravitation acts along the line $E'F$ the maximum deflection will be along this line. There is no deflection along the line $GE$, as there is no force acting along this line.

Mark the points *E* and *G* on the crank disks diametrically opposite with a scribe. This can easily be done by placing a spirit level across the center of the shaft, or in some other convenient manner. Also mark the points $E'$ and *F* midway between *G* and *E* as shown in diagram *B*. Both disks must be marked in this manner and the marks must be in alinement with the axis of the shaft. Wire *C* is then drawn taut across the faces of the disks at the point *E*.

At a point on the shaft, between the bearings, at which maximum deflection would occur if the axis $GE$ of the shaft were vertical, the distance between the shaft and the wire *C* is accurately measured by the gage *H*. This constitutes the first measurement at *E*. A chalk ring should be marked about the point on which the gage rested on the shaft, in order to locate it approximately when the second measurement at *E* is taken.

After taking the first measurement at *E* the wire *C* is taken down and the crank shaft is given a quarter turn. This brings the point $E$ to $E'$. The wire $D$ is then strung taut across the faces of the disks and a second measurement at $F$ is taken in the same manner and between the same points as the first.

It can readily be seen that the first measurement subtracted from the second measurement will give the deflection of the shaft in thousandths of an inch, and that any eccentricity of the crank disks or high spots on the shaft will not affect the results obtained in the least, as the error is no greater with the point $E$ in the position shown (view $B$), where the first measurement was taken, than it is after the point $E$ has been rotated to $E'$, where the second measurement is taken. In other words, only the deflection of the shaft is measured in the method stated, it being unnecessary to consider any discrepancies that may exist in the shaft or disks.



DETERMINING THE DEFLECTION OF AN ENGINE CRANK SHAFT

After taking the second measurement at $E$ the wire $C$ can be strung again and a first measurement taken at $F$ which (with $E$ at $E'$) is now at $E$, and so on around the shaft, taking the deflection in so many points as desired, four points generally being sufficient.

In using the gage $H$, care must be taken not to deflect the wire. The inside micrometers are run up to the wire until it is barely possible, with the aid of a glass, to see light through the space between the micrometer point and the wire, the writer having found it possible to see light through a space of 0.0002 inch with the aid of an ordinary glass magnifying to three diameters.

Suitable supports for holding the wire were erected at each end of the crank shaft. A No. 77 piano wire measuring about 0.016 inch in diameter was used.

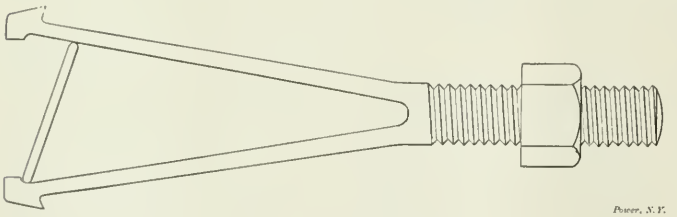
W. C. Adams.

Waterville, Conn.

## Handy Bushing Extractor

In the sketch is shown a handy tool for extracting bushings of any kind which are not accessible to be driven out. It is a very convenient tool in a repair kit, as it can be easily adapted to fulfil most purposes for which a bolt is used. It is made of mild steel or iron, the points which grip the bush and the thread and nut being case-hardened. The forked part being fairly long, it can be used for bushings of varying diameter.

In making it, it is only necessary to thread the part for the nut, an ordinary standard thread and nut being quite suitable, and file up the points, the outside of which are slightly rounded. To insure that the tool will catch into the metal, the two gripping points are filed at a slight angle. This raises a ridge in the bush, but nothing compared to what is sometimes necessary when wedging and drawing out a bushing.



A HANDY BUSHING EXTRACTOR

For drawing a valve seat the tool is slipped through until it catches on the under side of the seat, then the locking piece is placed in position and the seat withdrawn. This locking piece is a small length of flat iron, rounded on the ends and fitted into the fork, as shown. As the tool costs practically nothing to make, a set can be made of various lengths within the range of the fork. In use, the locking piece nearest the size is selected and placed in the fork, as shown. It is then sprung into the bushing. If there is no shoulder for the prongs to catch on, the upper end of the packing piece is tapped gently down with anything handy; this forces the points into the bushing; then the nut is gradually tightened, and after one or two taps the points will usually have enough grip to withdraw the bushing. It is best to form the fork so that the prongs are extended to their full distance and have to be compressed to enter the bushing. Thus, in withdrawing any bushing or seat when the prongs can be got under the shoulder, no locking piece will be necessary, as the spring of the fork and the dovetail points will hold the tool firmly in place.

W. Burns.

Glasgow, Scotland.

## Temporary Flange Repair

A 10-inch steam valve was leaking at the flange where the top is bolted to the body. In order to make a temporary repair, long, taper pine wedges were driven in and then calked with No. 15 ampere fuse wire, which stopped the leak.

Five bolt heads were leaking, so the flange was given several coats of "Smooth On" cement, which was allowed to dry for several days. Then the five bolts were taken out one at a time, washers were put on the bolts and asbestos wicking put between the flange and washers. When the nuts were tightened the leaks had been stopped.

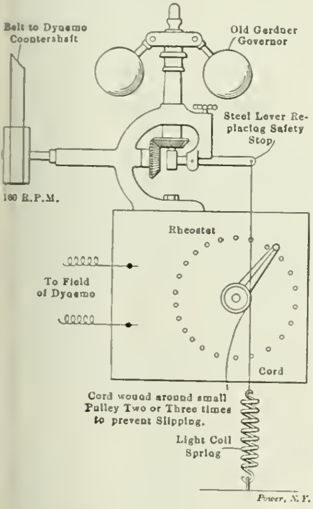
W. H. Worden.

Cadillac, Mich.

## Automatic Voltage Control

In installing an electric-light plant in a factory, the writer came up against a difficulty which no doubt has often been found in installations of a similar nature. The dynamo is driven by a countershaft connected to the line shaft. There is considerable speed variation in the rotating equipment, as much heavy sawing is done. As the fluctuations of the lights were very annoying, it was up to me to get rid of this trouble. The owner had an old pair of Gardner flyball governors lying in the attic, which gave me an idea. Removing the valve, valve stem and safety-stop lever and springs, I put a steel lever in place of the safety-stop lever. I then measured the distance the outer end of the lever traveled when the balls moved from rest to their maximum position, and found it to be 5½ inches. I made a small pulley 1¾ inches in diameter and fastened it to the hub of the con-act arm of the field rheostat of the dynamo. Thus, the lever, in moving from one position to the other, would travel a distance equal to the circumference of he pulley. A cord was attached to the outer end of the lever, wound around the pulley a couple of times, and fastened to a light coil spring which was opposite the ever and in line with the rheostat hub. The normal working speed of the governors was 200 revolutions per minute, but on experimenting I found that it was more sensitive to slight speed changes when running at 160 revolutions per minute. It was then driven at this speed by a belt running from the dynamo countershaft. The dynamo is a shunt-wound machine, delivering direct current at 110 volts.

Running the governors and dynamo at their proper speeds, and cutting out enough resistance to raise the voltage to 110, connection between the lever and pulley by the cord, which was fastened to the spring also, was made. The governor lever had, of course, assumed a certain position at 160 revolutions per minute. When the speed of the engine drops, the governor lever drops, and the tension of the spring draws the contact arm around in proportion to the amount of speed change. This cuts out resistance and maintains the proper voltage. When the engine comes back to speed the arm raises and pulls the contact arm around in the opposite direction, against the tension of the spring, and cuts in the resistance, thus lowering the otherwise high voltage.


Belt to Dynamo Countershaft
Old Gardner Governor
Steel Lever Replacing Safety Stop
160 R.P.M.
Rheostat
To Field of Dynamo
Cord
Cord wound around small Pulley Two or Three times to prevent Slipping.
Light Coil Spring
Power, N.Y.

AUTOMATIC VOLTAGE CONTROL

In this case the arrangement of the resistance at the contact had to be fixed to suit the working of the lever, as at certain speed changes the lever increases its rate of motion out of proportion to the change of speed, thus cutting out or in resistance more rapidly.

With this arrangement a steady light is obtained, while before the fluctuations were very annoying. As the number of lamps burning is always constant, and as the factory load is continually changing, the action of the governors automatically cuts in or out resistance as the speed changes demand, and thus maintains a steady light.

H. F. Bowman.

West Unity, O.

## Experiences with Gasolene Engines

One of the writer's earliest experiences with the gasolene engine proved a puzzle for quite a while. The engine was located in a grist mill. The miller said that there was no complaint about its running, but that it gave trouble when starting up after a shutdown, with the engine still warm. It had a hand pump on the side for forcing in the first charge, which was ignited by a match.

About half an hour after I reached the place the engine was shut down and I was asked to start it. After going through the usual operation the engine failed to start. Thinking that there might be trouble with the match igniter, a match was inserted and ignited, when a flame shot out of the port in which the electric igniter was inserted. Again a match was struck and again the flame shot out. This seemed to show an excess of gasolene. The reservoir at the bottom of the hand pump was drained of all gasolene. It had been filled with excelsior and this was left in and soaked with gasolene. This time the engine started on the first trial. After some experimenting it was found that only half the amount of gasolene was required in the hand pump when the engine was hot as when starting cold.

Another time a man said that he had been unable to start his engine since he had put in a special grade of gasolene. He had paid two or three cents a gallon more than usual. The special grade proved to be coal oil.

An engine which had been running on artificial gas, refused to start on natural gas. After trying a number of starting mixtures, it was found that the gas valve could be opened only about half way on starting. The natural gas had a pressure equivalent to 10 inches of water. When starting, the speed of the engine was not sufficient to overcome the pressure, with the result that too rich a mixture was taken into the cylinder.

The owner of a hay-baling outfit ran out of gasolene and bought some from a country grocer. The engine soon stopped working. Investigation showed that the grocer did not happen to have a clean barrel when the supply wagon arrived and so had had the gasolene put into a molasses barrel. This mixture soon fixed the engine. It had to be taken apart and cleaned.

One great source of trouble with the gas engine is the tendency of the operator to "monkey" with the various adjustments. If the engine does not start, he will grab a monkey wrench and screwdriver and turn everything in sight. The usual result is that someone with experience must be called in to readjust matters.

The ignition system is responsible for about 75 per cent. of the troubles with the gas engine. Weak batteries are a frequent source of trouble, particularly if the battery stands in a damp place.

A make-and-break igniter caused frequent shutdowns in one instance. One day, as the engine was slowing down, the writer noticed that the igniter did not snap back as it should. Upon taking it apart, it was found that there was not enough clearance between the parts of the moving electrode, and the valve at the lower end was leaking. The hot gases heated up the stem and it would expand and stick. The valve was ground in and greater clearance allowed, and no further trouble was experienced.

Louis J. Buschman.

Cleveland, O.

## Why the Turbine Stopped

My friend from the turbine plant dropped in the other morning with that tired look so common to engineers disgusted with life.

"What's happened?" I asked.

"Oh, nothing, only our 1000-kilowatt turbine laid down just after 12 o'clock. Never made a sound, nor a jar, just simply stopped. When the voltage got clear down, I pulled the switch, but the speed didn't rise again, so I started the old cross-compound and put the load on it. Then I looked for the trouble and, not finding it, telephoned to the chief and got him out of bed.

Of course, he was good natured about it, but we just had to have that turbine at seven this morning, so he came down and we hunted and hunted and—what do you guess we found?"

"Damfino," I replied.

"Well," said he, "when the load gets light the fireman cuts out No. 3 boiler and runs on Nos. 1 and 2. He thought he cut out No. 3 this time, but he pulled the wrong chain and cut the turbine branch off the main and left three boilers on. What do you think of that?"

"Damfino."

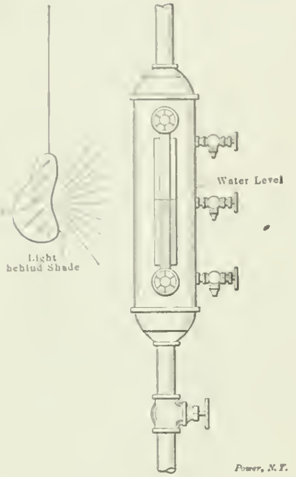
Frank Eastman.

Montpelier, Vt.

## Easy Reading Water Gages

I have read several times about easy-reading water gages, one method being to place a strip of tin, painted black with a white stripe in the center, behind the glass.

This is all right for well lighted boiler rooms, but for dark boilers I find that



EASY-READING WATER GAGE

white with a black stripe, or pure white and a shaded light placed to throw its rays diagonally through the glass, as per sketch, is best, the light causing a bright white line to fall on the tin alongside the glass, thus showing at a glance the water level.

**Frank Gartmann.**

Sheboygan, Wis.

## Safety Cams

I cannot agree with the statement in the letter on "Safety Cams," on page 973, of the June 1 number, where the author says that the trip collars must be set so that valves will unhook, as the remark refers to a single-eccentric engine.

In the case of a double eccentric Corliss engine, where the steam valves are set with negative lap, and the eccentric less than 90 degrees ahead of the crank, it is necessary that the valves should trip off, or with a heavy load, or, in starting up the exhaust valve would open before the steam valve closed, allowing steam to blow through.

Now considering the single-eccentric engine the conditions are different, as the steam valves are always set with lap, and the eccentric in advance of the 90-degree position. The eccentric will, therefore, close the steam valve before the exhaust opens and there is no occasion for the valves tripping off when the governor is in a starting position, as it would shorten the range of cutoff, as well as cause unnecessary inconvenience in handling the engine.

It also appears to me that the writer of "A Cause of Engine Wreck," page 938 of the May 25 number, is mistaken when he says the proper way to change the speed of the governor is by changing the size of the pulley. The governor will be running at its proper speed when it has developed centrifugal force sufficient to raise it to its central position, and there is just one speed that will do this, according to the design of the governor. Of course, the governor may be varied within certain limits by changing the weight on the weight arm.

Now since the governor is designed to run at one certain speed, if conditions will allow, that is the speed it will run at and should the size of pulley be changed, the engine would have to run faster or slower, as the case may be, in order to carry the governor in its normal working position, and thereby give it opportunity to do its work. Hence by changing the size of pulley the speed of the engine is changed, but not the speed of the governor.

**L. Roundy.**

Concord Junction, Mass.

## The Elbow Burst

In our plant the engine room is close to the boiler room so that when one of the safety valves blows we hear it, and the firemen report when they blow down and if any of the blowoff pipes are blocked.

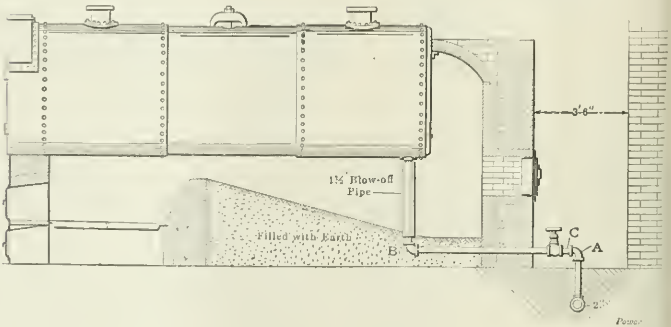
The other day the fireman was reporting a blocked up blowoff pipe when bang! she went and burst the elbow at *A* (see sketch). He had left the blowoff valve wide open and came to report, when the scale started and the shutoff water, moving at the velocity due to the pressure in the boiler (which is 125 pounds), was too much for the elbow.

It was not the first time this had occurred, and what puzzles one is that it happens on the same boiler. We have five boilers in a battery and all the blowoffs are connected as shown in the illustration, with the exception of No. 5 boiler, which has a 45-degree ell at *B*. I know this blowoff connection is dangerous to anyone who might be inside cleaning, repairing or inspecting a boiler, as it would only be necessary for the blowoff to be opened on the cold boiler and the fireman to blow down one of the other boilers. On the other hand, if one of the elbows should burst while the fireman is blowing down one of the middle boilers, I doubt if he could get out of the alley.

Will someone suggest a better plan of connecting up the blowoff? I have thought of inserting a check at *C*, but don't know whether it would be practicable. I should think a water hammer that would break an extra heavy elbow would put a check valve out of working order in a short time.

**Thomas Sheehan.**

Pittsfield, Mass.



SHOWING BLOWOFF CONNECTIONS

## Saving by Throttling Steam

On page 925, Mr. Johnson has his friend Sawyer tell about the saving in throttling steam, superheating it and gaining a big economy in so doing, although all these years the throttling engine has been discarded, and we have been taught that full boiler pressure should be obtained in the cylinder if we did not want to exhaust the coal supply.

In the case mentioned, it seems that the machines, boilers, etc., were large for the work, furnaces too big, pressure too high and all the evils of underloads present. In such cases reducing the boiler pressure has made similar savings.

The question arises, how much superheat is there added to the steam, say at a reduction of 20 pounds? Why does steam superheat, and all other gases cool by reducing pressure? If air is compressed it is heated, but by expanding it, or reducing the pressure, it cools.

Superheating steam is quite a job, as before it can be superheated it must be thoroughly dry, and reducing the pressure a few pounds will not make it very hot.

Apparently there is less steam used in underload work by carrying the steam pressure high and throttling than by carrying just the pressure required, but we know the fate of the throttling engine.

W. E. Crane.

Broadalbin, N. Y.

## Firing Boilers

In reading the replies in the June 8 number, to Victor White's article on "Firing Boilers," I noticed particularly the one by A. Adler, in which he says that Victor White conveys the idea that firing boilers is a matter of practical theory.

Ordinarily this is probably so, but I am inclined to think that Victor White is pretty nearly right, as far as the practical experience idea goes. In a period covering over twenty years, I have had ample opportunities to see the manner of working and the results produced thereby, of a great many firemen in both stationary and marine practice, and I feel perfectly safe in saying with Victor White that it is a matter of practical experience.

Now as a matter of fact the best fireman I ever saw could not read or write, and I am sure he had never heard of any theory in regard to burning coal at the time I first met him, and yet at a later period it was my good fortune to see him firing a plant at which a test was being run. He was firing under instructions from one of the foremost mechanical engineers in the country, one who today bears a national reputation. The results obtained did not seem to be satisfactory, and the mechanical engineer said so; then the fireman bluntly told him that if he would let him fire in his own way he could carry better steam and burn less coal. The mechanical engineer appeared rather sceptical about it, but finally told him to fire his own way, with the result that less coal was burned per horsepower-hour, and the steam was carried with a variation of less than five pounds throughout the remainder of the test, except at stopping times.

Now there is no doubt in my mind, but that the mechanical engineer who was conducting the test knew more about the theory of burning coal than that fireman ever will, but the fact was demonstrated pretty thoroughly to everybody on that job, the mechanical engineer included, that the fireman with only his practical experience could burn less coal and furnish more steam to those engines than he could by following to the letter the instructions of the mechanical engineer. Strange isn't it, but nevertheless a fact.

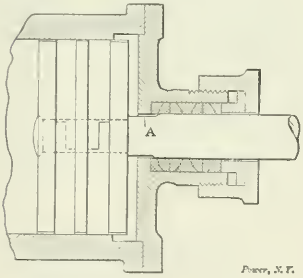
Few, if any, firemen understand the chemical combustion of coal, and I might add, care less about it, and while it may be explained to them at times, it does not strike them hard enough to hurt them, or at least that has been my experience. A fireman who is sufficiently interested to study upon the matter will generally move out of the fireroom to a better position. There are no doubt a great many cases where firemen can be taught to be more economical in the use of coal, but as a rule they get more information from what they call a "good fireman" than they do from any theoretical source. Of two men to choose from, to keep a plant running on the least coal, one a theoretical and the other a practical fireman, I will take the practical man every time.

W. N. Wing.

Brooklyn, N. Y.

## More Stock in Piston Rods

I have often wondered why engine and pump builders do not put more stock in their piston rods and turn them smaller at the ends of their stroke, as at *A* in the illustration, just as cylinders are bored larger to avoid wearing the shoulder. If it is essential in one place it is in another, and especially where the packing comes, in order to keep it from leaking. It should not cause any trouble with metallic packing, but with hemp packing it might crowd and bind.



MORE STOCK IN PISTON RODS

C. G. Kranz.

Chicago, Ill.

## Getting What You Pay For

I note an editorial in the June 15 number on "Standard of Excellence." I always tried to make my specifications clear and binding and always required a sample to show the texture and weight, and provided that when the belt arrived and it was not according to specifications and equal to the sample submitted, the maker should put it on the pulleys and allow it to be used until a suitable belt could be procured without extra charge.

I once awarded the contract for two 42-inch belts, each of them over 100 feet long, containing two hide centers on one side and three on the other. When they arrived I notified the maker that the belt was not up to contract, and asked them to send a man to look them over and he owned up. They deducted a little over 15 per cent. and we kept them. I have returned pipe at the shipper's expense that was not up to full weight.

There is not much trouble if you understand what you want. If not, and won't hire some one who does, then it is another story. A pipe coverer said that his covering was all right and of the proper thickness until I stuck my knife through and showed him that instead of being a full inch thick, it was less than ½ inch.

W. E. Crane.

Broadalbin, N. Y.

## Changing Centigrade Readings to Fahrenheit

On page 926, May 25 number, is a long article about changing Centigrade thermometer readings to Fahrenheit. If one wants to do it in his head, all that is necessary is to add eight-tenths of the Centigrade reading to the reading and then 32 to that, and he has it. Ten degrees Centigrade would be

$$8 + 10 + 32 = 50$$

degrees Fahrenheit.

John E. Sweet.

Syracuse, N. Y.

## Sewer Gas in Boilers

The letter by Milton Heglin, page 935 of the May 25 number, states that it was supposedly sewer gas that was drawn into the boiler through an open blowoff valve and caused the explosion. If such a thing is possible, it should be known, for many boilers are connected to sewers through the blowoff pipe. I have interviewed several men who have had experience in sewer work, and in every case they stated that sewer gas will generally put a light out, if it is present in any great quantity, but that in most cases it will not ignite. What would happen if it were drawn into a hot boiler, and a light applied, they could not say, but were under the impression that sewer gas could not be made inflammable by the application of heat alone.

Surely some reader has had experience with sewer gas. What is it?

James E. Noble.

Toronto, Ont.

# Some Useful Lessons of Limewater

## The Part Nitrogen Plays in the Study of Common Chemicals; the Numerous Ways in Which Ammonia Is Formed; Interesting Experiments

### BY CHARLES S. PALMER

One of the most important and interesting things about the air is the part which nitrogen plays in common chemicals. A ton of coal in burning takes about ten tons of air to take care of the carbon in the coal, yet of all this ten tons, only about two and one-half tons, the oxygen, really has anything to do with the burning, because the seven and one-half tons of nitrogen simply dilutes the oxygen, and of course goes in and comes out as nitrogen. Now this seven and one half tons of nitrogen has to be heated, and one of these days we shall discuss the heat side of all this, and see what might be the advantage of using some of the waste heat from the stack to warm this seven and one-half tons of nitrogen, so that, at least, it may not hinder the burning of the one ton of coal and the two and one-half tons of oxygen into carbon two-oxide any more than need be.

But the fact at which we are aiming just now is that one would hardly guess that this sluggish nitrogen which goes into the furnace as cold air and comes out of the furnace as hot air is really one of the most active elements in the whole list. But like many good men it needs to get well started before it can show its hand and before it can prove what a terribly active and all-round chemical sport it is. Just take a look at the oxidation table of nitrogen (Table 1) given herewith—don't stop to memorize it, but simply give it one good look. At the reduced or left-hand end is common ammonia, with its basic form of aqua ammonia, ammonium hydroxide or common ammonia water; and its salts, such as salammoniac (ammonium chloride or ammonium muriate), ammonium nitrate, ammonium carbonate, etc. for this basic thing, "ammonium," which is hidden in ammonia, can form salts by uniting with any respectable acid; and hence there are as many possible salts of "ammonium" as there are acids in the chemical list to unite with the ammonium.

This basic compound of nitrogen with hydrogen, $NH_3$—that is all that ammonia is—is formed in many ways; but usually it is obtained from the decomposition of "organic matter," which means the kind of stuff found in plants and animals, or coal. The ammonia comes out of this organic matter in the form of some salt of ammonium, "$NH_4$," such as ammonium nitrate, or ammonium chloride, common salammoniac, which last was named because it was obtained as an important article of commerce way back, nearly two thousand years ago, from the heaps of camels' dung which accumulated near the temple of Jupiter Ammon, at Alexandria in northern Egypt. In those days, camels were the common carriers, and purely as a matter of accident, this salt, salammoniac, ammonium chloride, which came out of the heaps of manure as a natural crystallization in that dry climate, became a common article of sale. Salammoniac is still an important chemical; and from it common ammonia water can be easily made.

About this time, you will be quite ready to say that all this is very interesting, but where does that barrel of lime come into the game? Well, it comes in right here, for one thing. The lime is basic, and it is not volatile, while the ammonia is a volatile gas, and if you mix common salammoniac with some lime, the lime takes hold of the acid (HCl, hydrochloric or muriatic acid) in the salammoniac, holding it back, while the ammonia can go off. In fact, this is nothing but one common and very cheap way of making "smelling salts." To show this, just do the experiment shown in Fig. 1.

TABLE 1. OXIDATION TABLE OF NITROGEN.

| Reduced End. | | | | | | Oxidized End. |
|---|---|---|---|---|---|---|
| $NH_3$<br>Ammonia. | $N_2$<br>Nitrogen. | $N_2O$<br>Nitrous Oxide. | NO<br>Nitric Oxide. | $N_2O_3$<br>Nitrogen Sesqui-oxide. | $NO_2$<br>Nitrogen Di-oxide. | $N_2O_5$<br>Nitric Anhydride. |
| $NH_4OH$<br>Ammonium Hydroxide. | | HNO<br>Hypo-nitrous Acid. | | $HNO_2$<br>Nitrous Acid. | | $HNO_3$<br>Nitric Acid. |
| $NH_4Cl$<br>Ammonium Chloride. | | | | | | $KNO_3$<br>Potassium Nitrate (saltpeter). |
| $NH_4NO_3$<br>Ammonium Nitrate. | | | | | | |

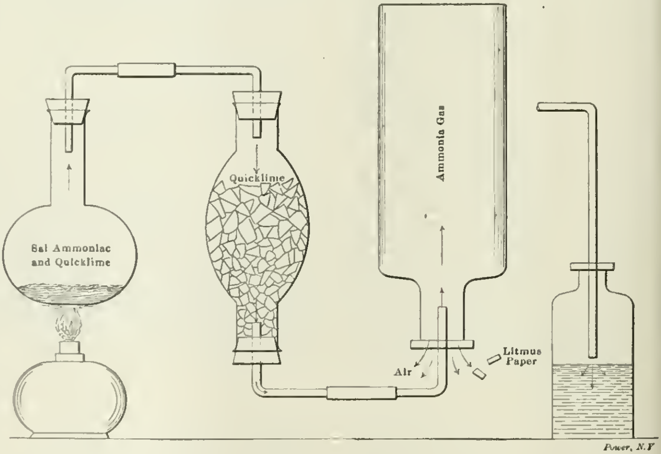


FIG. 1. MAKING AMMONIA FROM SALAMMONIAC AND LIME

Mix some salammoniac, about an ounce or so, with some common quicklime, about two ounces; really, one ounce of quicklime can take care of about two ounces of salammoniac, as the equation in Table 2 with combining weights shows; but it is well to have some extra lime to take care of the moisture which always gathers about the experiment, and to help dry the gas, ammonia, which will come off as soon as you heat the mixture gently. If you want to dry the ammonia more carefully, arrange a drying jar, as shown in Fig. 1, by taking a common lamp chimney, filled with lumps of quicklime. The lamp chimney is closed top and bottom with wide and flat corks, through which pass glass tubes through which the gas, amonia, is led to dry it. You will see that is a trick all by itself to dry gases. the gas is chemically neutral, almost ny drier can be used; such as lime, or rong sulphuric acid, or calcium chloride, r the like, all of which are good in their ays; but if the gas has a chemical activ- y of its own, then some care must be ken in selecting the right drier to dry ie gas. If the gas is acid, one would se the sulphuric acid; if the gas is basic and there are quite few gases which are asic, as the ammonia is), then one would elect such a drier as common quicklime.

TABLE 2

| aO + | $2NH_4Cl$ = | $CaCl_2$ + | $H_2O$ + | $2NH_3$ |
|---|---|---|---|---|
| ime. | Sal-ammoniac. | Calcium Chloride. | Water. | Ammonia. |

| | | | |
|---|---|---|---|
| | | 2 N = | 28 |
| Ca = | 40 | $2 H_4$ = | 8 |
| O = | 16 | 2 Cl = | 70.8 |
| | 56 | | 106.8 |

These figures are the combining weights of the calcium, oxygen, etc.

After the ammonia is dried by passing through the lamp chimney filled with uicklime, lead it into several things in rder, and as shown. In the first place, ou will have all ready, a large bottle, which has been carefully cleaned and ried the day before, so that it has no irt nor water, not a drop, to bother the xperiment. Set this large bottle mouth ownward, with a delivery tube leading up into the bottle. As soon as the bottle s full of gaseous ammonia, (and you can ell when the bottle is full by holding a it of red litmus paper at the mouth, when t will turn blue instantly), remove the delivery tube, cork the bottle with a tight and dry cork, and set the bottle aside for a few minutes.

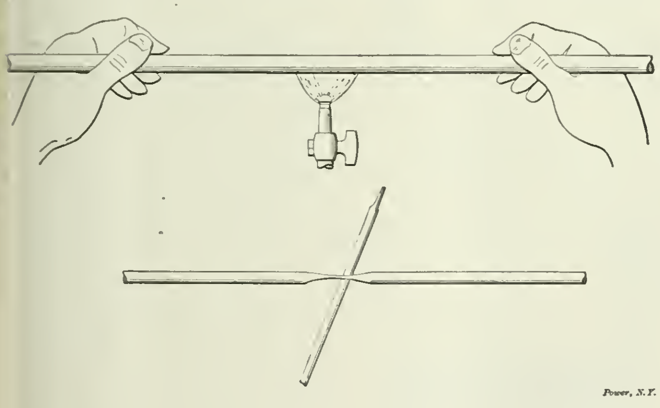

Power, N.Y.

FIG. 2. HEATING GLASS TUBE PREPARATORY TO PULLING OUT AND FILING OFF

Then lead the rest of the gas ammonia which is still coming off from the flask into a bottle half full of water, clean and plain water (keeping the delivery tube out of, but just above the water), and make a solution of common water of ammonia or common ammonia, as it is called; for that is nothing but a solution of the gas, ammonia, $NH_3$, in water. The ready solubility of the gas, ammonia, in water is one of its chief characteristics, one pint of water being able to dissolve as much as several hundred pints of the gas ammonia. If you watch carefully, you will see that as the gas strikes the water, there is a solution which is different from the water, and which flows away with the look of cutting it, just as two liquids look when they are mixed. The Germans have a special name, "schlieren," for these layers of different density which form when two liquids are mixed, which can mix completely so that they will be "smooth" but are not yet completely mixed. It would not be a bad thing if we had a name in English for these solution layers; and perhaps we may as well call them solution layers, for that is just what they are.

These layers of solution of ammonia in water may seem to sink, but this is perhaps because the current of ammonia gas is driving down on the surface of the water; for really the solution of ammonia gas in water is lighter than plain water itself, being only about eight or nine-tenths the weight of pure water. The common "concentrated ammonia" has about 35 per cent. of ammonia gas and has a specific gravity of about 0.88 as compared with pure water, which has a specific gravity of 1. To give yourself a notion of what this wonderful solubility of ammonia gas in water means, go and take that dry and corked bottle of ammonia gas which you set aside a few moments ago, and perform the experiment shown in Fig. 3.

You will rig the bottle as follows: Take a cork the same size as that which is still in the mouth of the bottle. Cut a hole through it to fit a piece of glass tubing, about a foot long. Have the end of the tubing drawn out to a fine point as shown in Fig. 2. Draw out the glass, after heating it by holding it in a gas flame, and turning it around till it can be pulled out. The hot part will draw down thin, as shown in Fig. 2. Cut off one end of the thin part, shove the tube up through the cork, with the jet to go in the bottle; and when the experiment pulls off as it will in a few minutes, you will have the fountain effect shown in Fig. 3.

Hold the bottle mouth downward, and quickly take out the plain cork, substituting it by the one with the glass-tube jet. Let the jet point set up well into the bottle, so that the fountain effect will not be choked off by having the jet too low in the bottle. Take some minutes with this. The outside end of the jet tube of glass must be placed in a large pan of water, or a pail will do; only have enough water to fill the bottle of ammonias gas. It will take some coaxing to get the first drops of water to get through the glass jet into the bottle; but you can work it by putting your finger over the mouth of the glass tube outside of the bottle, to keep any air from getting into the bottle and to hold the vacuum, and inverting the bottle, when a few drops of water will flow into the bottle, and begin absorbing the ammonia gas.

As soon as this absorption is once started, the vacuum formed will call for more water, and if you have kept your finger on the outside end of the glass tube, being careful not to take away your finger till you have turned the bottle upside down again and put and kept the glass tube end under water, then the absorption of the ammonia gas will go on with a rush, and the water will gush into the bottle with fountain effect. Of course, you will see to it that you have rounded the outside end of the glass tube by heat, or at least rounded the edges with a file so that you can hold your finger tight on the glass tube without danger of cutting yourself; also, it will not be a bad thing to have two bottles of the dry ammonia gas prepared, so that if you make a fluke with one of them, you can learn how to make the other one work all right.

If you color the water in the pail or pan with some red litmus, which you can get from any chemical-supply house, you will see a very pretty additional test, as you go on with this experiment; in that, as the red-colored water is sucked up into the bottle, it will be colored blue by the ammonia gas in the bottle. If you have really filled all of the bottle with pure ammonia gas, you would get a complete filling of the bottle with water; but usually in your first experiments in this direction you will not get the bottle more than half full of water, which is, however, fully enough to show the absorption of ammonia gas by water.

Just a word about the chemistry of this ammonia. Look at these equations. You will note that in every case, as the ammonia unites with the acid, hydrochloric, sulphuric, nitric, or carbonic, there is formed some salt of the theoretical base, "ammonium," $NH_4$.

$NH_3 + HCl = NH_4Cl$ Ammonium Chloride.

$NH_3 + HNO_3 = NH_4NO_3$ Ammonium Nitrate.

$2NH_3 + H_2CO_3 = (NH_4)_2CO_3$ Ammonium Carbonate.

$2(NH_3) + H_2SO_4 = (NH_4)_2SO_4$ Ammonium Sulphate.

Similarly, when ammonia gas unites with plain water, as shown in the following equation

$NH_3 + H_2O = NH_4OH$ Ammonium Hydrate.

it makes ammonium hydrate, just as sodium and potassium and calcium oxides do in the following equations:

$Na_2O + H_2O = 2NaOH$ Sodium Hydrate.
$K_2O + H_2O = 2KOH$ Potassium Hydrate.
$CaO + 2H_2O = Ca(OH)_2$ Calcium Hydrate.

You need not bother to remember all these equations, only that ammonia can step into, and as easily step out from, relations where it is a base like sodium and potassium. Indeed, if sodium or potassium can make a salt with any acid, you can roughly figure out that ammonium will do the same; and so far is this carried out, that the salts of ammonium are classed with those of sodium and potassium, in the alkali group.

But there is another side to this ammonium, and that is the heat side, for it has a remarkable heat side. Common ammonium hydrate is nothing more than a solution of the gas ammonia in water; but now stop and think what the gas would be if one had it pure and dry in strong pipes so that one could lead it about by itself, the gas ammonia I mean. This gas is readily condensed by the pressure of a few atmospheres; and as it is cooled it gives out heat; as it is allowed to evaporate, it absorbs the same quantity of heat, all the while inclosed in tight iron pipes. And that is the secret of the cooling apparatus which is used about every bottling works, every artificial ice plant and every brewery. The ammonia is condensed in pipes, and the heat of condensation is taken out by water flowing round the outside of the pipes. Then this condensed and pure liquid ammonia is led into the cooling pipes, where it is allowed to evaporate off, when it takes up heat of vaporization from the first thing it can steal from, a vat of beer, a tank of strong brine, or what not. As it evaporates, all under control of a closed-pipe system, it is pumped back to the condensing part of the apparatus, to be condensed again, and so on the round. This experiment, which you can follow in any artificial-ice plant or brewery, will teach you more about the reality of heat than any amount of reading. It will show you that heat can be moved; that it can be put here and taken there, and the same is true with the opposite of heat, or its absence, coldness.

This chapter of ammonia would not be fairly complete without some tests for ammonia. You will need some salts of mercury, of copper, some litmus, and a bottle of hydrochloric acid. You can make the mercury salts by dissolving a drop of mercury in nitric acid. Add barely enough nitric acid to a drop of mercury in a test tube so that the mercury is not all eaten up by the nitric acid. That makes a solution of "mercurous" mercury; bottle it, cork it, and label it "Mercurous Nitrate."

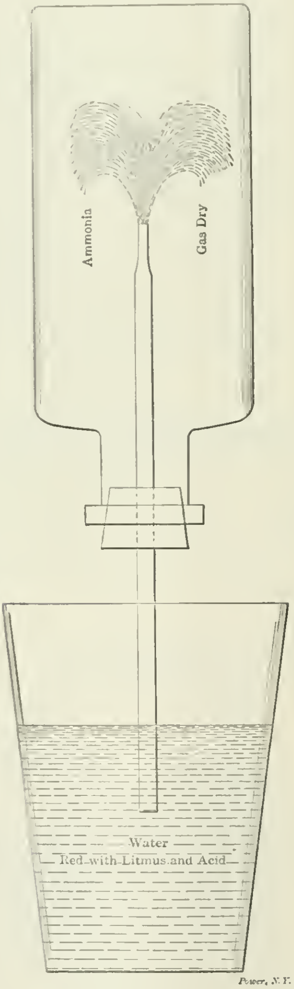


FIG. 3 WATER FOUNTAIN IN DRY AMMONIA

Then get a little, a pinch of corrosive sublimate, dissolve it in some clean water in a bottle, and label it "Mercuric Chloride," and remember that it is shockingly poisonous. Then dissolve a bit of blue vitriol in another bottle, and label it "Copper Sulphate."

You have your litmus and your hydrochloric acid. Now, in as many test tubes, add to separate portions of the salts mercury and copper a little of the sol tion of ammonia water that you made while ago. You will get a *black* precip tate from the mercurous nitrate; a *wh* precipitate from the mercuric chloride; *blue* precipitate from the copper sulphat which dissolves with a slight excess ammonia to a magnificent deep-blue sol tion. If you hold your nose, carefully, any of the ammonia-water solutions, yo will get the marked "pungent" odor; you hold red litmus near the bottle of am monia water, you will get the blue te for bases and alkalies; and if you ho a bottle of hydrochloric or of nitric ac near the bottle of water of ammoniu you will get the white smoke of salam moniac or of ammonium nitrate. No these six tests for ammonia and am monium are worth trying till you get of them and get them right; for they w clinch the proof for the presence of am monia and ammonium as you run acro it from time to time. Of course, if yo have the ammonium locked up in som salt of ammonium, all that you have do to release it as ammonia, is to ad a bit of your friend lime, when it w be set free and will give you these test If you should want to test for ammoniu as ammonium, you can treat it as alkali metal, hunting for it with som special reagents, such as platinum chlorid or with other things; but that is anoth story.

Just here, to clinch some of thi evaporate some of your solution of am monia in water down to dryness; all th you will get, if you have used clea dishes, and clean water, will be the di or saucer in which you did the evapora ing; but if you add to the water of am monia some acid like hydrochloric aci then you will find all the ammonia le as a white salt, in this case, salammoni or ammonium chloride; which can be i self driven off by more heat; for all the salts of ammonium are volatile wi heat.

The next time we shall wind up th chapter on the nitrogen of the air, b studying the other end of the oxidatio table of nitrogen; but there is one thin that you will want to try all by you self; that is, heating a piece of meat cheese with some of your friend lim You will get some very bad smellin things; but they will all probably tu litmus from red to blue; and that w give you more food for thought as yo realize that meat, milk, cheese and th like are only so many complicated am monia derivatives, mixed up with som of those thousands of compounds whic we ran across in the oxidation tables carbon. And most interesting of all, th brains and nerve tissue with which yo are doing your thinking as you read th article, they are only so many complicat ammonia compounds. Indeed, the gre chemist Liebig discovered years ago th ll living things, animals an.' plants, must ave nitrogen to grow and live, and it s only keeping up the same line of hought to be reminded that plants and nimals do their *living* by the aid of tissues which are largely made up of nitroen compounds which are first cousins to mmonia. And as lime can make ammonia out of all of these things, you are ever very far away from the chemistry f the lime barrel.

## The Greenwich Station of the London County Council Tramways

From a paper recently read to the Intitution of Electrical Engineers in Lonon, it appears that the electrified tramvays of London—excluding the underround and tube railways and private nes—amount only to about 70 route iles worked by the municipal authories; the slow progress being due to the ery costly system of conduit construcion

The power station at Greenwich, in ngitude 0° 0′ 0″, has a boiler house easuring 445x80 feet, an engine room of ike dimensions, auxiliary buildings and a al-landing wharf on the river.

There are four chimneys, two 250 feet igh by 14 feet inside diameter, and two 82 feet in hight, the shortness being due o the pressure of the admiralty, for the t gas from the first two chimneys made he stars in the lower sky to dance in the elescopic field, the station having been built by blunder right on the line of the reat telescope in the observatory on the ill near the station

There was also trouble from the vibraion of the four 3500-kilowatt engines, which was cured by floating the mercury rtificial horizon in a different manner. But in the event of the extension of the tation, machinery is to be in the form of rbo-generator sets. There is not much f particular interest about the station. oal is landed by grab buckets and run ack to the bunkers over automatic weigh ridges and thence conveyed by a bucket nveyer to the boiler hoppers, the reurning conveyer taking off the ashes to a eceptacle below the high coal wharf, this eceptacle discharging into barges alongle the river wall and inside the wharf, hus keeping the ash barges clear of the l steamers outside the wharf in leeper water. Coal is purchased on a asis of 12,500 B.t.u. per pound and 10 er cent. of moisture, the price being varied for other values and percentages. There are 48 boilers, 24 being of Stirling ype and 16,300 pounds evaporative apacity from and at 212 degrees Fahrenheit, and 24 of Babcock type and 18,200 horsepower capacity per hour. These latter have 4780 square feet of heating surface and 88 feet of grate surface. There are thus six boilers discharging into each of the north and south sides of all four chimneys. Each two boilers have 300 pipes of economizers on the floor above. Steam is superheated to about 500 to 550 degrees Fahrenheit. Water for makeup comes from an artesian well in the chalk and needs softening and considerable blowing off is required to deal with the accumulation of sulphate of soda which results from the reduction of the permanent hardness by means of soda. Temporary hardness is dealt with by lime. The final residual hardness is still as high as 7 or 8, which seems considerable for the elaborate apparatus employed.

All pipes are drained to separators by the engines, and the engine drainage is attended to by keeping the low-pressure cylinder horizontal, an inversal of the "American" or "Manhattan" engines, of which these are copies, except for the reversed position of the high power and low-power cylinders. Considering that the steam is superheated, it is thought by some that it is perhaps a mistake to drag the low-power piston horizontally for the idea of constant gravitation of water without traps.

The engines are four in number of 5000 horsepower and there are now just added two turbo-generator sets of 5000 kilowatts each.

The normal station capacity is thus 34,000 kilowatts, but an overload capacity of 42,500 is possible, the maximum load being assumed at 30,000 kilowatts, after allowing for repairing sets. The reciprocating engines have each four cylinders, two of 33½ inches diameter and two low-power of 66 inches, the stroke being 4 feet. No particulars are given of the turbo sets. The engine speed is 94 revolutions per minute; the piston velocity being 750 feet per minute. There is a steam-heated receiver between the high-power and low-power cylinders, of 1100 square feet area, fed by live superheated steam, but no tests appear to have been made to demonstrate the value of the arrangement. The lubrication is forced and the engines inclosed

Each side of the engines is practically independent, except through the crank shaft, there being a separate condenser and air pump to each. The two cranks are 135 degrees apart so as to secure eight impulses per revolution. The flywheel energy of the alternator is 16,000,000 foot-pounds and the angular variation not above 0.15 of one per cent. either way.

The steam consumption is about 16.75 pounds per kilowatt-hour on full and on half load, and that of the turbines is guaranteed at 15 pounds. There are also in course of erection two British Westinghouse-Rateau turbo-alternators of the same capacity as the Williams-Dick-Kerr sets.

Six 30-inch pipes will ultimately serve to draw condensing water from and return it to the bed of the Thames, the incoming water passing through a revolving-cage sieve and the returning water going back through the same cage in another compartment. Thus the sieve is always washed clean. Ultimately there will be four incoming and two outgoing pipes, the outgoing streams having the higher velocity, thus minimizing the collection of débris and facilitating its return to the river. Current is generated and distributed at 6600 volts and transformed in various substations to the usual 550 for tramway service.

The cost of the station works out at about $115 per kilowatt capacity, including land, buildings and piers. Current costs to deliver to substations 0.662 cent and about 3 pounds of coal is consumed per unit generated.

The present annual car mileage will be about 32,000,000, the receipts being 23.4 cents per car mile and the maximum load 18,500 kilowatts, with a 47½-per cent. load factor. Last year the passengers numbered 279,000,000. They should be well over 300,000,000 when this year's accounts are made up.

## A Wind Power Plant at Hamburg

By E. Hoffmeister

There is a noteworthy wind-power plant near Hamburg, Germany. The tower is 90 feet high, the diameter of the wheel 36 feet. The wheel drives with gear wheels a dynamo which charges accumulators. The capacity of the plant is 6 horsepower at 15 feet velocity of the wind, 14 horsepower at 20 feet and 30 horsepower at 26 feet. If the electric current is too feeble, an automatic circuit-breaker switches the current off, and if it is too intense, an auxiliary resistance is brought into play

This plant took the place of a gasolene-engine plant on a farm and saves $800 a year. The wind turbine needs very little attendance, which is limited to a filling up of the lubricators. The gasolene engine is held as a reserve machine. Several times the wind motor has worked without interruption for 90 days.

High volatile matter in coal gives low efficiency and *vice versa.* The highest efficiency is obtained when the furnace is run at low capacity. When the furnace is forced, the efficiency decreases.

Most coals that do not clinker excessively can be burned with 1 to 5 per cent. greater efficiency and with a smaller percentage of black smoke on a rocking grate than on a flat grate.

# I. A. P. S. Holds Annual Convention at Syracuse

## Three-day Session of the International Association for the Prevention of Smoke Brings out Some Valuable Data on Reduction of Smoke

The International Association for the Prevention of Smoke held its fourth annual convention in Syracuse, N. Y., on June 23, 24 and 25, 1909. The active membership of this association is composed solely of officials of various city governments, who are associated with the work of smoke prevention. The associate membership is made up of others who are interested in the subject of smoke abatement, such as mechanical and consulting engineers, members of the United States Geological Survey, and those in the stoker and smokeless-furnace business. At the Syracuse convention there were present 16 active members and about 55 associate members.

President John Krause, smoke inspector of Cleveland, O., presided at all meetings and proved himself a very capable and efficient officer. R. C. Harris, of Toronto, Canada, who has been secretary and treasurer ever since the founding of the association, again took care of the business end of the convention.

During the convention nine papers were presented, all dealing with the problem of smoke abatement. Seven of these discussed the subject from an engineering standpoint, one considered the legal phase and one paper covered the subject as a nuisance and as a menace to health.

In the past the subject of smoke abatement has largely been left to the physician and to the civic reformer, and unfortunately among practical engineers the subject was to some extent at least considered a joke. It is gratifying now to note that this young organization has year by year been discussing the problem from a technical standpoint, and that the present sessions were almost entirely devoted to the consideration of the practical engineering questions involved. It shows that the subject of smoke prevention is now where it rightly belongs, that is, in the hands of the engineer, and the rapid strides made during the last few years show that the engineer, in exercising the same study and skill that has succeeded so well in other fields, is likewise accomplishing striking results in ridding our cities of the smoke nuisance. The keynote of most of the papers presented was the necessity of special furnace design for steam-boiler plants. This point was brought out forcibly in every technical paper presented.

In the past we have been building our boiler settings, grates, breeching and stacks without the close study that is necessary for complete and smokeless combustion. Professor Randall pointed out that the soft coal varied widely throughout the country and that boiler furnaces should be specially designed for the fuel to be used. L. F. Beers, a consulting engineer of Rochester, showed the importance of draft in the smoke problem, and that special design was required in connection with breechings and stacks. Paul P. Bird, chief smoke inspector of Chicago, showed from the experience of the Chicago smoke department the importance of special furnace design for boiler plants that are to run without smoke.

It was stated in several papers and in the discussion, that although hundreds of so-called smoke devices and smoke consumers had been patented, satisfactory results could not be obtained as a rule by the addition of a mere device to a faultily designed and constructed plant, but that it is better to study the problem before the plant is built and design properly.

### SMOKE ABATEMENT IN CHICAGO

Paul P. Bird, chief smoke inspector of Chicago, told of the experience of the Chicago department of smoke inspection in approving all designs for new plants. The Chicago smoke ordinance makes it necessary for anyone installing a new boiler or reconstructing the setting of an old one to submit the drawings to the smoke inspector for his approval. His approval means that the plant can be operated without making dense smoke. The speaker told of the various improved methods of setting the ordinary hand-fired return-tubular boiler that had been followed, and brought out the fact that the completely brick-inclosed furnace with a brick arch over the grates had not proved the success from a smoke standpoint that had been hoped for it. With the brick arch over the entire grate surface in the return-tubular boiler setting, the furnace temperature was so hot that the resulting rapid distillation of the volatile gases was usually too rapid to insure complete combustion before the gases escaped to the boiler and stack from the furnace.

Other objections to the brick arch over the fire were that the brickwork absorbed so much heat when starting the fire that on an 8- or 10-hour working day, the coal consumption was higher and the first cost and maintenance of such construction was high.

The speaker gave as his opinion that the best setting for a hand-fired return-tubular boiler, having in mind smoke prevention, was to set the boiler higher than has been customary heretofore, say about 42 to 48 inches above the grates for the ordinary size of boiler, and then to build some sort of arches, piers, etc., beginning at the front edge of the bridgewall and extending 3 or 4 feet behind the bridgewall. This design should always include a deep deflection or drop arch behind the bridgewall to provide facilities for mixing the volatile gases thoroughly with the air that comes through the grates and through the front firing doors. The speaker told of hundreds of improved settings that had been installed in Chicago with good results.

A number of slides were shown illustrating improved or special settings of all sorts of boilers, with particular reference to smokelessness, the general tendency being to set boilers higher than has been customary heretofore, and either by bringing the furnace out in front of the boiler in a "doghouse" form or by baffling the boiler horizontally to get a long travel for the gases after they leave the grates and before they strike the heating surface of the boiler. It was shown that the standard forms of setting hand-fired Stirling, Babcock & Wilcox, Heine or vertical types of water-tube boiler made smokeless operation when running at capacity practically impossible with most grades of soft coal. Slides were shown illustrating improved settings of these boilers that had been successful in reducing the smoke.

In steam-boiler practice there have been developed certain standard methods o setting various boilers. These standard settings (usually recommended by the boiler manufacturer) all make smoke when operated at the rated capacity with soft coal. Certain improved settings are possible which could be used satisfactorily with any soft coal and not make objec tionable smoke.

Joseph Harrington, Green Engineerin Company, Chicago, opened the discussion by saying that he considered the paper to be a plea for automatic stokers, in tha all the faults and objections to the hand fired furnace that the speaker had mentioned were overcome by the stoker.

R. H. Kuss, chief assistant smoke inspector of Chicago, told of the difficultie the Chicago smoke department had experienced in getting any exact information on the performances of different type of furnace, and made a plea that som technical school or other institution mak a series of tests, carefully analyzing th results to prove which forms are best.

### THE RELATION OF THE CHARACTER OF COALS TO THE PREVENTION OF SMOKE

In this paper, D. T. Randall, the author, ointed out that throughout the country, rom the anthracite of eastern Pennsylania to the lignites of the western States, he coals differed widely in analysis, eating value and in smoke-making charcteristics. He described the work of the Technological branch of the Geological Survey, in making and tabulating analyses f all these different coals, and of the boiler tests run to get at the boiler efficiencies and information as to the smoke with the various coals. Professor Randall pointed out the necessity for particular furnace design for these widely different coals. He described the station for his investigation work by the Geological Survey, and said that the reason the work was practically stopped today was because of the small appropriation by Congress for this purpose.

H. M. Wilson, of the Geological Survey, n discussing this paper, described farther he plans of the Survey for working along his line.

### COMPARATIVE CONSUMPTION OF COAL WITH AND WITHOUT STEAM JETS

Prof. James B. Faulks, Jr., of Syracuse University, told of a test of a returntubular boiler equipped with automatically operated steam jets. The jets turned on with the opening of the fire doors and automatically closed about two minutes later. The jets were in use about 30 per cent. of the time. The steam jets were in the front of the furnace, over the fire, and were made by plugging ¼-inch pipes and drilling 1/16-inch holes through the plugs. In order to get at the amount of steam used by the jets a small auxiliary boiler was used to furnish steam for this purpose. The firing doors were left open for about two minutes after each firing to keep the smoke down. The coal used was Westmoreland gas coal having 6 per cent. ash, 1½ per cent. moisture and 36 per cent. volatile. The principal data are given in the following:

| | |
|---|---|
| Number of jets in boiler furnace | 8 |
| Duration of test, hr. and min | 8:42 |
| Steam pressure, main boiler, lb. | 110 |
| Steam pressure, auxiliary boiler, lb. | 50 |
| Rated hp. of main boiler | 150 |
| Developed hp. of main boiler | 185 |
| Stack temperature, deg. F | 562 |
| Coal fired per sq.ft. grate surface per hr., lb | 17.5 |
| Equiv. evap. per lb. of dry coal, lb | 9.37 |
| Equiv. evap. per lb. of combustible | 10.0 |
| Boiler efficiency, per cent | 62 |
| Percentage of total steam used by jets | 2.06 |

Tests made with and without steam jets show that the economic results are practically alike in both cases.

In the discussion it was brought out that the steam jet is an excellent device for preventing smoke with certain boilers, but that with certain water-tube boilers it is of practically no assistance. It was further pointed out that it was quite important in installing steam jets to get them at exactly the proper angle over the fire, and that this angle could only be determined by the cut and try method, as it depended on the particular furnace and on the draft.

### THE INFLUENCE OF DRAFT ON ECONOMY AND SMOKE PREVENTION

L. M. Beers dealt with the importance of draft in securing boiler economy and smokelessness. The speaker pointed out that in the past the breeching had not received much attention in the design of boiler plants, and that often, even with a high stack, there was insufficient draft in the furnace because of a poorly designed breeching. A right angle in a breeching cuts down the draft very materially, so that all bends and turns should be avoided where possible. Where a bend is necessary, make it as easy and straight as possible. The speaker mentioned numerous instances from his experience where large savings had been made by simple alterations in the breeching. It was shown that the arrangement of baffling in boilers greatly affected the loss of draft between the breeching and the furnace, and that careful study of flow of gas through boiler settings was necessary. Boiler manufacturers as a rule object to changing the baffling from their standard forms, but often the boilerman doesn't know that certain changes in the baffling may lessen the smoke and increase the efficiency or capacity of the boiler. The average velocity of gases in a boiler furnace is about 15 feet per second, so there is very little time available for the combustion process.

In opening the discussion, Prof. D. T. Randall said that in operating a boiler the draft gage was almost as important as the steam gage. He urged the use of permanently installed draft gages, and that those in charge of boiler plants be taught to watch the draft gage continually and control their fires thereby.

In the opinion of Joseph Harrington, the most likely place in which to look for trouble in all boiler-furnace jobs was with the draft. In his experience with chaingrate installations, he always pays a great deal of attention to this subject. He spoke of the location of the stack relative to the boiler and breeching. It is bad practice to bring two breeching connections into a stack from opposite sides, so that the gases flowing from one collide with the gases from the other. This should always be avoided when possible.

Paul P. Bird said that although it was theoretically proper to regulate the operation of a boiler by means of the damper, it was dangerous advice for a smoke inspector to give to the average fireman. The ordinary fireman will make more smoke by using his damper than by leaving the damper wide open and controlling the draft with the ashpit doors. Automatic damper regulators are likewise dangerous things for smoke prevention.

E. Fitts pointed out that a long horizontal run of breeching had but little effect on the draft if it was well covered with some insulating material.

### SMOKE AS A PUBLIC NUISANCE

Dr. Thomas Darlington, health officer of New York City, was not present because of sickness, but his paper was read by Secretary Harris. The writer discussed his subject from a legal standpoint, explaining the anti-smoke laws of New York City. The Board of Health has authority to abate nuisances, whether they affect the public health or not, and in this manner they proceed against smoke offenders.

Dr. Darlington said that in the year 1906 there were 240 arrests in New York for infringement of the health laws as to dense smoke, and in the year 1908 there were only 16 such arrests. In 1906 there was $350 collected as fines and nothing collected in 1908.

### FUEL ECONOMY AND SMOKE PREVENTION

H. M. Wilson, chief engineer of the United States Geological Survey, described the work of the Geological Survey in seeking to abate the smoke nuisance by showing how coal may be burned most efficiently. He touched on that phase of the question that came up so often during the convention, the importance of special furnace design for the fuel and service. Mr. Wilson told of the plan, put into successful operation in Germany, of educating firemen to operate boiler plants without making smoke. It was stated that in America most of the smoke comes from the small hand fired boiler plants, and that it was customary to employ in these plants the cheapest of unskilled labor for firemen. He pointed out that if these small plants are to be operated economically from a fuel standpoint and without smoke, more attention must be paid to the education of the firemen, and he recommended a system where firemen could be educated in the classroom as well as in the fireroom. He reported that in the work of the Geological Survey they had been much more successful in educating the miners in the classroom about the dangers of certain practices than in the mine through their foreman or others. His experience in the mine-accident work convinced him that some sort of school should be started for the proper education of firemen. Today the fireman is not appreciated in accordance with his importance.

During the discussion that followed this paper, Mr. Wilson exhibited samples of briquets made in the briquetting plant of the Geological Survey in Norfolk, Va. Some were made from the cheaper grades of bituminous coals and others from lignites. He said that the cost of making briquets, exclusive of the coal, is now about $1.25 per ton. This is chiefly due to the use of pitch for a binder, which is expensive. Many experiments are being made to find other material for binders. The lignite coals of the West may be briquetted without a binder, and briquets from lignite will some day undoubtedly play an important part in the fuel supply of the United States.

Briquets are used quite extensively in railway locomotives in Belgium, Germany and France. The locomotives carry a supply of briquets and use them for heavy pulls over grades and when in cities. They burn with much less smoke than raw coal, and the boilers can be forced more rapidly by their use.

The tests of the Geological Survey show that the use of briquets is a help in reducing the smoke nuisance, but requires careful handling, as does coal.

### The Smokeless Furnace

S. B. Flagg, of the United States Geological Survey, referred to the boiler tests made by the Survey, which showed that the trouble from smoke increases with the percentage of volatile in the coal. He spoke of the present methods of figuring the heat balance in making boiler tests. In the unaccounted for item is included any loss that may be due to the unconsumed hydrogen in hydrocarbons, also the heat lost by evaporating moisture in the air, and that lost by radiation. The Orsat gas apparatus only records $CO_2$, CO and oxygen. There are very few data on the presence of hydrogen and hydrocarbons in flue gases. The work of the Geological Survey in studying these losses and in attempting to analyze them, shows that the smoky chimney indicates uneconomical conditions in the furnace, and that these conditions can be remedied.

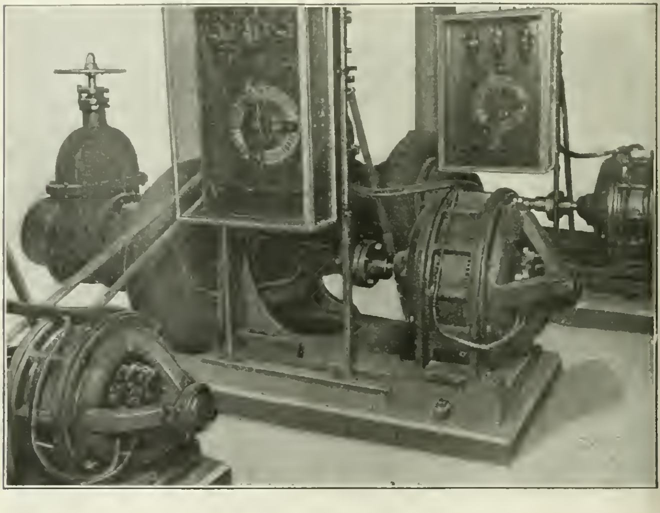
## A Novel Pumping Station

By Charles F. Adams, Jr.

A rather interesting sewage-pumping station has just been installed in Lynn, Mass., for besides being automatic in its action it certainly has a unique location. The necessity for a station was brought about by a decision of the supreme court ordering the city to abandon the outlet of an old sewer that emptied directly into the harbor and to connect with a sewer that was 11 feet higher at the place of interception. As it was impossible to make a gravity-flow connection, a pumping station was the only solution of the problem. The room containing the pumping apparatus is located under the street and is entered through a manhole which is the only external indication of the station's existence. This room is 21 feet long, 11 feet wide and 14 feet high and is of reinforced-concrete construction.

The pumping equipment comprises three General Electric motors directly connected to centrifugal pumps that are set below the level of the sewage to be pumped, so that they are always submerged, obviating the necessity of priming. Branching from the main sewer is a settling chamber where the level is comparatively calm and in this chamber are located the floats which make the contacts. When the sewage in this chamber reaches the 2-foot level the first float makes a contact, causing the controller to operate and start the small motor seen in the foreground. The pump connected to this motor is capable of discharging 1200 gallons per minute. Should the small pump be unable to take care of the sewage and the level in the settling chamber continue to rise, two larger pumps, each having a capacity of 4000 gallons per minute, are set to work, giving a total pumping capacity of 9000 gallons per minute.

Should the starting devices fail to operate from any cause, a telltale operating an indicator at the fire-alarm headquarters gives notice. A fan blower belted to the small motor serves to ventilate the room, and any surface water that may enter is taken care of by a water siphon working automatically.



THE PUMPING EQUIPMENT

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With the beginning of the present fiscal year the republic of Cuba established a bureau of information, President Gomez appointing Leon J. Canova, an American newspaper man, who has resided in Cuba eleven years and has a wide acquaintance with the island, as its director. Parties wishing information of any nature concerning Cuba can obtain it free of charge, by writing to Leon J. Canova, U. and I. Bureau (Utility and Information Bureau), Department of Agriculture, Commerce and Labor, Havana, Cuba.

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To make a leaky, dried-out tank hold water long enough to enable it to swell, put asbestos pulp into the cracks on the inside while filling.

## High Pressure Engines and Low Pressure Turbines

By H. F. Sanders

In order to compare engines and turbines they should be operated under similar conditions. Until recently reciprocating engines were generally operated with saturated steam; and to compare them in regard to steam economy with turbines which are usually operated with highly superheated steam results in a decision in favor of the turbine. How would this comparison stand if both were operated under the same conditions?

Small turbines, for instance the De Laval, running noncondensing with dry steam use from 60 to 75 pounds of steam per kilowatt per hour, while small engines under those conditions require from 30 to 35 pounds per indicated horsepower per hour, an equivalent to from 47 to 55 pounds per kilowatt per hour.

It is not the purpose, however, to discuss such comparisons, but to give the results of a little study along a line suggested by an article in Power for November 17, 1908, on "The Low Pressure Steam Turbine." The engine there reported as running noncondensing at 810 kilowatts required 30.6 pounds of steam per kilowatt per hour. When running with the low-pressure turbine the same weight of steam developed 1550 kilowatts. Or, the low-pressure turbine developed 740 kilowatts on 33.5 pounds per kilowatt per hour. The other two records show a consumption for the low-pressure turbine of 34.1 and 34.4, respectively, or an average for the three of 34.0 pounds per kilowatt per hour.

Treating reciprocating engines in the ame way the steam consumption for a w-pressure engine can be obtained. For revity, only four engines will be conidered, although numerous examples ould be obtained. These are triple-exansion engines, three being pumping enines and the other a cotton-mill engine. s the power and steam consumption of ese engines are based on the indicated orsepower, it becomes necessary to make ne approximation; that is, that 85 per ent. is assumed as the efficiency of the ectric-generator and engine mechanism. he steam used was of ordinary quality, xcept in one which had a trifle superеat, and entered the low-pressure cyliders at pressures ranging from zero to pounds above atmosphere, or an average f about 1 pound.

In engine No. 1, the indicated horsepwer of the three cylinders was 257.6, 4.5 and 300.8, respectively. The engine ed 9001 pounds of steam per hour. The w-pressure cylinder used 30 pounds per rsepower per hour, or 47.3 pounds r kilowatt per hour. The other two linders developed 482.1 horsepower on 67 pounds per horsepower, or 29.5 unds per kilowatt per hour.

Following is a table of the results from e four engines:

| NGINE | Horse-power. | | | Steam, Lb. per Kw.-hour. | | |
|---|---|---|---|---|---|---|
| | H.P. and I.P. Cylinders. | Low Pressure Cylinders. | All Cylinders. | H.P. and I.P. Cylinders. | Low Pressure Cylinders. | All Cylinders. |
| 1 | 481.2 | 300.8 | 782.9 | 29.5 | 47.3 | 17.95 |
| 2 | 295.26 | 199.14 | 494.4 | 33.85 | 50.2 | 20.2 |
| 3 | 595.6 | 401.2 | 996.8 | 33.6 | 49.8 | 20.25 |
| 4 | 367.3 | 206.4 | 573.7 | 30.95 | 55.0 | 19.8 |
| erage kilowatt | 274 | 175.5 | 453.0 | | | |

Turbines with three stages might be mpared to triple-expansion engines and e third stage considered as a low-presre turbine. The third stage here is nsidered to begin at that point where e pressure is one pound above atmohere.

There are not many records of tests turbines running noncondensing, using turated steam. One reported in 190 wed a steam consumption of 35 pounds r electrical horsepower, or 47 pounds r kilowatt. The output was 400 electril horsepower. This same turbine when nning condensing used only 15 pounds steam per electrical horsepower, or a tal of 6000 pounds per hour. Dividing is by 35 gives 171.5 horsepower as the rtion of the load carried by the highessure end of the turbine, leaving 228.5 rsepower to be delivered by the lowessure turbine. The water rate of the w-pressure turbine was, therefore, 26.25 unds per horsepower, or 35.2 pounds r kilowatt.

There are a number of records of tests on turbines running condensing using saturated steam, three of which show consumption rates of 9.8, 8.5 and 8.5 kilograms per kilowatt. The average for the three is 8.93 kilograms, or 19.7 pounds per kilowatt per hour. These are the best results out of a number of records at hand. The output of the turbine was 750 kilowatts; steam used per hour, 14,750 pounds. Dividing this by 34, the average consumption of a low-pressure turbuine, gives 434 kilowatts delivered by the low-pressure turbine, leaving 316 kilowatts delivered by the high-pressure turbine at a rate of 46.75 pounds per kilowatt per hour.

The following table is a summary of these results:

| | Steam, Lb. per Kw.-hour. | | |
|---|---|---|---|
| | High Pressure. | Low Pressure Portion. | Whole. |
| Triple-expansion engine. . . . | 32 | 50.5 | 19.5 |
| Turbine. . | 46 75 | 34 | 19.7 |

From this, it appears that the high-pressure engine is as much better than the high-pressure turbine as the low-pressure turbine is better than the low pressure engine. Hence, if this high-pressure engine and low-pressure turbine are combined in a plant of 1500 kilowatts capacity, 773 kilowatts will be delivered by the engine and 727 kilowatts by the low-pressure turbine. The plant would use 773 × 32 = 24,750 pounds per hour, which gives a rate of 16.5 pounds per kilowatt per hour. This is a gain over the all-turbine plant or the all-engine plant of 15.2 per cent. The steam consumption here is 1 pound more than reported in POWER, which results from the selection of tests from the engines poorer comparatively than those from the turbines, which give at least conservative comparisons. The plant reported in POWER shows a saving of 21.3 per cent. over the all-turbine plant.

From this the conclusion would be that a saving of from 15 to 20 per cent. over the all-turbine or the all-reciprocating plant is to be had by compounding a high-pressure compound reciprocating engine with a low-pressure turbine.

It may be that the proper division between the high-pressure engine and the low-pressure turbine is not at 1 pound above atmosphere, but at some higher pressure which could be determined by tests.

Perhaps the accuracy of this deduction will be doubted because turbine plants have delivered power on a water rate of 14 pounds per kilowatt. True, but that steam was highly superheated and of a higher initial pressure. In one record of test at hand a water rate of 14.2 pounds was attained with 200 degrees Fahrenheit superheat.

According to curves plotted and exhibited in "Steam Turbine Engineering," by Stevens and Hobart, the reciprocating engine gains more from superheating the steam than does the turbine, and much more by increasing the initial pressure.

If this is true, then the water rate for the plant just mentioned, instead of being 14 pounds, as with the turbine, would have been 11.9 pounds with the compound reciprocating engine compounded with the low-pressure turbine.

Further to corroborate the conclusion arrived at here, Mr. Orrok is quoted in POWER, November 10, 1908, as saying: "As far as steam efficiency is concerned, there is nothing to choose between a reciprocating engine, properly designed and run, and a turbine. That is, for the all-engine or all-turbine plant."

Professor Rateau points out that in order fully to use the expansion of steam to 1 pound absolute would require a low-pressure cylinder so large that its cost would be prohibitive, and the friction of the large parts and effect of wiredrawing the large volume of steam through the small ports would largely offset the gain from such expansion. But the low-pressure turbine uses the large volume of steam without becoming large itself and the rarified steam offers but little resistance to the revolving blades.

Mr. Neilson says, in substance, that turbines are not more efficient because of eddy currents and fluid resistance to the blades revolving in the dense medium.

It seems that increasing the admission pressure would increase the loss due to fluid friction, since the density of the steam is greater, just as superheating at any given pressure lessens the density and hence the loss due to fluid friction. Also, on the small blades of the high-pressure turbine the clearance between the ends of the blades and the cylinder is a greater proportion than on the larger blades of the low-pressure cylinder, thus causing a greater loss from leakage in the high-pressure than in the low-pressure turbine.

On June 30, at the $2,000,000 plant and dam of the Connecticut River Power Company at Hinsdale, N. H., and Vernon, Vt., current at 75,000 volts was turned on and transmitted over a distance of 53 miles, supplyng motive power in Fitchburg, Worcester, North Adams, Springfield, Clinton, Winchendon and Girdner, Mass. and Lewiston and Manchester Vt., as well as many smaller places for lighting, traction and factory purposes.

Often the question as to whether a building should supply its own light and power and utilize the exhaust steam for heating, or whether it should buy current and in addition spend nearly as much as before for coal for live-steam heating, depends largely upon the possibility of getting all the machinery required into the limited basement space available.—*American Ball Engine Company.*

POWER
AND THE ENGINEER

DEVOTED TO THE GENERATION AND
TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

John A. Hill, Pres. and Treas. Robert McKean, Sec'y.

505 Pearl Street New York
355 Dearborn Street Chicago.
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of Power solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "Powpen," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During* 1908 *we printed and circulated* 1,836,000 *copies of* Power.

*Our circulation for June*, 1909, *was (weekly and monthly)* 186,000.

*July* 6.................. 42,000
*July* 13 .................. 33,000
*July* 20.................. 33,000

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*

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## Don't Stand in Your Own Light

If a man were seen standing with a book in his hand and his back to the only available light, straining his eyes in an attempt to read the text matter in the shadow, the impulse would be to ask why he did not get out of the light so he could see. The same question can be asked of the engineer who believes he has no chance of gaining the confidence of his employer, at least as far as his skill as an engineer goes.

Just why an engineer should assume that his employer will not listen to any proposition is not evident, but a great many have taken the stand that it is useless to suggest improvements, or the adoption of new methods in the steam plant. Such an attitude is next to idiotic, because it places both the engineer and the employer in a position where neither gets an opportunity of showing the other what he can or will do.

The complaint is made by some engineers that they never have a chance to talk matters over with the head members of the firm, owing to the petty jealousies of the minor officials, who either bury their suggestions or take the credit to themselves. These difficulties can be overcome if the proper course is pursued. The reason men are able to hold any position is because they give a reasonable amount of satisfaction; where they do not give satisfaction the position is filled by someone who can. The man who gives more than a reasonable amount of satisfaction need not fear but that his arguments will be listened to, even though they may not be adopted. This kind of men are close to those in authority in their own particular line, and are able to command a larger salary than the man who just slides along on the marginal line between satisfactory and unsatisfactory work. The thing to do is to perform the daily duties with promptness and despatch, and as well as circumstances will permit, and not be afraid of sometimes doing work that perhaps belongs to the other fellow; few have ever died from overwork. In other words, make yourself of such value to your employer that he will believe you are indispensable to him. When that time comes, suggestion and advice will receive the consideration they deserve.

An employer can't be blamed if he does not take notice of his engineer's suggestions at first, even though they may be of great merit. The thing to do is to stop saying and thinking that your suggestions are of no value, but when you have an idea to propose, produce an argument with it to show you know what is to be done, how it is to be done, and, above all, the results to be obtained. An engine was never built in one day, neither can an engineer gain the complete confidence of his employer in so short a time; more likely years. Get out of your own light, and show what you can do!

A boy once said to his father, "I ca run faster than you can." The "old man took little stock in the boast, and to show the boy he did not know what he wa talking about, ran a race and left the bo far in the rear. A few years later th same boast was again made and again th "old man" started in to show the boy h error, but the boy won out and left th "old man" behind. The boy showed th as a runner he had improved; natural the "old man" was satisfied that the b could run the faster and the one proc was enough.

Now the point is this: The first tin you propose to do something, the "ol man" will doubtless have but little fai in your ability, but to try you out wi let you go ahead, and you fall dow Naturally the impression created is not t your advantage, and the probabilities a that another opportunity will not prese itself right away. The "old man" is pe haps satisfied, because his disbelief your ability has been vindicated, and y —you feel humiliated because you did n make good. A wise man never mak the same mistake twice. Therefore, after a failure to make good, the less has been learned, you are really better than before. Then the thing to do is profit by what has happened and ful understand what your next proposition before attempting to put it into executio or, be sure you can run before you ch lenge another to a race.

But, the first essential is to have ide that are good for something, and t can be done only by knowing your su ject and thinking about it.

## Know Your Power Cost

The time is not distant—in fact is he now—when the steam-plant engineer m show that he can operate his power pl as cheaply as the power can be purchas from a central station.

The methods employed by some en neers are obsolete, and the wonder is t the plant owner has stood for such lo methods for so many years. In the av age steam plant, the coal is ordered j in time to secure a fresh supply bef the old order is used up. No record kept as to the amount of water evaporat per pound of coal, the ash contained it, or the cost of evaporating the nec sary water to operate the engine.

The supplies are ordered, paid for a used, no one knows how or by who The engine may be in good order or n not, depending as to whether the engin knows enough about engines to keep th in condition, and has gumption enough do so when they do require adjustme Operating a plant under such conditi is "going it blind," to say the least, and a condition that would not be tolera in any other branch of manufacturing, e cept occasionally, and then it usually ends in bankruptcy.

No sane engineer can expect his employer to put up with such loose methods, for he is constantly being approached by the representative of the central station, and when his interest has become sufficiently aroused, out will come the books which will show the cost of operating the plant, with the chances that the central station will get the business, and out will go the engineer.

It is time for engineers to take notice of the cost of producing power in their plants, or some fine morning they will be found anxiously looking over the want column of the daily papers.

## The Boiler Trust

Early this year a resolution was passed by Congress calling for information as to the cost of installing a plant to construct steam boilers at the Brooklyn navy yard or other suitable location. Constructor Capps, while acting chief of the Bureau of Steam Engineering, said that the plant in the Brooklyn navy yard is now competent to make naval boilers with the exception of the Babcock & Wilcox and the Niclausse types, but that their manufacture would require the installation of special tools and appliances at a cost of upward of a million dollars. He said further that the Babcock & Wilcox Company is willing to furnish the machinery or drawings therefor, but would charge a royalty for the use of their processes, etc., which, with the other expenses, would bring the cost of manufacture by the Government up to the price now paid to that company, about $3.86 a square foot of water-heating surface. It is not denied that this price, which is about three times what boilers for industrial purposes bring, is what is being paid, but it is explained that this is the more complicated and expensive "marine type."

And now comes a letter from the vice-president of the Heine Safety Boiler Company charging that the Babcock & Wilcox Company, having formed a combination with the Aultman & Taylor, the Stirling and the Rust companies, is trying to get a monopoly of the boiler trade of the United States, and that they have managed to have inserted in certain Government specifications for boilers 'a clause stating that "no boilers having stayed surfaces or stay bolts will be considered under this bid," and this in the face of the fact that every locomotive boiler in the world, and most of the marine boilers on the high seas and the lakes and, with few exceptions, all the battleships of the world have boilers with stayed surfaces.

The Mosher Boiler Company has also become active in the matter, has placed a complaint in the hands of Congressman Barchfeld, and it is intimated that complaints will be forthcoming from others who are precluded from bidding under such specifications.

A naval officer familiar with the situation thus described the attitude of the Bureau of Steam Engineering in a recent interview with the editor of POWER: "Our battleships and armored cruisers rarely use anything but a straight-tube boiler, and as a result of experience we have practically adopted the Babcock & Wilcox as our standard for high-powered ships. This was not done until the Niclausse had been given a thorough trial in a number of ships, a trial attended with much expense, I assure you. The only other straight-tube marine boilers that have received recognition by any naval power are the Belleville and the Yarrow. The former we were fortunate enough to steer clear of, thanks to Admiral Melville's firmness in resisting the importunities of the Belleville people at a time when Great Britain and other countries were using it almost to the exclusion of other types. The Yarrow boiler has been used in some of our small vessels, but not in any of the large ones. The fact that Great Britain has, after exhaustive tests, decided upon the Babcock & Wilcox and the Yarrow as the only types for battleships, and this some years after we had adopted the former, would indicate, if our experience did not confirm it, that the judgment of Admiral Melville and his successors was sound. If anything further is needed, the experience of the battleship fleet is the best reply that can be made to the criticism of people who can build a cheaper boiler. I am credibly informed that the repairs to boilers were insignificant upon the return of the fleet.

"It is extremely unfortunate that we have not a competing boiler, for everybody recognizes that criticism of an unpleasant character is invited by sticking to one type, but we do not want to adopt a poorer boiler just for the sake of silencing criticism and at the expense of getting a less efficient ship. We have had no boiler failures, and do not want any.

"As to the charge of the Heine Boiler Company, I feel sure that it required no pressure from anybody to have the clause inserted in the specifications forbidding stayed surfaces. Engineers who have had experience with them know that they are a happy riddance; and if the vice-president of the Heine company knows of *any* battleship in *any* navy, built during the last 15 years, that has water-tube boilers with stayed surfaces, he is in possession of information which the average engineer has failed to note. About twenty years ago, France built one or two ships with Lagrafel-D'Allert boilers, which resemble the Heine, but the experiment was enough—it has not been repeated.

"The navy has been using Mosher boilers in torpedo boats for many years, and also put them in the monitor 'Tallahassee' (ex 'Florida'). Within the last year or two they were put in the 'Nashville' as a substitute for Yarrow boilers, and also in two destroyers built by Cramp. This doesn't look as if the navy department is opposed to the Mosher boiler—in its proper place; but it does not think that place is in a first-class battleship. I am told that the Cramps were so pleased with their Mosher experience that when it came to boilers for two more destroyers they gave the contract elsewhere, although at a higher price.

"We use water-tube boilers of the following types in vessels of different classes: Almy, Normand, Yarrow, Thornycroft, Mosher (two types), Seabury, Fore River, Niclausse and Babcock & Wilcox. We wouldn't think of using some of these in a battleship; neither would we be foolish enough to use a Babcock & Wilcox in a destroyer."

## Keep Right

In looking over the station log book with the chief engineer, a visitor noticed that the average evaporation in the boilers under actual conditions was recorded as being ten pounds of water per pound of coal. As this included all of the coal used in banking fires, getting up steam from cold water when a boiler was put into service after cleaning and after the light Sunday load, he asked, "if you get ten pounds evaporation per pound of coal in everyday practice, what would you get on a test?"

The engineer's reply was characteristic of the man: "I keep the plant under test conditions all of the time from the scales on which the coal is weighed to the last valve in the air pumps." This was no fairy tale but a plain statement of the facts in the case. Being methodical in his habits he had a system of daily reports by which he was able to know from his subordinates and assistants the exact condition of every piece of apparatus in the plant, and matters of upkeep were attended to when they needed attention instead of when they could no longer be used.

"Wherever and whenever you see a head, hit it," was his working motto, and the whole force followed his example. As one result his hands were always free. No difficult or disagreeable piece of work left over for a more convenient season ever claimed his attention when he wanted to talk with a visitor, entertain a salesman or discuss a proposed change or a new installation with the manager.

This engineer's way of doing his work was the foundation on which his success was built, and every man who follows the plan of keeping every piece of machinery in his care in the best working order that is possible within the limits of his ability will be a successful engineer.

# Massachusetts N. A. S. E. Convention

The fourteenth annual convention of the Massachusetts State Association of the National Association of Stationary Engineers was held at Springfield Thursday, Friday and Saturday, July 8, 9 and 10, with headquarters at the Cooley hotel. The meeting proved to be the largest and best ever held in the State, and the "boys" of Massachusetts are justly proud of its unqualified success.

The business sessions were held in Lenox hall, the meeting room of the local association being too small to accommodate the delegates in attendance. The first business meeting was called to order on Friday morning by the chairman of the local committee, W. H. Damon, who introduced Mayor Sanderson, of Springfield, who warmly welcomed the visitors to the city. State Deputy Edward H. Kearney responded for the engineers and paid tribute to the mayor for his kind words and cordial reception. C. H. Ostrander, vice-president of the Connecticut State Association, spoke earnestly in favor of State associations. Past National President P. H. Hogan called State President Ole B. Petersen to the rostrum and presented him a handsome gavel, the gift of the Massachusetts association. Mr. Petersen's speech of acceptance was generously applauded. He then assumed charge of the meeting and the necessary committees were appointed, after which the meeting was adjourned.

MASSACHUSETTS STATE CONVENTION, N. A. S. E., AT SPRINGFIELD, JULY 8-10, 1909

At the Friday afternoon session, the important business of the convention was disposed of with dispatch. The report of the finance committee showed that the State organization is in a most healthy condition financially. The officers elected for the ensuing year were: Ole B. Petersen, past president; Preston F. Tirrell, president; George L. Finch, vice-president; Walter H. Damon, treasurer; James H. Sumner, secretary; A. M. Day, conductor; H. W. Richardson, doorkeeper. The officers were installed by W. J. Reynolds, national vice-president, assisted by Past National Presidents H. E. Stone, P. H. Hogan and T. N. Kelsey. Resolutions were passed upon the deaths of F. H. Boyer and James H. Wittemore. The last thing of the session was the presentation by T. N. Kelsey of a past president's badge to Mr. Petersen.

On Saturday morning a most interesting and instructive lecture was given by F. R. Low, editor of POWER. The display of the supplymen at Graves' hall was excellent, and for its kind the largest ever seen in Massachusetts. The fine exhibition awakened unusual interest, and the two large halls of the building were constantly filled by those interested in the various new devices of the engineering world. Following is the list of exhibitors:

Mechanical Rubber Company, Lunkenheimer Company, Dearborn Drug and Chemical Works, Jenkins Brothers, Hart Packing Company, H. W. Johns-Manville Company, American Oil Company, Garlock Packing Company, Ashton Valve Company, Keystone Lubricating Company, Strong, Carlisle & Hammond Company, Chapman Valve Manufacturing Company, William R. Winn, M. J. O'Malley, Enterprise Rubber Company, Wyckoff & Lloyd Company, Heine Safety Boiler Company, Patterson Lubricating Company, Crosby Steam Gage and Valve Company, Pennsylvania Flexible Metallic Tubing Company, Knowlton Packing Company, Bemis & Call Hardware and Tool Company, Deane Steam Pump Company, Quaker City Rubber Company Monarch Valve Manufacturing Company M. W. Kellogg Company, Holyoke Valv Company, Strong Machinery and Suppl Company, Adam Cook's Sons, Perfectio Grate Company, Mason Regulator Company, W. J. Hyland Company, A. W Chesterton Co., Brewer & Company, McLeod & Henry Company, William G. Starkweather, M. T. Davidson Company Hydro-Palm Soap Company, America Steam Gauge and Valve Manufacturin Company, M. S. Converse Coal Compan Bacon & Donovan Engine Company, American Radiator Company, Williams Gag Company, Philadelphia Grease Manufacturing Company, Feodor Bergma Company, Federal Metallic Packing Com pany, Grip Coupling Company, American Diograph Company, *New England Engineer*, *Practical Engineer* and POWER.

On Friday evening a banquet was held t the Cooley hotel, at which more than hree hundred delegates and guests were resent. Herbert E. Stone was the toastnaster and, after the coffee had been erved, introduced the several speakers, vho gave short, snappy and enjoyable addresses. The speakers included the following: W. J. Reynolds, P. H. Hogan, C. H. Hathaway, F. R. Low, T. N. Kelsey, dward H. Kearney, George L. Finch, William D. McLean, W. H. Damon, Ole 3. Petersen, John A. Sumner, Charles A. Winther.

During the evening "Jack" Armour enertained with songs, stories and recitals, nd the Springfield Male Quartette sang.

On Saturday afternoon, under the leadrship of W. H. Damon and a band of nusic, a march was made to the plant of the United Electric Light Company, of which Mr. Damon is the chief engineer. fter the inspection was completed and a ight lunch partaken of, Mr. Damon was alled to the midst of the company and resented three handsome tokens, a ring, stickpin and sleeve buttons.

The steamboat was then boarded to isit Riverside grove, where a shore linner was served. A feature of the outng was a baseball game between the engineers and supplymen, resulting in a ictory for the engineers by the score of 12 to 8. Mr. Damon and his local committee deserved the many words of praise estowed upon them.

Air admitted freely at firing and for a short period thereafter increases efficiency nd reduces smoke.

## Jersey City Engineers' Blue Club Outing

The Engineers' Blue Club of Jersey City, N. J., held its fourteenth annual outing and field day at Selmer's park, Staten Island, on Sunday, July 11. The event was largely attended and was most enjoyable. There were present many prominent officials of Jersey City.

After a hearty breakfast, the baseball game, which had been arranged between the members of the Blue Club and the "Bunch," was played, the "Bunch" winning by the score of 13 to 4. John Callahan gave universal satisfaction in the capacity of umpire.

There were races and games of all kinds, the winner of each event being presented a very handsome prize.

Refreshments were constantly on tap, and the day's festivities came to a happy ending with the serving of an appetizing dinner.

The group photograph was taken by B. H. Nensel.

ENGINEERS' BLUE CLUB OUTING AT STATEN ISLAND, N. Y., SUNDAY, JULY 11, 1909

## Obituary

Egbert Pomeroy Watson, with whose writings most of us are undoubtedly familiar, died on June 22, from a stroke of paralysis with which he was stricken early in September last. Mr. Watson was born April 17, 1835, in New York City, and was educated in the New York public schools and at a private boarding school in Connecticut, where he spent about three years. At the age of 15 he was apprenticed to the then largest marine-engine works in the country, where he remained for three years, and then went to Lowell, Mass., working there in a locomotive shop for two years. The shop closing permanently, Mr. Watson went to Detroit, Mich., where he found employment on the Michigan Central railroad, leaving there to run on the Great Lakes as a marine engineer. After a few years he returned to New York and went to work in the old Novelty Iron Works as a lathe hand, and while in this position was surprised to receive a call to become one of the editors of the *Scientific American*, with which he remained for five years.

In 1881, Mr. Watson founded the *Mechanical Engineer*, which he successfully conducted for 16 years and then disposed of it to younger men. Mr. Watson wrote several books on mechanical subjects and among his publications are: "Modern Practice of American Machinists and Engineers" (1868), "How to Run Engines and Boilers" (1899), "Small Engines and Boilers" (1899), "Manual of the Hand Lathe," "The Professor in the Machine Shop," etc. During his later years, Mr. Watson occupied himself by contributing to various periodicals of the day. He was a member of the Marine Engineers and Naval Architects Association and a past vice-president of the National Association of Marine Engineers.

In the article by A. L. Hodges, page 926, May 25 number, a correspondent calls attention to an error which appeared in the illustration and also in the reading matter. The point at which the reading of the absolute scale equals that of the Fahrenheit scale is not 540.25 degrees, as given, but instead 574.25.

# Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

## The Eureka Automatic Water Softener and Purifier

The Eureka automatic water softener and purifier, made by the Dodge Manufacturing Company, of Mishawaka, Ind., may be characterized as a saturated limewater machine, as distinguished from the so-called milk-of lime apparatus, in which the lime is added without being entirely dissolved before coming in contact with the water which it is desired to purify. The device consists of two portions: a large vertical decanting tank in which the reactions take place, and a smaller, or lime-saturating tank, where some of the water is prepared before passing to the main tank. A sectional elevation, which will aid in explaining its operation, is shown in Fig. 1.

Water, furnished either by gravity or under pressure, first enters the top of the small sheet-iron tank *A*. The water is here maintained at a constant level by means of a float and, falling through a weir, revolves on a small gravity water wheel which furnishes the necessary power to operate the apparatus. A definite portion of the incoming water is deflected through the pipe *B* into the lime-mixing tank *C*.

The vertical shaft of this mixing tank is hollow, and a predetermined portion of the incoming crude water passes to the bottom of the tank, turns upward and is mixed, by the stirring arms on the lower part of the vertical shaft, with the hydrated lime which descends by gravity from the lime basket *O* in the top of the tank. In thus passing through this part of the apparatus, there is formed a saturated lime solution which is used as a reagent farther on in the softener. Bicarbonates of calcium and magnesium are two of the principal scale forming materials found in feed water, and these are precipitated by the saturated-lime solution.

The bicarbonates are held in solution by carbonic-acid gas, and upon adding lime solution the soluble bicarbonates are converted into carbonates which, being insoluble, are precipitated. The main body of water falls to the bottom of the container *A* passes out into a trough and discharges into the central tube *D*. It will be noticed that the overflow *X* from the lime saturater also leads into this trough, causing the limewater thoroughly to mix with the raw water. The tank *K* contains a solution of soda ash, which is the other reagent ordinarily used in the apparatus. This is introduced into the incoming water in accurately measured quantities, according to the volume being used. In the sectional drawing is shown a float *H* connected with an arm in the trough through which the water enters. This float is raised or lowered in direct proportion to the quantity of water used, and thus introduces a greater or smaller amount of the soda solution.

Another float *F* has connected to it a rubber tube leading down to the valve

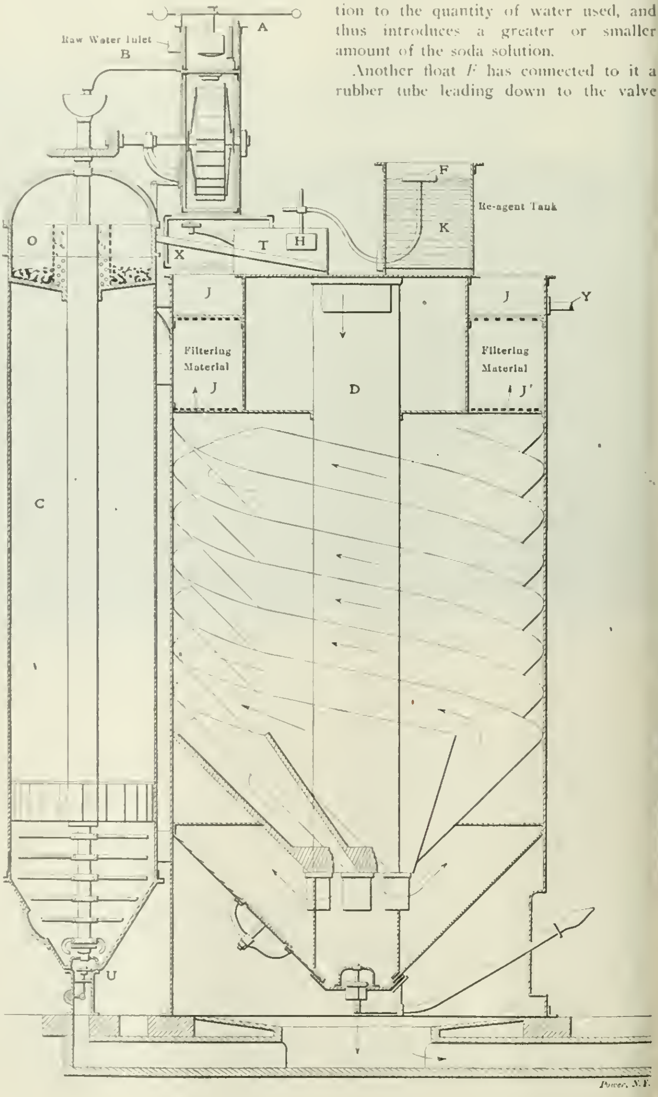


FIG. 1. SECTIONAL VIEW OF "EUREKA" AUTOMATIC WATER SOFTENER

through which the solution is introduced into the main current of water, so that any given opening in the valve will give practically uniform results regardless of the head of solution in the tank *K*. Sulphates when present in feed water form a hard scale, and it is for removing these that the soda-ash solution is used. Soda ash has the formula $Na_2Co_3$, and combining with calcium and magnesium sulphates forms sodium sulphate, and the carbonates of calcium and magnesium, which are insoluble, are precipitated. Sodium sulphate is infinitely soluble in water and does not make scale, its only disadvantage being that when present in a concentrated solution, it is liable to cause foaming; therefore, an occasional blowing out of the boilers is necessary to reduce the density of the sodium-sulphate solution.

Immediately upon the commingling of the reagents with the crude water, the chemical reaction sets in, the mixture usually assuming a milky appearance, according to the amount of impurities present. In Fig. 1 is shown the center tube *D* in which the reaction takes place and which extends down nearly to the bottom of the apparatus. After passing from the bottom of this tube the water and suspended precipitants pass spirally among the slanting settling plates as indicated. The cross-section of water here is relatively large, the velocity is greatly lessened and the scale-forming material has ample opportunity to be deposited in flakes which gravitate to the conical bottom of the main tank, whence they may be passed off into the sewer by occasionally opening the valve at the bottom.

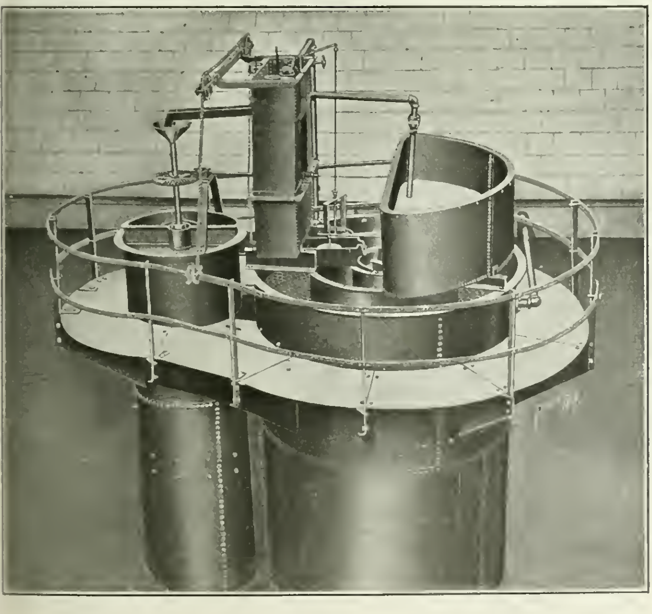
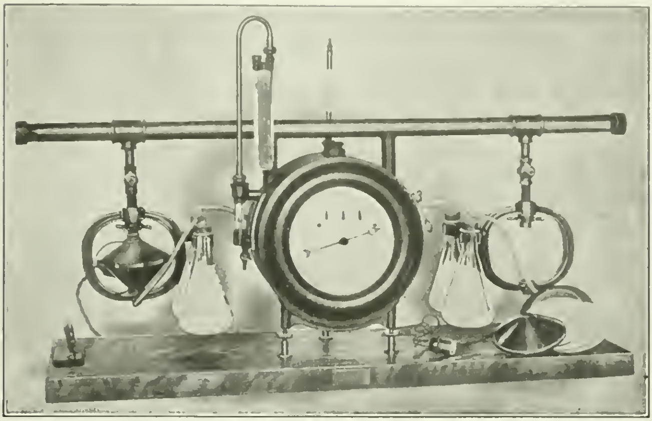


FIG. 2. TOP OF "EUREKA" WATER SOFTENER, SHOWING DETAILS OF MECHANISM

The water, continuing upward, passes through the perforated diaphragms *J* and *I* between which is placed filtering material to arrest any suspended matter which may have escaped settling on the conical plates. The purified water is then drawn off through the pipe *Y* as needed. The apparatus is full of water at all times, and when the purified water is drawn off it lowers the level of the water in the decanting tank and opens the water supply through a float valve. Fig. 2 shows the location of the float and other principal details of the assembled mechanism. In operation it is automatic, requiring no attention whatever except the daily charging of reagents and blowing off by opening sludge valves to remove precipitated impurities in the lime tank and decanter. Where the water has suspended impurities, such as animal or vegetable matter, silica, etc., other reagents are added, when needed, in addition to the ordinary ones.



SARGENT GAS DUST DETERMINATOR

## Sargent Gas Dust Determinator

An instrument known as the Sargent gas-dust determinator, the purpose of which is to determine the amount of dust, tar or moisture in gas, has recently been put upon the market by the Sargent Steam Meter Company, 271 to 285 East Madison street, Chicago, Ill.

When desiring to make a test, a filter paper which has been perfectly dried and weighed is placed in the cone-shaped holder on each side of the gas meter. A small incandescent lamp is fastened in the lower half of each cone and is kept lighted while gas is passing through the filter paper. This lamp keeps the filter paper dry, so that any moisture in the gas may pass on to be absorbed by the calcium chloride, which is contained in flasks and is connected with the discharge of the filter. From these flasks the gas passes through the meter to a calorimeter, gas-analyzing apparatus or into the atmosphere. Generally from 3 to 5 cubic feet of gas is allowed to pass through the meter for each determination and while this is in progress the filter holder on one side of the meter may be thrown into commission as soon as the other is shut off. The stop cock above the filter holder and the cock back of the meter are used to change the flow of gas from one filter to the other. After a known quantity of gas has passed through a filter holder, a differential screw at the top is loosened and the cone containing the filter paper is removed, taken to a laboratory and the filter paper taken out and weighed. The difference between this weight and the weight of the filter paper determined before testing divided by the number of cubic feet passed through gives the amount of dust or tar per cubic foot of metered gas.

A similar increase in the weight of the calcium-chloride glass after a known quantity of gas has passed through divided by the number of cubic feet metered gives the amount of moisture per cubic feet of gas.

## Business Items

The American Pulley Company, of Philadelphia, has leased the store at 139 South Clinton street, Chicago, Ill., and carries there a complete assortment of its wrought-steel belt pulleys and sash pulleys.

The Harrisburg Foundry and Machine Works has appointed F. W. Jackson, who has been connected with its engineering and sales departments a number of years, district manager of the Baltimore (Md.) district, with headquarters at 1415 Continental Trust building.

R. L. Baker, who has been recently connected with the department of experimental engineering, of the University of Wisconsin, of which he is also a graduate, has entered the services of A. Bement, consulting engineer, Fisher building, Chicago, Ill.

John Stevens, consulting engineer, announces that he has opened offices at 107 Merrimack street, Lowell, Mass., and will give especial attention to power and industrial plants. He is a member of the A. S. M. E., A. S. N. A. and M. E., National Association of Cotton Manufacturers and the Massachusetts Board of Boiler Rules.

August Kittleberger, who, for the past 15 years has been associated with the Clayton Air Compressor Works, has been engaged by the American Air Compressor Works, as superintendent of its plant in Brooklyn, N. Y. Mr. Kittleberger has had wide experience in the construction of air compressors and vacuum pumps.

The Ball Engine Company, of Erie, Penn., has just issued a new catalog, "P," treating of its single-valve automatic and Corliss engines, with nondetaching valve gear. The catalog contains 40 pages, 10x7, and besides describing and illustrating these engines, six full-page illustrations of typical installations enhance the value and attractiveness of the work.

The International Acheson Graphite Company, of Niagara Falls, N. Y., has just issued a new folder descriptive of its various products, which include electrodes, dry battery filler, paint pigment, electrotyping leads, graphite for lead pencils, firearms lubrication, general lubrication, and a superior line of graphited greases. The folder, 295 B, is handsomely printed in two colors, and will be sent on request.

The American Steam Gauge and Valve Manufacturing Company has received from the Newport News Shipbuilding and Dry Dock Company an order for eight Government composition triplex safety valves for the torpedo-boat destroyers, "Roe" and "Terry." A similar order has been received from the William Cramp & Sons Ship and Engine Building Company, for eight triplex valves for torpedo-boat destroyers Nos. 30 and 31.

The H. W. Johns-Manville Company, New York, has taken the selling agency in the United States and Canada for the products of the American Hair Felt Company, which includes hair felt for all purposes. Baeder, Adamson & Company, Philadelphia, Penn., have discontinued the sale of hair felt. Henry J. Bellman, who, for many years, was connected with that branch of their business, has been appointed manager of the hair-felt department of the H. W. Johns-Manville Company, with headquarters at 100 William street, New York.

The William B. Scaife & Sons Company, Pittsburg, Penn., manufacturer of the Scaife and "We-Fu-Go" water-softening, purifying and filter systems, has completed an addition to its present plant at Oakmont, Penn., to accommodate its increased business in the building of systems for the purification of water for steam boilers, industrial and domestic uses. The investigation on the part of manufacturers using steam boilers and water in industrial processes has meant a continued increase in the number of "We-Fu-Go" and Scaife water-purifying systems installed.

The E. Keeler Company has been awarded the contract by the United States Government for boilers for three separate electrical installations at Pacific-coast fortifications. There will be two 100-horsepower water-tube boilers for Fort Stephens, Ore., at the mouth of the Columbia river, about one hundred and ten miles west of Portland; two 150-horsepower at Fort Casey on Puget sound, about forty miles north of Seattle, and two 200-horsepower at Fort Scott, for the Presidio, which adjoins the city of San Francisco, Cal. This contract was awarded after careful examination of the details of the equipment offered and a thorough investigation of the service rendered by boilers already in operation on the Pacific coast, using California oil as fuel.

The business of the Wisconsin Engine Company, at Corliss, Wis., continues to increase and they report orders for this week for five more engines. One order covers two standard-speed, horizontal, cross-compound, heavy-duty Corliss engines, each of 1200 horsepower and direct-connected to 800-kilowatt direct-current generators. They will be installed in the central power plant of the Oliver estate, at Pittsburg, completing the layout of engine room No. 1. Another order (constituting the fourth order from the Oliver estate) covers two simple heavy-duty Corliss engines of the Wisconsin Engine Company's higher-speed type. Each develops 600 horsepower and is direct-connected to a 400-kilowatt direct current generator. The J. F. McMillan Company, of St. Paul, Minn., has also ordered one of these higher-speed Corliss engines for direct-connected service to furnish power for the remodeled electric-transmission system now being installed.

The Trimont Manufacturing Company, of 55 Amory street, Roxbury, Mass., has for over 20 years been developing its line of wrenches. The "Trimo" wrenches consist of five distinct types, all manufactured under the trade mark "Trimo." They are as follows: Pipe wrench, monkey wrench, chain wrench, basin wrench and narrow-jaw automobile wrench. These, with the "Trimo" pipe cutter, comprise the output of this important industry. Each wrench manufactured by the company is interchangeable in all its parts, so that each part can be easily replaced when worn, guaranteeing to the user of wrenches a large saving of money. The handles and jaws of all these wrenches are made of drop-forged steel and are paneled in the forging, so that the handles combine both lightness and strength as prominent features. Upon that part of the handle nearest the frame a lug is formed which protects the spring and acts as a reinforcement to that part where the greatest strength is required. The threads in the movable jaw and nut are rounded, thus preventing the threads in these parts from stripping or burring.

## Help Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

WANTED—A good live agent in every shop or factory in the U. S., to sell one of the best known preparations for removing grease and grime from the hands without injury to the skin. Absolutely guaranteed. An agent can make from $5.00 to $25.00 over and above his regular salary. This is no fake. Write for free sample and agents' terms. The Klenzola Co., Erie, Pa.

WANTED—Young man, graduate in mechanical engineering, with one or two years' practical experience in combustion, to take charge of lime kilns. Plant located 25 miles from Philadelphia. State age, training and experience. Charles Warner Co., Wilmington, Del.

WANTED—Experienced draftsman on steam piping, building construction and power plant design. State experience, salary expected, and give references. Address Construction Dep't. Consolidated Gas, Electric Light & Power Company, Lexington and Liberty streets, Baltimore Md.

MASTER MECHANIC for large pumping station; must be first-class machinist and familiar with water tube boilers and Corliss engines. Apply by letter giving age, education and experience. Box 74, POWER.

WANTED—By a leading casualty company technically educated men with practical experience in mechanical lines, for positions in inspection department. Reply fully, stating experience, references, salary expected, etc., to Box 72, POWER.

## Situations Wanted

*Advertisements under this head are inserte for 25 cents per line. About six words mak a line.*

MECHANICAL ENGINEER, graduate, wit several years' experience in general machinery gas engines, automobiles and pumping machin ery, desires responsible position. Age 28. Bo 70, POWER.

CHIEF ENGINEER, accustomed to th operation of large industrial, electrical powe plants, and capable of producing results, woul like to connect with a concern which desire a first-class man. Box 73, POWER.

WANTED—Position as electrician, 29 year of age; 12 years' experience as machinist an electrician. Can give good results. Married sober; like to change place. "J. A. L.," Bo 75, POWER.

ENGINEER, married, 35 years' experienc with stationary and locomotive engines, desire position. Address F. H. Van Noye, 51 Centra Ave., Jersey City, N. J.

## Miscellaneous

*Advertisements under this head are inserte for 25 cents per line. About six words mak a line.*

PATENTS secured promptly in the Unite States and foreign countries. Pamphlet o instructions sent free upon request. C. I Parker, Ex-examiner, U. S. Patent Office McGill Bldg., Washington, D. C.

ANY FIRM or engineer in charge of a stean plant that are troubled with scale in their boiler can get absolutely free, the best indicator an reducing wheel made, with velvet-lined mahogan case. For particulars address Great Lake Chemical Works, Manitowoc, Wis.

CARD PUNCHING MACHINES; POSTPONEMENT OF OPENING OF BIDS.—Th time for the opening of bids for furnishing al the labor, materials and work necessary for th construction in lots of 100, 150, 200, 250 o 500 automatic card punching machines an delivering the same complete, free of charg for transportation, at the Census building

# Plant of the Commonwealth Power Company

## Superheated Steam for Reciprocating Engines, a Novel Feed Water Heater and an Oiling System Unusually Complete in Its Appointments

BY OSBORN MONNETT

In the business district of Milwaukee there are a number of office buildings, theaters and business blocks owned by the Schlitz and allied interests, the lighting and heating of which have been maintained by a number of isolated plants. As the number of buildings increased, these plants became inadequate, and when the Majestic theater building, which is the last and largest property to be added to the holdings, was projected, it was deemed advisable to work out some plan by which relief could be obtained from the existing power conditions, and the service improved. The matter was placed in the hands of the Power Improvement Company, consulting engineers, and a solution of the difficulties was finally evolved in the shape of a central station with which to supply all the lighting and power for the different buildings, the new plant to be favorably situated as to water and fuel and to deliver its output as high-tension current to substations in the heart of the city for local distribution.

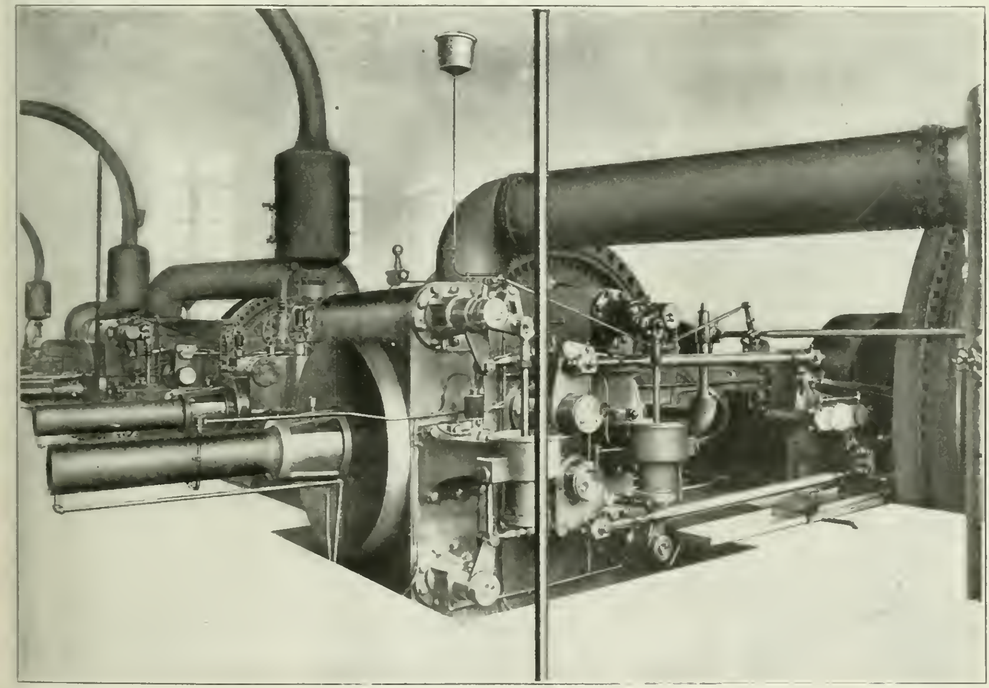


FIG. 1. STEAM END OF GENERATING UNITS

In working out this arrangement the further decision to furnish all the power for the Schlitz brewery greatly improved matters from an operating standpoint, so that when all necessary transformations which are now in progress have been made the load factor should be remarkably high, resulting in correspondingly low operating cost and investment charges, considering the service rendered. Theoretically this will work out somewhat as follows: Beginning with the day power load, the demand will be fairly heavy and constant from the brewery, and in the afternoon the matinee theater lighting will increase the load factor. About the time the day power load drops off, the office building lighting will come on, and in the evening the regular theater lighting service will take current until a late hour. Some elevator and power load will also be supplied to the downtown buildings. Working in this manner the plant will operate under exceptionally favorable circumstances, aided to no little extent by the synchronous motor generator sets in one of the substations, with their beneficial effect on the power factor. All these things taken together demonstrate the wisdom of a central generating plant displacing the several small, uneconomical, overcrowded ones formerly used. Considerable boiler capacity is retained in the substation at the Alhambra theater building, and will be used to furnish steam for heating purposes in the brewery as previously noted.

### COAL HANDLING FACILITIES

Located on the Milwaukee river at the Holton street crossing, the power plant is about [illegible] miles from the [illegible] brewery with the [illegible] between. It consists of a [illegible] steel and brick structure, Fig. 8, approximately 110 feet square and divided by a fire wall into boiler and engine rooms. Adjacent to the plant is the main coal yard for the brewery and other interests requiring fuel, and coal for power purposes is delivered to the furnaces without having to be handled by hand. The coal is carefully selected West Virginia mine-run bituminous. It is unloaded by means of electrically operated grab buckets and Gantry cranes, from the boats in which it has been transported from the lower lake ports, and stored in the yard which has a capacity of some 10,000 tons. That portion of the coal which is diverted to the power house, however, consists of screenings, these being separated when dumping the coal from the grab buckets into storage, the screenings being collected in a hopper discharging onto a Robins belt conveyer which extends along the dock line for a distance of several hundred feet to the power house. This is shown in Fig. 8 terminating in a hopper or chute leading to the power-house basement. Inside the plant the lofty ceilings and large windows for light and ventilation give a comfortable, roomy effect, pleasing to the visitor, and which will be appreciated by the attendants in warm weather.

A Webster bucket conveyer transfers the coal to individual steel hoppers, one of which is placed in front of each of the four 500-horsepower Edge Moor boilers installed. Each hopper will hold 38 tons of coal and has an Avery coal-weighing device attached for keeping track of the fuel consumption.

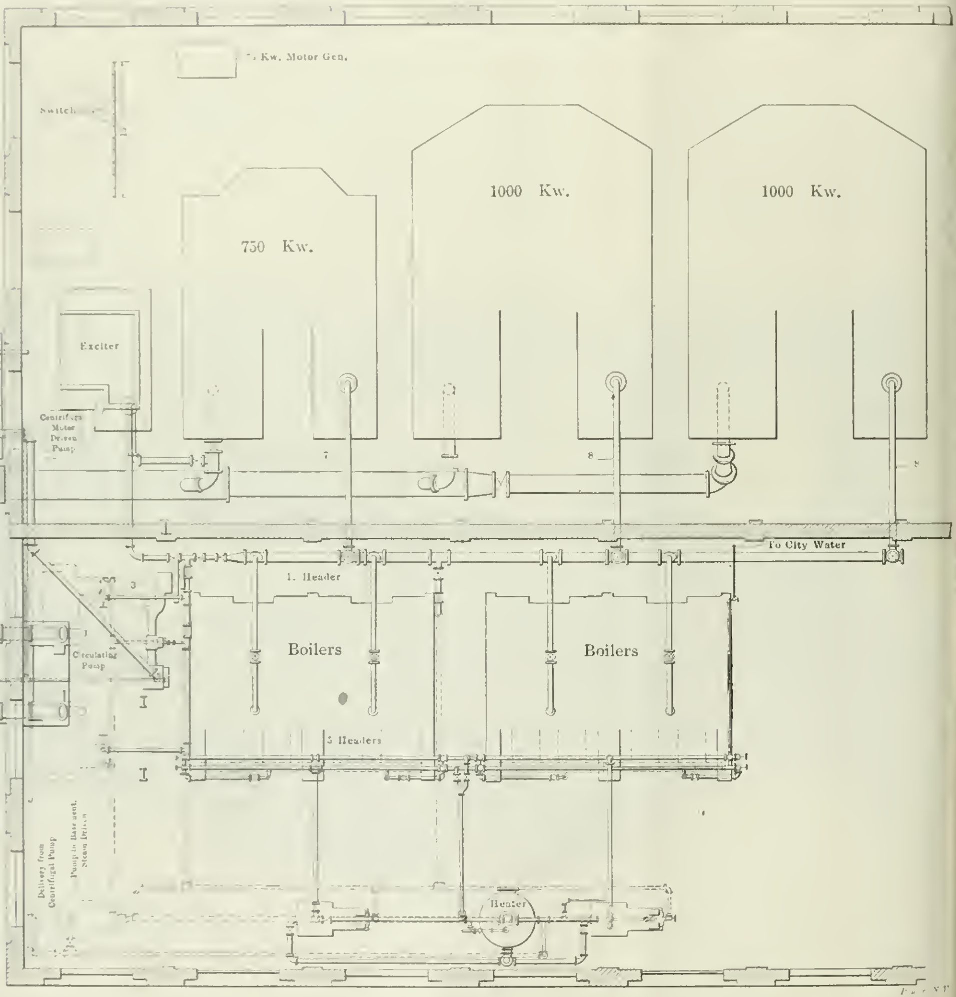


FIG. 2. GENERAL PLAN OF STATION

### SPECIAL FURNACE CONSTRUCTION

The boilers are divided into batterie of two each, with space for another ba tery of the same size, and are fitted wit improved Roney stokers. In the settin as shown in Fig. 4, the boilers and fu naces have been treated as separate an distinct institutions and illustrate tl modern tendency in this directio

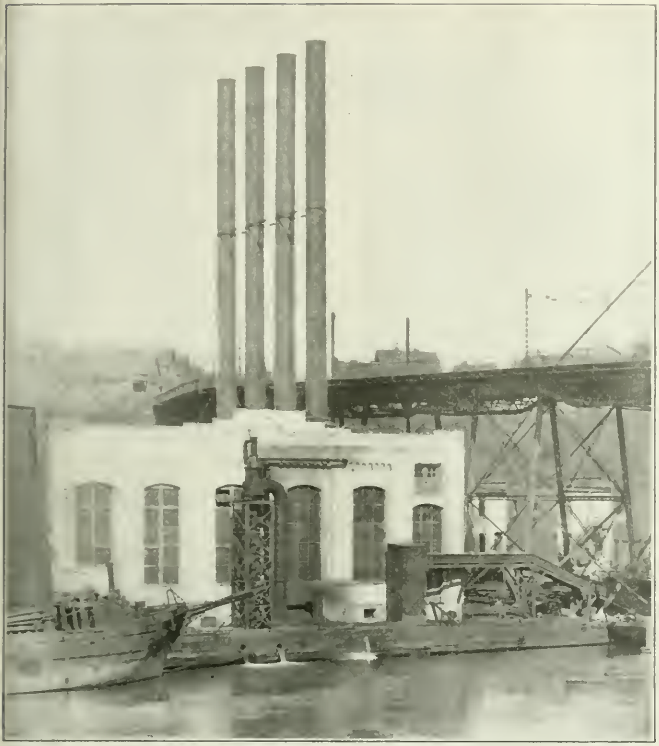


FIG. 8. EXTERIOR OF POWER HOUSE SHOWING CONDENSER AND COAL CONVEYER

Covered with a roof of fire tile supported from the lower row of boiler tubes, the combustion chamber extends nearly the full length of the boiler, and with the brick side walls forms the furnace in which complete combustion is secured before the gases come in contact with the heating surface. On the brickwork, which extends some 5 feet above the floor, rests the boiler, lagged with vitrified clay and block asbestos alternating with air spaces. Gases pass three times through the bank of tubes, encountering after the first pass the Foster superheater, as shown. Steel stacks, 5 feet in diameter by 145 feet high, are provided for each boiler, and rest on the boiler itself, being supported by guy wires on the outside. Each stack has ladder steps permanently riveted to the shell all the way to the top.

Steam is taken from the top of the rear boiler manifolds, passes down through the superheater and up through 6-inch long-radius connections into the top of the main steam header. At the apex of these vertical sweeps are located G. M. Davis non-return valves, being so situated that when closed condensation may fall away in either direction. The header is 12 inches in diameter and although around 100 degrees of superheat is carried, precautions are taken to drain out any condensation through traps. All high-pressure piping has Crane Best oxygen-acetylene blowpipe welded flange joints made up with Wilcox self-sealing gaskets.

Branches to the engine are tapped off from the top of the header and come

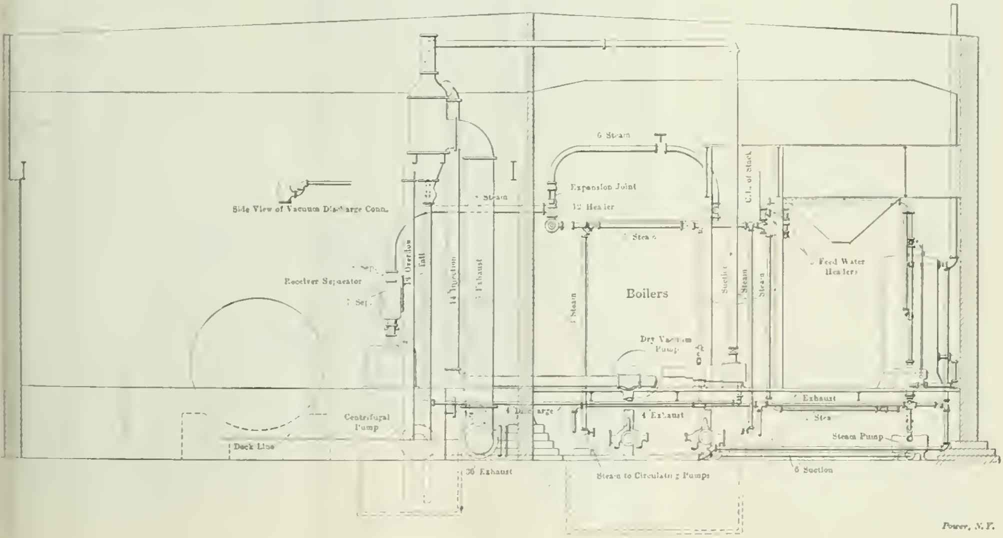
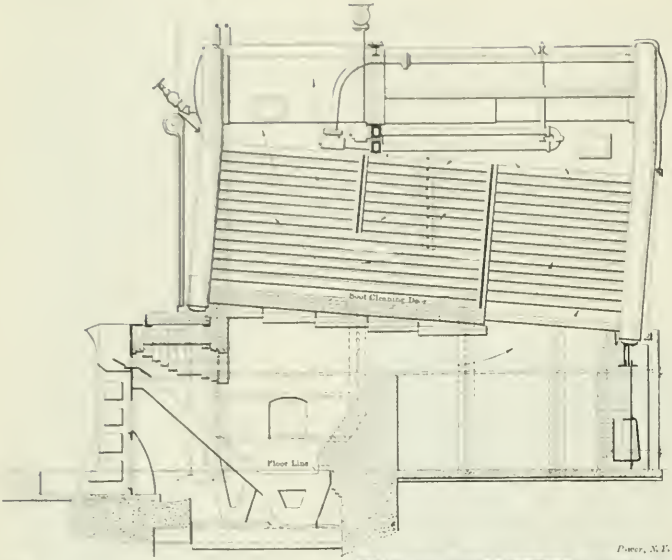


FIG. 3. SECTIONAL ELEVATION THROUGH STATION



Power, N.Y.

FIG. 4. LONGITUDINAL SECTION THROUGH BOILER SETTING

down overhead to the throttles through Crane receiver separators. One of the features of the boiler room is found in the convenient iron grating runways which are so located as to make the piping, coal conveyer and weighing apparatus accessible to the operators.

Feed water is ordinarily taken from the condenser hotwell by a service pump in the basement and delivered to the heater. As all auxiliaries, except one exciter set, are steam-driven, there is always an abundance of exhaust steam for maintaining a proper feed-water temperature. From the heater, either one of two Prescott feed pumps delivers the water to a duplicate feed header laying over the boilers with suitable branches to each. These pumps are of the outside center-packed type with brass plungers and 10x6x12-inch cylinders. A connection direct to the river for feed water is also provided on the service pump, and as a further precaution city water is piped to the heater, as shown in Fig. 2.

### Feed-water Heater of Novel Design

In front of the boilers in Fig. 5 will be noticed the feed-water heater. It is a combination open and closed heater, purifier and filter, made in Milwaukee by John Dodge. As it has several unique features and has never been described, its construction will undoubtedly be of interest. Referring to Fig. 7, which is a sectional view of the heater, the principal characteristics are easily seen. It is rated at 2500 horsepower and consists essentially of a vertical cylinder of boiler plate 6 feet in diameter by 14 feet high. Exhaust steam enters at the bottom, passes through the oil separator and mingles with the incoming water on the circular pans in the upper part of the heater, passing out on one side at the top. As shown by the arrows the water passes upward through the quartz sand filter in the lower chamber, and is forced by the feed pump into the pressure filter chamber which itself is surrounded by exhaust steam. Passing downward through this filter the water goes to the boilers. On opening the blowoff *X*, the lower filter bed is flushed in a direction opposite to that of the filtering action. Similarly, when the gage *Y* shows that the pressure filter has become foul, it may be blown out in an upward direction with boiler pressure by opening valve *A*. If it becomes necessary to clean the upper filter, the chamber can be bypassed, the top may be removed without breaking any joints and the filter cleaned, during which time the rest of the apparatus is in operation as an ordinary open heater.

It will be noted that the overflow *E* runs into the oil-extractor drip pipe. Thus when the heater overflows it flushes this

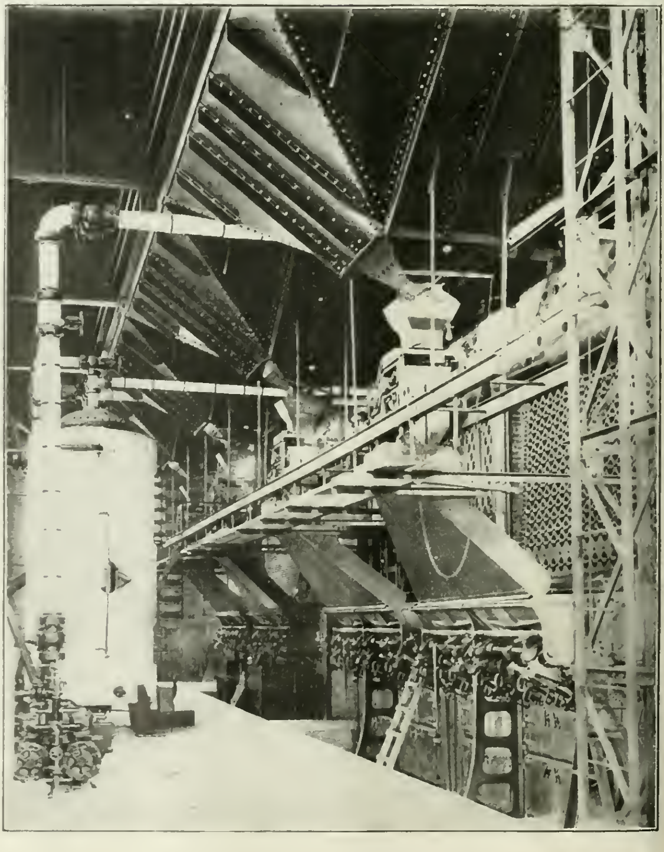


FIG. 5. VIEW IN BOILER ROOM

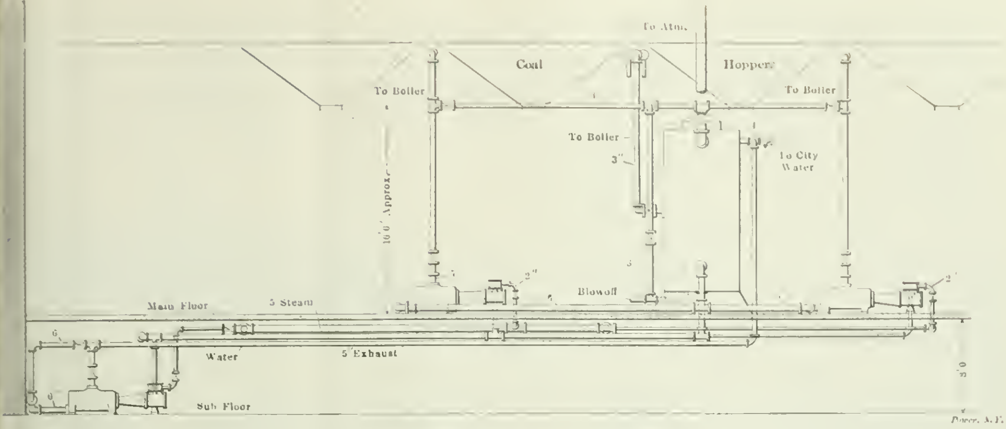


FIG. 6. ELEVATION OF PUMP AND HEATER PIPING

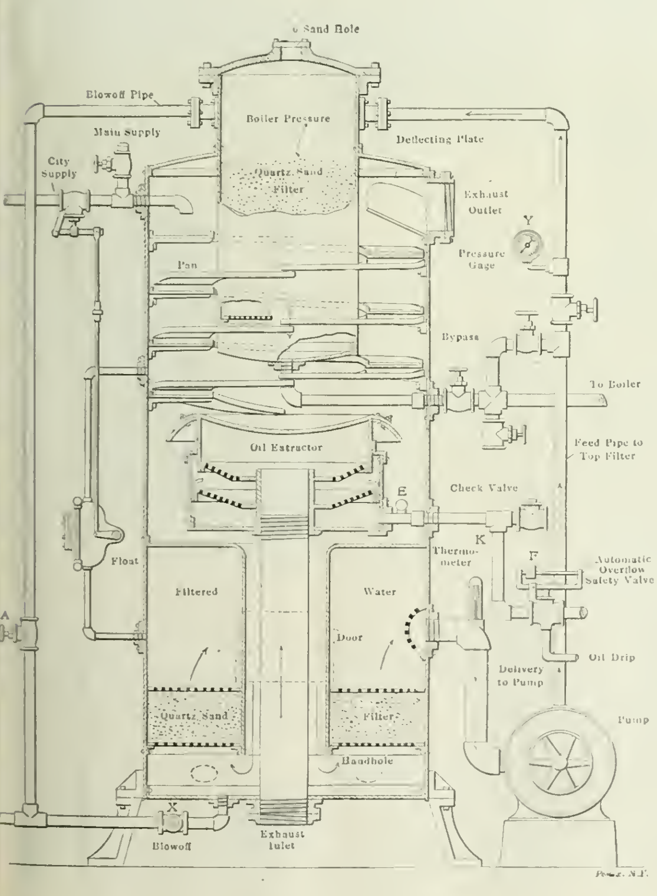


FIG. 7. FEED-WATER HEATER IN SECTION

pipe with hot water. An automatic valve *F* on the oil drain traps the steam, but allows water of condensation in the pipe *K* to pass to the sewer. To allow for different back pressures which it may be desired to carry on the exhaust system, a graduated arm and sliding weight are provided. One of the features of the heater is that the incoming exhaust steam has to pass up through the main body of water, thus reducing the tendency for it to cool off after passing over the pans.

### THE ENGINES

Here the smooth cement walls as well as the ceiling are painted a dark yellow, while the concrete floor is done in brown. Spanning the room is an electrically operated traveling crane controlled from the floor by pendants, making it a simple matter to handle any piece of apparatus. Three main generating units are installed, two of 1000 kilowatts capacity, with 24x52x48-inch cylinders, and one 20x40x36-inch unit rated at 750 kilowatts. They all consist of Allis Chalmers cross-compound engines and three phase revolving-field generators, the engines being guaranted to operate satisfactorily with superheat of 70 degrees at the throttle. In construction the engines do not differ from the standard Corliss design made by this company, no special feature of valve gear or other details being considered necessary to take care of this amount of superheat. They are of the heavy duty type with two eccentrics, and it will be noted that each cylinder is fitted with a tail rod.

### OILING SYSTEM UNUSUALLY COMPLETE

An oiling system especially complete in its appointments has been installed. It is known as the Morris two-batch gravity system, and has for its distinguishing feature the fact that two lots of oil are used, one being at rest and precipitating the fine

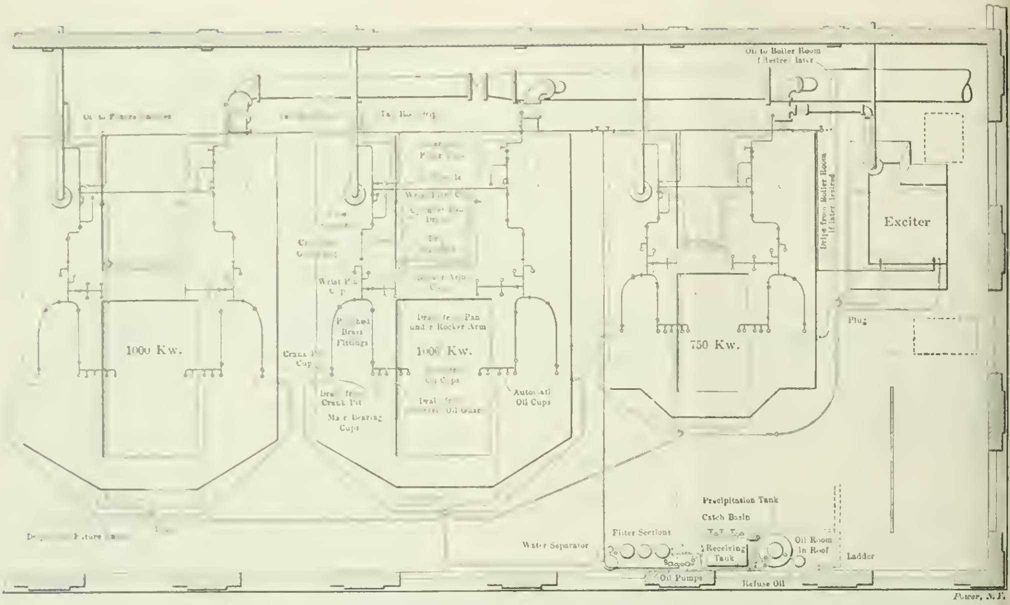


FIG. 9. PLAN VIEW OF OILING SYSTEM

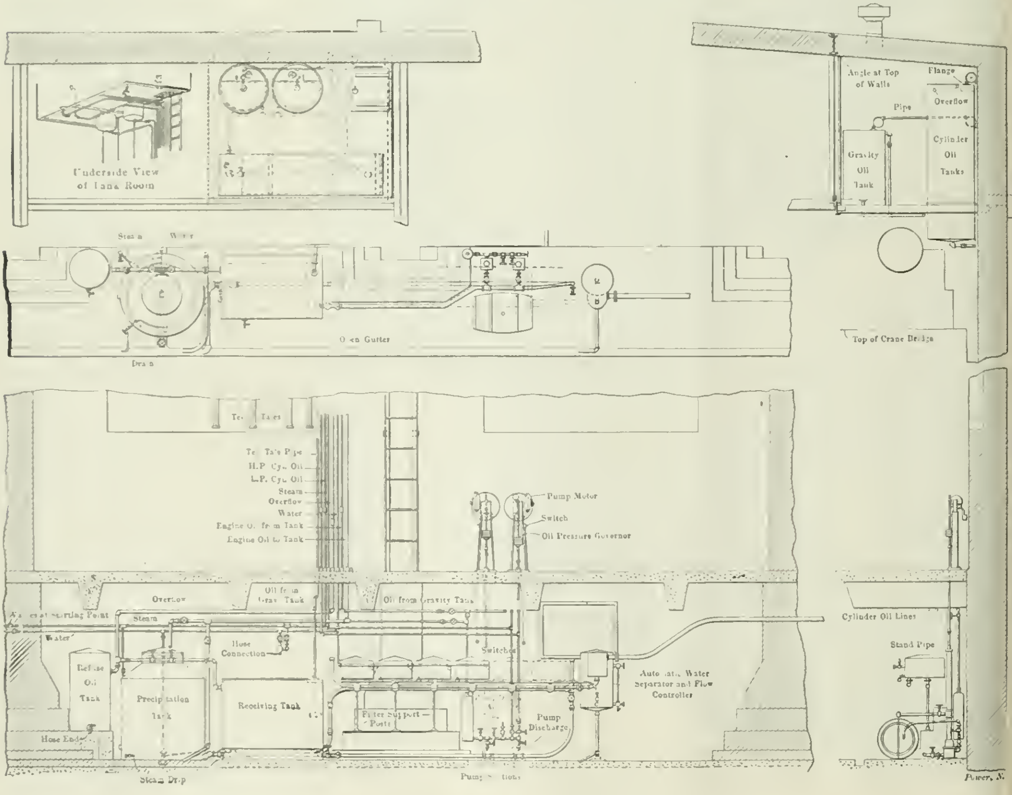


FIG. 10. DETAILS OF OILING SYSTEM

impurities that the filter is unable to remove, while the other is in use passing through the filter in the ordinary manner. In this particular installation approximately 275 gallons of oil are in circulation in the system, with an equal amount being purified by precipitation while being held in reserve. The essential elements of the system consist of an elevated gravity tank from which the oil flows to the engines, a separator to take out water, a fine-mesh brass-wire screen for removing the coarser impurities, the filters, a receiving tank and oil pumps. These latter are of novel design, consisting of vertical single-acting weighted plunger pumps driven by electric motors. The upper pump pedestals are shown in Fig. 12 and the lower part of the pumps can be seen in the view of the equipment in the basement, Fig. 11. Each pump has an individual electric motor which, when the pump is in service, runs constantly, driving by worm gear a disk and connecting rod attachment by which the plunger and weights are lifted. Gravity then causes the plunger to descend pumping the oil. It is evident that the lifting arrangement works full stroke at every revolution but the plunger has only to be raised that portion of its downward stroke which has been completed and which depends on the amount of oil being used.

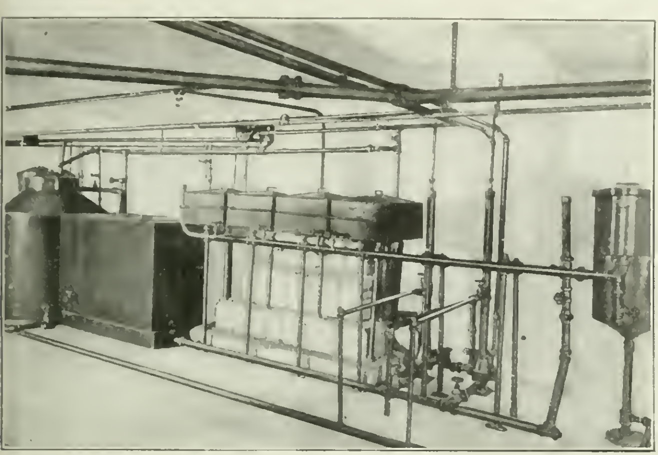


FIG. 11. TANKS, FILTERS AND OTHER EQUIPMENT OF OILING SYSTEM

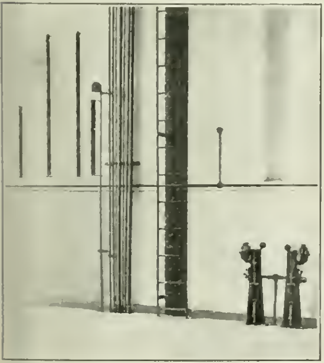


FIG. 12. OIL PUMP PEDESTALS AND TELLTALES

The advantages of this system as installed are due to the fact that the two batches of oil may be changed and each element cleansed while the plant is in operation, without interrupting the oil supply, and being able to purify the dirty oil so that when needed back in the system it is practically as good as new.

When it is desired to change the oils, the contents of the receiving tank is pumped to the gravity tank and the pump is connected to the filter discharge direct. Then the receiving tank is thoroughly cleaned with a special hot-water scrub brush with hose connection, furnished with the system. Clean oil in the precipitating tank is then raised and pushed into the receiving tank by water under low pressure, and the precipitating tank is cleaned, after which the dirty oil coming from the gravity tank by way of the engine drains is turned into it direct, and the system is allowed to run without the pumps. Meanwhile, the water separator and drip lines are being cleaned; the wash water, oil, dirt, etc., being allowed to flow to the precipitating tank. When the gravity tank is empty it is by-passed by suitable valves. The pumps are put on the system direct and draw from the clean oil in the receiving tank, the oil returning through the separator and filters back to the receiving tank. The special accumulator type of pump permits the maintenance of pressure without the use of the gravity tank. When the cleaning of the upper tank is completed, the pumps may be turned into this tank and the sytem returns to gravity feed of clarified oil. All the elements have been cleaned without interruption of the service, and the dirty oil may be safely stowed away for purification.

As to the filters themselves, they are of the charcoal type in four units connected in multiple so that they may be cleaned one at a time at leisure. In designing the system the three main tanks were made of the same capacity and slightly greater in volume than either batch of oil, so that when emptying from one to another there is never any danger of running the oil over. All details of the oil piping system have been worked out so that the different leads can be easily cleaned of obstructions. Fig. 9 indicates the location of the piping as applied to the different engines. It will be noticed that the drains for each unit concentrate in one drip manifold and that there are no elbows or sharp turns in the system, so that the runs of piping are accessible with a flexible wire, without breaking any joints or interfering with operation. Morris patent automatic oil cups or outlets are used wherever necessary and Nugent telescopic oilers are provided on eccentrics and pins.

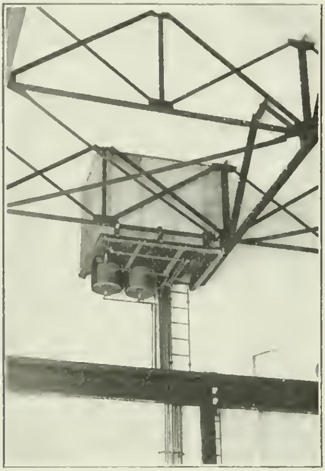


FIG. 13. ELEVATED TANKS FOR ENGINE AND VALVE OIL

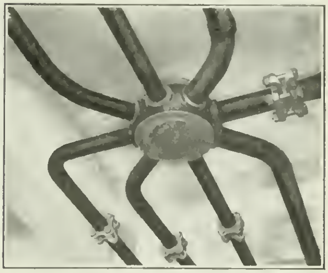


FIG. 14. DETAIL OF OIL DRIP MANIFOLD

For valve oil there are two elevated tanks, Fig. 13, one for high-pressure and one for low-pressure lubrication, conveniently piped to Richardson sight feed oil pumps. Connections are provided on the plunger oil pumps so that the valve oil may be pumped from the barrel into the elevated tanks, and an ingenious bypass arrangement permits the pumps to be flushed out with engine oil, the resulting mixture going to the "dope" can to be used on the coal conveyer together with the settlings from the precipitation tank. Thus practically no oil goes to waste in this system.

### Auxiliaries

All the engines exhaust into a line in the basement leading to a 30-inch Tomlinson barometic condenser on the outside of the station. The exhaust line starts with a diameter of 24 inches and increases to 30 inches at the riser leading to the condenser. Injection water is taken from the river by 10-inch single-stage centrifugal pumps in duplicate, which are located in the boiler room basement just about at the level of the river and thus giving a minimum lift. These pumps are driven by 12x12-inch Lycoming engines, operating in common with all the other steam driven auxiliaries on superheated steam, the pressure being reduced to 100 pounds for this purpose. To complete the condenser equipment, there is a Burnham rotative dry-vacuum pump in the boiler room, connecting with the condenser through a 4-inch pipe. Twenty-six inches of vacuum is ordinarily carried, but 28 inches could be easily obtained if necessary.

For regular excitation purposes, an Allis-Chalmers motor-driven exciter set is used, consisting of a 96-horsepower, three-phase induction motor, driving a 75-kilowatt, 110-volt generator, while in reserve is held a 100-kilowatt Jenny multipolar dynamo, direct-connected to a 12x12-inch Ideal engine.

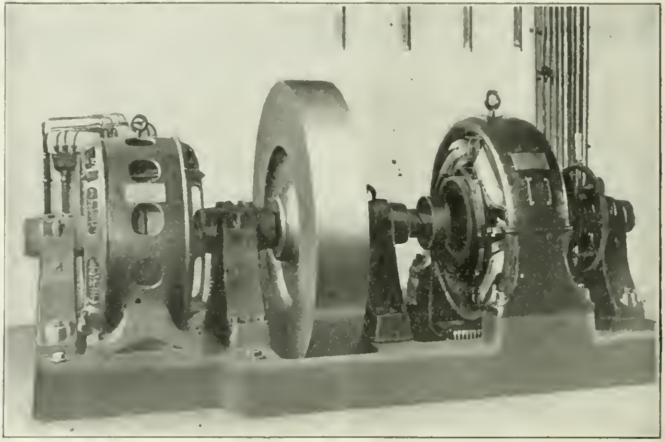


FIG. 15. MOTOR-GENERATOR SET WITH SOLID FLYWHEEL

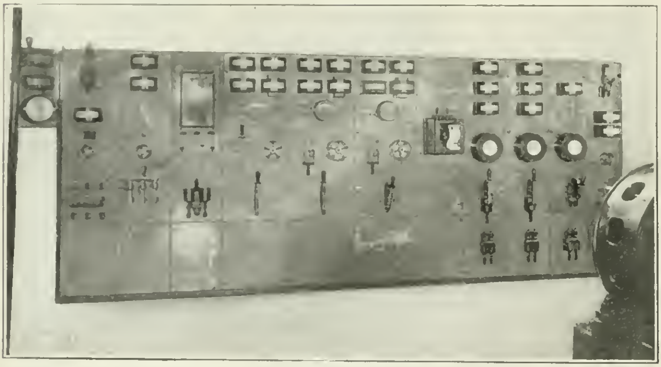


FIG. 16. SWITCHBOARD

Fig. 15 shows another motor generator set of special design used to supply continuous current for the electrically operated coal unloading devices in the storage yard. The load here is intermittent, and should two or more of the motors be started at the same time it would entail a considerable, instantaneous overload. To take care of this fluctuating, intermittent load the motor generator, which is of 75 kilowatts capacity, is provided with a 7000-pound flywheel and the direct-current generator is of the interpole type, guaranteed to stand a 250-kilowatt momentary overload without sparking. This set runs at 825 revolutions per minute.

### Distribution of Current

Switchboard facilities are simple but adequate. No high tension current is brought to the board itself, the main buses being located at a considerable distance back of the board and closed in by a locked grating. Generator and exciter panels carry the usual instruments for current control and on the main station panel is located a curve-drawing wattmeter. One panel is provided for each of the two main three-phase power circuits leaving the power house. These are laid underground and consist of 250,000 circular mil conductors, terminating at the busbars in the brewery. From this point one circuit of the same-sized conductors leads to the Alhambra theater building and a similar one extends to the Majestic building. Both the latter circuits are also underground.

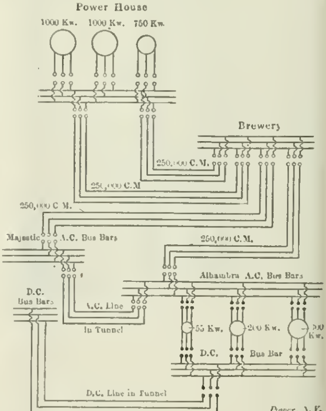


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FIG. 17. DIAGRAM OF ELECTRICAL CONNECTIONS

In the basement of the Alhambra building, where the largest substation is located, are three motor generator sets of 55, 200 and 300 kilowatts capacity, respectively. Both of the larger ones are synchronous outfits, while the smaller one is operated by an induction motor and takes care of the light load periods, being also used for starting the others on the direct-current side. Current at 220 volts and distributed on the three-wire system is taken off these machines for general purposes. This direct-current service extends by means of a tunnel to the Majestic theater building, where no motor generators have been installed. The alternating-current busbars at the Alhambra and Majestic are tied together with a line also laid in the tunnel, so that in case either one of the lines from the brewery is disabled, the other one may carry the entire downtown load. This is evident from an inspection of Fig. 17, which also shows the other salient features of the electrical system.

## Italian Boiler Requirements

Consul Albert H. Michelson, of Turin, furnishes the following report for the information of American manufacturers concerning the laws and regulations of Italy governing the construction and use of boilers.

The attention of American manufacturers of stationary and portable boilers, locomotives, locomobiles, steam rollers, steam automobiles, steam agricultural machinery, house-heating boilers, retorts, stills and condensers, and accessories and parts of all these, is drawn to the requirements in force in Italy governing the construction and use of boilers of all classes, which are rigidly enforced and must be most carefully observed.

The following abstracts from these laws and regulations cover their principal requirements, as far as American manufacturers are concerned:

Every new or rebuilt boiler must be officially inspected and tested before use; every boiler must be inspected not less than once in four years, and every boiler for a steam engine must be in charge of a duly qualified person.

All receptacles used for changing liquids into vapor at a pressure greater than atmospheric pressure, and all receptacles containing vapor at a pressure greater than atmospheric pressure, shall be deemed steam boilers.

### Construction of Boilers

The use of cast iron or sheet brass for parts exposed to fire is prohibited. Exception is made for brass tubes less than 10 centimeters (3.94 inches) in diameter, and for cast-iron parts less than 25 centimeters (9.84 inches) in diameter if cylindrical in form, and less than 30 centimeters (11.81 inches) in diameter if spherical in form.

The use of cast iron is permitted for steam domes, boiler heads, covers for manholes, cleaning holes and mud collectors for economizers, and for parts of other similar contrivances; provided, however, that these are not inclosed in masonry nor in contact with fire, and that they are not greater than 70 centimeters (27.56 inches) in diameter.

### Safety Valves

Every boiler shall be fitted with at least two safety valves charged in such a way as to permit the steam to escape as soon as the maximum effective pressure shall have been reached.

In stationary and semistationary boilers the valves shall be charged by a weight applied either directly or at the end of a lever. The weight and the length of the arms of the lever, as fixed by official test, shall not for any reason be increased by the person using the boiler, or by any person dependent upon him.

In portable boilers, boilers for launches, and in reversible and balancing receptacles the valves may be charged by direct-acting springs, or by spring balances applied to the ends of levers. In this case, however, the springs shall be of such sensibility that when the normal pressure increases one-tenth each spring, acting by itself, shall permit the escape of all the steam produced. The stroke of the spring balance, fixed by official test, shall be made invariable by appropriate means.

### Pressure Gages

Every boiler shall be fitted with a good pressure gage, conveniently placed and within easy reach of the fireman, graduated in kilograms, upon which shall be well and visibly marked the maximum effective pressure that the steam may not exceed.

In boilers used to produce steam at an effective pressure not greater than ½ kilogram (1.10 pounds) per 1 square centimeter (0.155 square inch), an open tube, with a minimum internal diameter of 80 millimeters (3.15 inches) and a maximum hight of 5 meters (16.40 feet) above the level of the water in the boiler, may be substituted for safety valves and pressure gage.

Every boiler shall, further, be fitted with a suitable connection for attaching a controlling pressure gage. The extremity of this connection shall be provided with a flat circular disk, 40 millimeters (1.576 inches) in diameter and 5 millimeters (0.197 inch) thick.

### Feeders and Steam Mains

Every boiler shall be fitted with two independent feeding contrivances, each equally able to supply in abundance the water required, and shall be provided with automatic check valves placed at the entrance of the feed pipes into the boiler. For portable boilers, however, one feeding apparatus may suffice, if upon inspection it appears exceedingly difficult to attach two appliances.

For a series of intercommunicating boilers two feeding appliances may be deemed sufficient, provided that they are independent of each other and that each is equally able to supply in abundance the water required for all the boilers.

It shall be possible, when a number of boilers furnish steam to one and the same steam main, to disconnect any one boiler from the others, whether as to feeders or outflow.

### Water Gages

Every boiler must have not less than two gages for determining the level of water, one of which shall be in the form of a glass tube. The gages shall be in direct communication with the interior of the boiler and shall be independent each from each. The said gages may be mounted on one and the same cylindrical body, provided that this and the pipes which connect it with the boiler shall have a free cross section of not less than 60 square centimeters (9.30 square inches). The glass-tube gage shall be so placed as to be easily cleaned and replaced.

The gages shall be marked with a fixed and visible sign showing the minimum level that the water in the boiler may reach.

For stationary boilers the minimum level mentioned in the preceding article shall be 8 centimeters (3.15 inches) above the upper line of the fire flues and shall be indicated by a clearly visible line marked on the outside of the boiler.

For portable boilers the minimum level shall be fixed with due regard to possible oscillation and to the necessity that the fire flues never remain uncovered by water.

The provisions of the preceding article do not apply to those flues in which the overheating of parts in contact with steam is not to be feared.

House-heating boilers need not be inspected in accordance with the regulations of August 17, 1907, if they comply with the following conditions: (*a*) That they be built of sheet iron or mild steel; (*b*) that their interior be in direct and continuous communication with the air by means of an open tube accessible and visible throughout its length, in order that continuous and immediate supervision may be exercised; (*c*) that the said tube have an internal diameter of not less than 80 millimeters (3.15 inches) and a hight of not more than 3 meters (9.84 feet) above the normal level of the water in the boiler.

The original Italian texts of the laws and regulations cited in this report are on file in the Bureau of Manufactures.—*Consular and Trade Reports.*

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The hose for washing out a boiler should deliver as heavy a stream of water as the blowoff pipe is capable of carrying off (with a temporary strainer in it). A small, sharp stream is sometimes useful, but it requires a heavy stream to give the proper flushing effect on the mud between the tubes.

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Coals which smoke badly give efficiencies 3 to 5 per cent. lower than coals burning with little smoke.

# The Selection of an Oil for Lubrication

## Reasons Why Physical Tests for Gravity and Viscosity of an Oil Have but Little Bearing on Lubricating Value for Any Given Purpose

HENRY M. WELLS AND WM. SCOTT-TAGGART

Lubrication is a perennial subject of interest to the engineer. It is, to him, an essentially practical question and its influence is one that makes itself felt in a variety of directions, all of which ultimately concentrate themselves in the one word efficiency.

Unfortunately, however, for the engineer, a lubricant lends itself readily to a number of scientific tests, so that it has become a kind of plaything for the chemist and the physicist. Unless the subject can be investigated on scientific principles by the chemist, with the ultimate object of solving the mystery of a lubricant, the less an engineer has to do with the chemist the better for his peace of mind.

Up to the present it is surprising how little has been done to solve the problem: "How can an engineer decide from a series of lubricants the best one for any given purpose?"

### Physical Tests Useless

In the old days, physical tests were used as deciding factors in choosing a lubricant and even today, it is no uncommon thing to find firms handing over to their chemist samples of oils, and requesting him to investigate their physical qualities and report on their suitability. The tests themselves are such child's play, that very few chemists ever make them, but simply hand them over to some young student or pupil, and then merely sign their name to a report, adding in the majority of cases, an opinion that a certain oil of the samples is the best lubricant.

Now this is clearly a wrong method. It is neither scientific nor practical. It has solved no problem, and in five out of six cases the engineer finds the chemist's opinion wrong. In other words, these physical tests as used at present, are of very little use to the engineer, and are certainly of no value at all in enabling him to choose the right oil.

A few years ago the writers published a book on "Cylinder Oil and Cylinder Lubrication," incorporating results of a series of tests undertaken with the object of seeing what reliance could be placed on the usual physical tests as compared with practical tests. Liverpool University engineering department carried out an extensive investigation for us: a well known chemist in oils and fats undertook the physical tests and we carried out the practical trials and collaborated in the other work. The whole series of tests seemed to prove conclusively that physical tests were useless. Much has been done since then in further investigations and the results obtained, but not published, have simply strengthened the conclusion at which we arrived.

It will be interesting to go over some of the ground covered by the term "physical tests." Such tests are usually as follows: gravity, flash point (open and closed), fire test or burning point, viscosity, acidity, fatty oils, gumminess.

### Gravity

The gravity of an oil is usually represented by a number which shows how much lighter a given volume of oil is than the same volume of water whose gravity is 1. Such a number is the specific gravity of the oil and it is only when the specific gravities are known that the oils can be compared as to their density. In distilling the oil at the refinery, the determination of gravity plays an important part for any given crude oil; but it by no means follows that the gravity of an engine oil from one crude oil is the same as an engine oil distilled from another crude oil. Gravity in the case of each crude oil must be found by experience. How far gravity can be used as an indication of the value of a lubricant may be seen from Table 1.

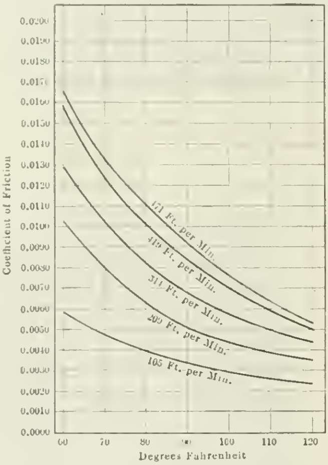

FIG. 1. INFLUENCE OF TEMPERATURE ON COEFFICIENT OF FRICTION OF LARD OIL

TABLE 1. SPECIFIC GRAVITY OF OILS.

| Name of Oil. | Gravity. | Name of Oil. | Gravity. |
|---|---|---|---|
| Castor oil | 0.962 | Heavy engine oil | 0.874 |
| Rape oil | 0.913 | Marine engine oil | 0.914 |
| Neatsfoot oil | 0.917 | Cylinder oil | 0.907 |
| Olive oil | 0.911 | Cylinder oil | 0.911 |
| Sperm oil | 0.880 | Cylinder oil | 0.890 |
| Lard oil | 0.915 | Cylinder oil | 0.887 |
| Ring spindle oil | 0.853 | Cylinder oil | 0.903 |
| Machine oil | 0.878 | Cylinder oil | 0.910 |
| Heavy machine oil | 0.893 | Cylinder oil | 0.898 |

The fact that gravity can be obtained so exactly either by weighing and measuring or by means of an oilometer and that it is represented by a comparatively larg number has led many to think it woul be a fair indication of quality in an oil. As a matter of fact, ordinary machine oil will show as wide a range as cylinde oils and many machine oils have a heavie gravity than many cylinder oils. Th point, however, to observe is that th gravity of such a range of oils as show in the table (all well known on the markets in America) is the small differenc between the gravities. Between the lightes spindle oil, 0.853, and the heaviest cy inder oil, 0.911, the difference is onl 0.058, which may be expressed as a littl over 6 per cent. from the highest to th lowest. If it is remembered that th

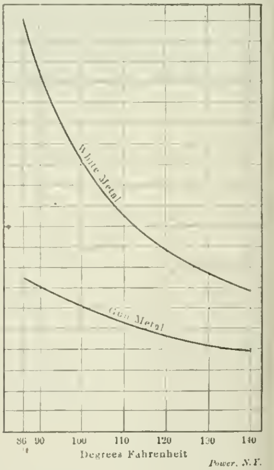

FIG. 2. INFLUENCE OF TEMPERATURE ON COEFFICIENT OF FRICTION OF MINERAL OIL

oils compared range from the lightest possible work to the heaviest engine work, it will be realized that the gravity of an oil cannot possibly be taken seriously as an indication of quality in a lubricant. In regard to cylinder oils, a careful test of over 300 different oils does not show more than 3 per cent difference in gravity, yet a very wide variation is observed in lubricating value.

Another point which has not, as far as the writers are aware, been taken into account, is the mixing or emulsion of the oil and water in the cylinder of a steam engine. Most oils will, when mixed with water, especially by a piston moving to and fro over a film, hold a relatively large proportion of water; indeed many cylinder oils form a complete emulsion. In such circumstances, the gravity of the oil under working conditions is changed from what its gravity was in the fresh state. To use gravity at all in connection with cylinder oil must therefore necessitate a perfect knowledge of the emulsifying properties of any given oil, and then obtaining the gravity based on such properties at required pressures and temperatures.

There is no doubt that gravity is not considered of so much value as it was once, but the superstition still lingers in the minds of many, and even when it is condemned it is done so half-heartedly that it does not convince. This is the sole reason for enlarging upon this phase of the subject. There will be some good done if the ground can be cleared of ideas that have clung to it from its very infancy.

It may be said that gravity serves some purpose in checking deliveries of oil by sample. This is also a foolish idea based on ignorance of oil manufacture. The refineries will not guarantee the gravity of the oil for different batches put through the stills. They insist that some latitude be allowed. Mineral oil is not a fixed chemical body of an unvarying character, and gravity in many cases is taken as the oil is finished. When anyone is so foolish as to insist on a definite gravity test the oil is simply doctored to obtain it and the chances are that the extra blending is not an advantage to the value of the oil as a lubricant.

### VISCOSITY

This property of a lubricant is an unusually interesting one. It bears directly on the question of the thickness or thinness of an oil. Viscosity represents its fluidity and this quality is clearly of some importance in choosing an oil for any given purpose. No one would use a thin spindle oil for a heavy mill engine bearing, nor would he use an engine oil for textile spindles running at 10,000 revolutions per minute. Both science and practice indicate viscosity as an important factor in the art of lubrication. It is because of this apparently self-evident truth that engineers have agreed that the viscosity is a clear indication of the value of an oil as a lubricant. It may be interesting to give one or two examples of tests made which prove that viscosity has an important bearing on the subject of lubrication and that even the same oil at various temperatures varies in its lubrication qualities.

In Fig. 1 are shown graphically a series of tests made by Beauchamp Towers.* The oil used was a lard oil and a constant mean pressure of about 100 pounds per square inch was on the bearing. It will be seen that the coefficient of friction decreased rapidly as the temperature of the bearing increased, so that as the oil became thinner, due to the higher temperature, its friction-reducing properties increased: in other words, as the oil became thinner it increased in value as a lubricant. Several curves are drawn to show that this effect was not due to one particular speed, but was apparent during a wide range of speeds.

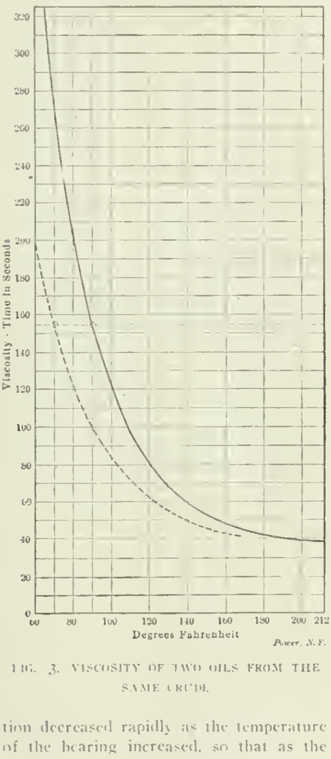

FIG. 3. VISCOSITY OF TWO OILS FROM THE SAME CRUDE.

Fig. 2 is adapted from the experiments of O. Lasche, of Berlin.** It is plotted to the same scale as Fig. 1 for comparison. In this test a mineral oil was used on the bearing and the difference in the coefficient of friction is most marked. During the test the speed and pressure were constant, but various metals were used on the bearing. Both curves show clearly the effect of viscosity on the friction. Thurston and others also give the results of a number of tests proving the same effect, so it is now an accepted fact that the thinner an oil becomes the better lubricant it is.

This recognition, however, is apt to lead one astray. As far as the tests go, the logical conclusion is that, with any given oil, the warmer the bearing is the less the friction will be. Engineers ought, apparently, to allow bearings to get hot, for by that means they reduce the coefficient of friction. An engineer can scarcely be expected to accept such a conclusion; he uses oil with the intention of keeping his bearings cool and at the same time keeping the coefficient of friction at a minimum. Viscosity must therefore be looked at, not from the direct results shown in the curves, but from a deduced result. No tests, as far as the writers are aware, have been carried out on strict scientific lines, showing the minimum friction with a maximum of temperature for a series of oils under given conditions of speed and pressure. All engineers, though, have seen cases where bearings attain a certain temperature and remain at that temperature under normal conditions of working. It is no uncommon thing to find bearings unusually warm and yet causing no anxiety to the man in charge; he knows from experience that the bearing, when it has reached the abnormal temperature, will not get warmer. In such cases especially, but as a matter of fact in all cases where bearings are hotter than the room in which they work, the oil used is a poor lubricant at first and causes friction, and naturally heat is developed which thins the oils and improves it. Friction still continues and as the temperature rises the oil ultimately attains such a viscosity that the bearing runs at a constant temperature, the heat being conducted away as fast as it is created, probably, in a great measure, by the greater supply or circulation of the thinner oil.

It may safely be premised that no engineer, worthy the name, can rest content with such paradoxical results. The matter must be examined from another point of view and the following remarks may be helpful in this direction. Suppose a bearing has a fairly constant temperature of 90 degrees Fahrenheit, and the temperature of the surrounding air is 70 degrees Fahrenheit. If it is presumed that no heat passes to the bearing except that due to room temperature and friction, then 20 degrees Fahrenheit is heat due to friction, and the particular oil used is at its most suitable viscosity at 90 degrees Fahrenheit. But 20 degrees Fahrenheit must be considered too great a difference; friction is too high and ought, in the interest of economy and efficiency, to be reduced. Deduced reasoning from the tests already explained point to a remedy in a less viscous oil, so a thinner oil is wanted. Now it is hopeless to expect no friction, so the engineer must ask his oil dealer or refiner to supply him with an oil from the same crude having a viscosity at, say, 70 degrees Fahrenheit that his present oil has at 90 degrees Fahrenheit. To make this clear a diagram of viscosities of a bearing oil is given in Fig. 3. This oil raises the temperature of the bearing to 90 degrees Fahrenheit; the new oil from the same crude must now have a viscosity at 70 degrees Fahrenheit equal to that of the faulty oil at 90 degrees Fahrenheit. This is shown dotted in the sketch, and it will be noted that the new oil is considerably thinner though the temperature difference is slight.

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*Proceedings of the Institution Mechanical Engineers, November, 1883.

**Zeitschrift d. v. d. Ingenieures, Vol. 46.

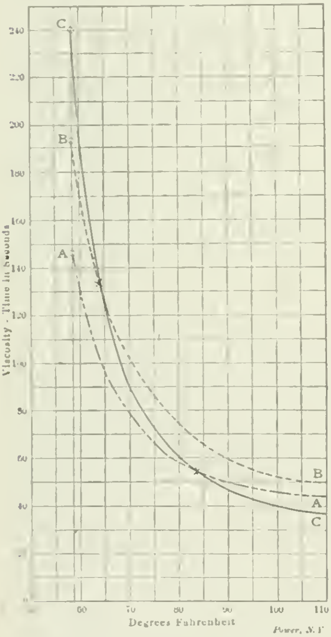

FIG. 4 VISCOSITY CURVES OF THREE OILS

A change of oil in the direction pointed out is sure to effect a reduction in friction. Instead of reducing the coefficient of friction by heating the oil and so thinning it, an oil thin enough in the first place to obtain the same effect should be used. Consistent with a due regard to circumstances, an engineer's motto ought to be "the thinner the oil the better the lubricant."

In this connection it may be useful to give Beauchamp Tower's conclusions on the tests he made for the Institution of Mechanical Engineers. Table 2 is a comparison of the friction with the various lubricants tried, under as nearly as possible the same circumstances, temperature 90 degrees Fahrenheit, lubrication by oil bath. "The above also represents the relative thickness or body of the various oils, and also in their order, though perhaps not exactly in their numerical proportions, their relative weight-carrying power. Thus sperm oil, which has the highest lubricating power, has the least weight-carrying power; and though the best oil for light loads, would be inferior to the thicker oils if heavy pressures or high temperatures were to be encountered."

TABLE 2. COMPARISON OF FRICTION WITH VARIOUS LUBRICANTS.

| Lubricant | Mean Resistance, Lb. | Per Cent. |
|---|---|---|
| Sperm oil | 0 481 | 100 |
| Rape oil | 0 512 | 106 |
| Mineral oil | 0 623 | 129 |
| Lard oil | 0 652 | 135 |
| Olive oil | 0 654 | 135 |
| Mineral grease | 1 048 | 217 |

So far, viscosity has been dealt with as having an influence on friction. If this were all, the question of lubrication would be a simple one to answer in any particular case, but when it was mentioned that an engineer could apply to his oil supplier to give him a thinner oil from the same crude, the words "same crude" were used advisedly. Any given crude oil may, for some time, yield oils of fairly regular lubricating properties, and if this is so, one could rely upon similar lubricating qualities existing in the thin and thicker oils. In actual practice, it is almost impossible to obtain a series of oils from the same crude, and certainly not for any length of time. Crude oils are mixed, wells give out, or the quality of the crude oil varies considerably from the same well; consequently there is no certainty of obtaining oils with a fixed lubricating factor. The refiners and blenders can easily manipulate oils to give the usual physical tests as required by specification, but the essential factor, viz., *lubricating value*, is not a quality that can be so easily introduced into the oil, and moreover each oil has its own peculiarities in this direction.

For instance, if three oils are offered for a particular bearing or purpose, the thickest oil may give the best results simply because it has a higher lubricating value. On the other hand an extremely thin oil may be the best for the same reason. In Fig. 4 three oils are shown. Their viscosities at 58 degrees Fahrenheit have a wide difference, but following them down, *A* and *C* are identical at 84 degrees Fahrenheit and *B* and *C* have the same viscosity at 64 degrees Fahrenheit. Throughout the curves there is very little to choose between the oils, and yet if viscosity were a deciding factor there is a wide difference to judge upon if a single test only were made on the oils at 60 degrees Fahrenheit. If viscosities are taken, engineers ought to do it themselves and cover all likely temperatures, or insist on the chemist doing so and plotting the curves.

A further case is given in Fig. 5. Here a Parsons turbine was using a certain oil and the temperature of the oil in the tank was 160 degrees Fahrenheit. No trouble was caused and very little oil was used. The oil was not cooled in any way, but the bearings were water-cooled. The oil-pump pressure was about 5 pounds. A test was made to try and improve the lubrication, the temperature of the oil being taken as an indication of value. The oil used was carefully tested for viscosity and plotted as at *A*, Fig. 5. Three other oils were also chosen and their viscosity curves plotted. To anyone acquainted with viscosity tests it was manifestly very difficult to find oils varying much in viscosity at 160 degrees Fahrenheit for such work as turbine lubrication. The curves show all four oils practically identical, *B*, *C*

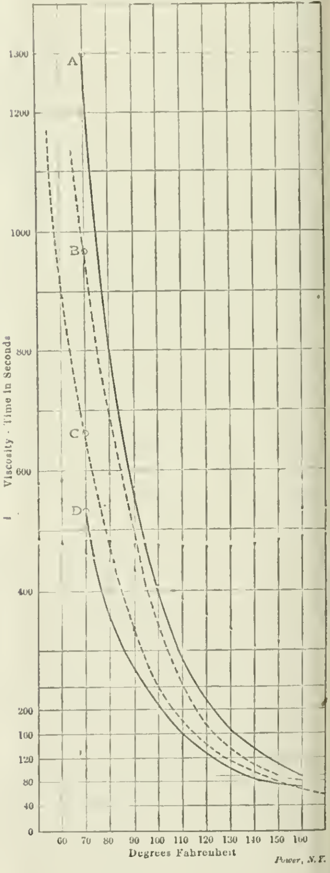

FIG. 5 VISCOSITY OF OILS FOR TURBINE USE

and *D* oils being all good lubricants for forced-feed work, but tests of the oils, as a preliminary, with the condensed steam (some of which always finds its way into the oil) showed signs of emulsion with oils *B* and *C*, so oil *D* was chosen. The mere fact of *D* being such a thin oil as compared with *A* at 70 degrees Fahrenheit had no influence whatever in the choice of the oil; the viscosities at the higher temperatures were the deciding factor, and as the result turned out the new oil reduced the temperatures by about 20 degrees Fahrenheit.

The emulsifying properties of an oil, its hygroscopicity and absorption of oxygen are matters that will be mentioned later. They have an important influence on the ultimate behavior of an oil, though a mere friction may indicate a good lubricating value when the oil is fresh.

In the case of cylinder oils, the unreliability of viscosity as a test of oil is probably seen. The persistence engineers and chemists show in fixing a definite viscosity at 212 degrees Fahrenheit in their specifications is perfectly astonishing. No cylinder oil ever works under such a temperature. If the viscosity is required or indicated, it ought to be taken at the temperature of the steam, but even then no value can be attached to the results.

Fig. 6 represents the viscosity curves of several oils, four of which are probably the best known cylinder oils in the world, for extreme conditions. They are sold as such by their manufacturers, and in actual work show themselves to be especially good lubricants. The oil *A* is practically a very heavy machine oil, but it has been plotted in order to make comparisons. The curves bring out very clearly several important points not usually met with in dealing with this subject. As a rule cylinder oils are specified at 212 degrees Fahrenheit and evidently the oil is judged on the viscosity at that temperature. The oils *B*, *C* and *D* would stand a poor chance compared with *E*, for, unfortunately, the thicker the oil at 212 degrees Fahrenheit the better seems to be the prevailing idea of cylinder oils. Now a little reasoning from the case of machine and engine oils, where the viscosities all come down to near a common viscosity, as shown clearly in the previous diagrams would have led to a similar conclusion in regard to cylinder oils, and when tests are actually made with a special viscometer for this purpose and viscosities found up to 600 degrees Fahrenheit, or higher, for extreme superheated steam use, it is found that the viscosities vary so little at working temperatures that no matter how widely they differ at 212 degrees Fahrenheit their difference in higher temperatures is so little as to be negligible.

In Fig. 6 the viscosities from 400 degrees Fahrenheit upward are almost equal for all the oils, and scarcely represent more than the personal error of the observer, especially as such a substance as oil running out of small apertures, a stop watch, thermometers and controlling methods of heating are being dealt with. Out of a series of over 400 oils tested, this uniformity of viscosity at high temperatures is characteristic, and the only conclusion to be drawn from it is that the viscosity test is of no value for cylinder oils as to their lubricating quality. The diagram further shows that the two thickest oils, *D* and *E*, at 212 degrees Fahrenheit become thinner than the third oil *C*, between 350 and 400 degrees Fahrenheit.

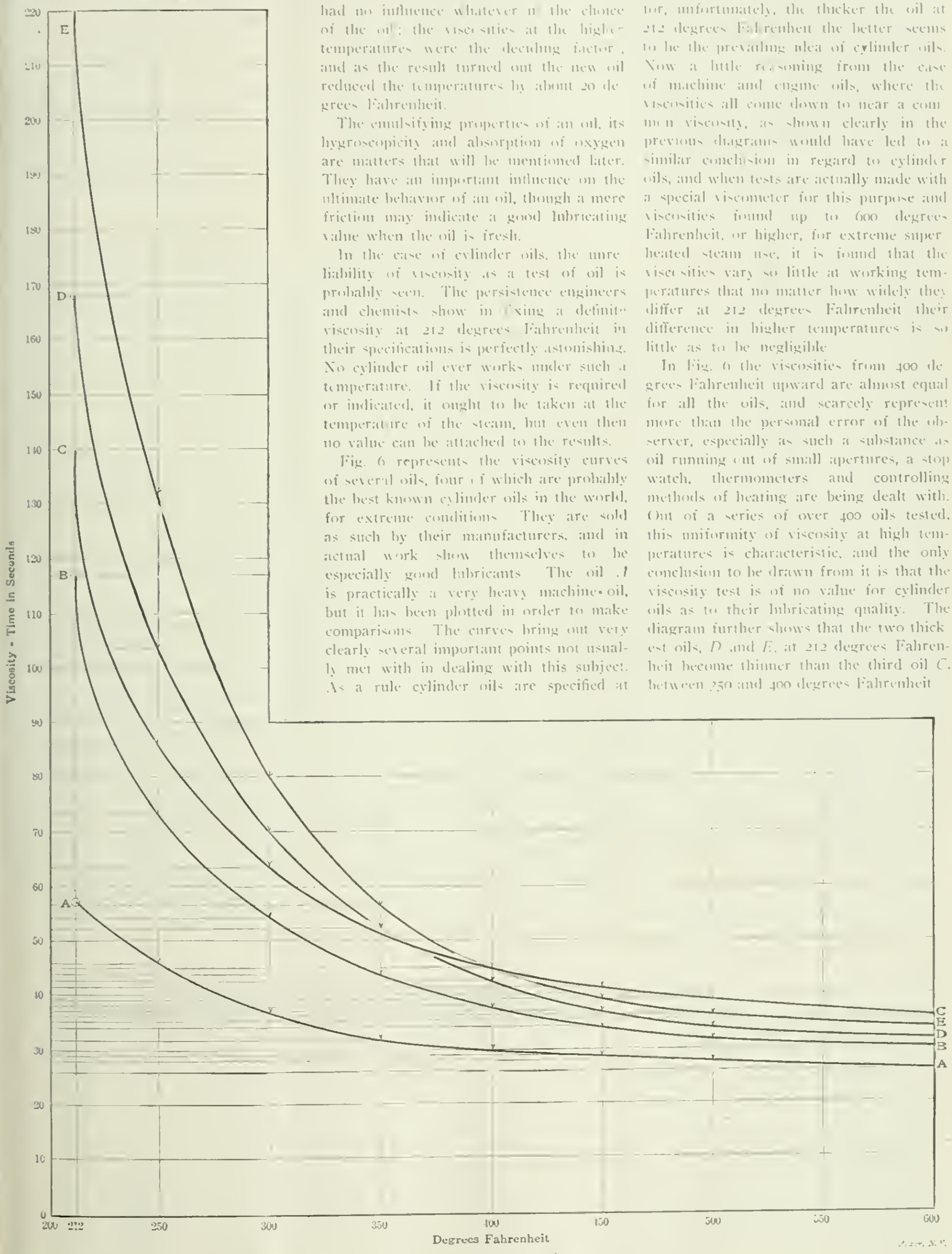

FIG. 6. VISCOSITIES OF CYLINDER OILS UP TO 600 DEGREES FAHRENHEIT

It must always be remembered that cylinder oils enter the steam or the cylinder when they are subjected to the extreme temperature of the steam, and under such conditions several other important factors, apart even from their lubricating qualities, have to be taken into account. Oil evaporates considerably under high temperatures, especially as the oil is in a finely divided state. Oils also contain asphalt, bitumen, etc., usually termed gummy matter, and deposits are found in steam engines and generally assumed to be a consequence of such gummy constituents. Oils also are subject to emulsification in the presence of condensed steam and form metallic soaps, etc. This will form the subject of a future article.

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# Lessons from the Power Station Load Curve

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By H. S. Knowlton

The analysis of power-station load diagrams is one of the most helpful aids toward efficient plant operation at the command of the engineer. Practically all installations of modern type are now provided with instruments from whose readings the output of the plant from hour to hour may be tabulated, and the methods of plotting such readings so as to exhibit in a graphic way just what the plant has done from hour to hour, or from week to week, are familiar through wide usage to the great majority of engineers running the stations of public-service corporations, as well as to many employed in general industrial power-station service. It is often irksome, however, to the practical operating man to be obliged to spend time regularly in the clerical recording of particulars of station operation. If the usefulness of such data could be more widely realized, it is safe to say that the analysis of plant conditions by graphical methods would be more acceptable to the average man behind the throttle.

When load curves are plotted to show the way in which different machines and boiler units are handled as the demand upon the station varies, much can be learned about the best ways to manipulate the equipment. This aspect of load-curve interpretation has been thoroughly discussed in technical journals and before associations of engineers, but the value of the load curve in enabling the performance and general conditions of station service to be more broadly studied in relation to the business of the plant as a whole, is perhaps less generally appreciated among operating men. The following curves are therefore presented as an example of how the service conditions upon a central station may be exhibited and interpreted in the light of their general effect on the plant load factor and the demand upon the installation at different hours of the day and different seasons of the year. If the value of such diagrams in the interpretation of general conditions can be appreciated by the operating engineer much will be gained. The curves shown herewith will help him to dispose of his machinery at different times, and they will show him where the plant owner can improve the external conditions, or at least what outside conditions are desirable for economical operation. If the outward conditions can be improved the result is more output for the same expenditure, or less expenditure for fuel and supplies per unit produced, with the creation of opportunity for higher wages and salaries within the plant.

The curves shown were taken from a central station of about 2000 kilowatts generating capacity under normal conditions of load. The station was equipped with five Stirling boilers aggregating 1290 horsepower and three vertical cross-compound McIntosh & Seymour General Electric engine-driven alternators rated respectively at 400, 600 and 1000 kilowatts. The entire output of the station was alternating current, and the service supplied included the street lighting of the city where the plant was located, commercial power and electric lighting.

Fig. 1 shows the output of the station from hour to hour on August 28, 1908, for the full 24-hour day. Curve *A* represents the variation in demand upon the station for all its service, and curve *B* shows the demand upon the plant from hour to hour for electric motor service alone. This is a typical summer day's load in the plant, and on examination the curves show that with the exception of a heavy and short drop in the demand at the noon hour the total requirements of the station are extremely even and satisfactory from about 7 a.m. to 5 p.m. Between 7 p.m. and midnight the load holds up fairly well, also, though naturally much lower in extent than earlier in the day. The general steadiness of the load between 8 a.m. and noon, averaging about 790 kilowatts, tended to enable the machinery then in operation to be run efficiently, and a similar state of affairs was experienced in the afternoon. The space between the two curves *A* and *B* is proportional to the energy generated by the company for lighting service, while the space between the base line of hours and the curve *B* is proportional to the energy generated for power service. The whole space under the curve *A*, extending to the base line of hours, is proportional to the entire energy output of the plant. In other words, if the space under any one of the curves were divided into rectangles, the area of each rectangle would be obtained by multiplying a hight by a breadth. The hight would in this case represent the kilowatt output of the plant during the time covered by the base of the rectangle, and their product would naturally be expressed in kilowatt hours. Thus the little rectangle *R* in Fig. 1 represents an area 1000 kilowatt-hours, since its hight is 100 kilowatts on the scale of the diagram, and its breadth the single hour between 10 and 11 a.m.

If one gets in the habit of looking at these areas, irregular though they are, as proportional to the work done by the plant electrically, it is much easier to see how the hourly loads and the total energy generated for different purposes throughout the day have run. Thus, a single glance at the area between curves *A* and *B* shows clearly that the lighting load on the station amounts to very little during the day time in proportion to the motor load, whereas in the evening the lighting load on the plant is the far greater proportion of the station's work. While it takes no load curve to deduce that the lighting load will in most stations follow such a course in the summer time, the curve actually does show that the motor load is the salvation of the plant from the standpoint of efficiency, during the daytime. That is, without the motor load between 6 a.m. and 6 p.m. the company would have been obliged to run its plant with even the smallest of the generators badly underloaded, and this means poor efficiency all along the line from the furnaces to the busbars.

The curve *A*, in Fig. 1, is typical of the best tendencies of practice since central station engineers began to realize that there is money in cultivating a good-sized day load. The company must keep a certain amount of machinery on hand all the time to supply the maximum demand, and this means that the interest on the cost of the equipment, including the cost of the land and buildings necessary to properly house the machinery, must be paid right along, together with taxes, insurance and depreciation, whether the apparatus is turning out current or not. Also a certain number of men must be kept on duty regardless of whether the machinery is all running or not, though of course, after a certain point is reached, it costs more to run the equipment than as though one or two more machines did not have to be started up. The long and short of all this is that it costs the company very little more than the fuel expenses, plus supplies and perhaps a little more for labor, to turn out each kilowatt-hour of energy during that portion of the day when the load on the plant is light, and for this reason a carefully managed company can afford to sell electricity at pretty low rates to large users during what are properly called the off-peak hours. In the case of the station whose curves are here shown, the power rate gets down close to 1.8 cents per kilowatt-hour for the largest user on the lines, and this is in face of the fact that it cost the company just 1.42 cents per kilowatt-hour last year to manufacture its energy, exclusive of any fixed charges like interest or taxes.

The operating engineer has little control over the load, but when he realizes how important it is that the capacity of the machinery shall be as fully utilized as possible, he can point out this condition when discussing the situation, and can do his best to run individual units in the station more closely in accord with the demands upon them than is yet the practice in many installations. In the curve of total output, *A*, Fig. 1, it is evident that between midnight and 6 a.m. the 400-kilowatt unit would be the best one for the service, and during the rest of the day it would be essential for the 400- and the 600-kilowatt units to be in constant operation. They would be somewhat underloaded, it is true, but still able to operate with good efficiency at approximately three-quarters of their total combined normal rating. In the early evening one of the machines could preferably be shut down with advantage, but if it happened to be necessary to run the 600-kilowatt set for any reason, the load could still be carried without great sacrifice of efficiency on the larger unit. It is interesting to note that the load factor of the entire station for August 28 was about 25 per cent., expressing that factor as the quotient obtained by dividing the total output of the plant for the day by the full-load station output, supposing all the machinery were run 24 hours at full load. The normal full load day output is,

$$2000 \times 24 = 48{,}000$$

kilowatt-hours. The total station output on the date given was 11,966 kilowatt-hours, which divided by 48,000 gives approximately 25 per cent. It is notable also that the power output of the plant was about 70 per cent. of the entire business of the station for the day. Another point is that in a station with all the generators of the same type and design, and capable consequently of operating in parallel successfully, it is on the whole easier to apportion the loads so that each machine is obliged to turn out a considerable percentage of its capacity, than in a plant where one kind of generator is used for railway power, another for factory motor service, and another for street or residence lighting.

Fig. 2 shows the output curves of the plant on September 1, 1908. The reason for the serious dropping off in load here is the fact that the company's largest purchaser of power, a factory having a connected motor load of 817 horsepower, was shut down for about two weeks at this time; consequently the amount of energy generated for power purposes was reduced from 8300 kilowatt-hours, as on August 28, to 4200 kilowatt-hours on September 1. That is, through the shutdown of this single customer, the power output fell off nearly 50 per cent. To the operating engineers of the plant this meant that the 400-kilowatt unit was able to carry the load throughout nearly the whole 24 hours, though for reasons of safety in case of trouble it is probable that the 600-kilowatt set might have been thrown into service about 6 p.m. These records do not show what machines were run, but it is plain that the use of three sizes of generator in the station produced a flexibility in operating this particular load curve which was very desirable.

So far as Figs. 1 and 2 are concerned there was no need of the 1000-kilowatt generating set, but in Fig. 3 this situation is altered. Before leaving Fig. 2, however, the tolerable steadiness of the total load may be noted, not so much throughout the day as a whole as for several hours at a time. This means that when a

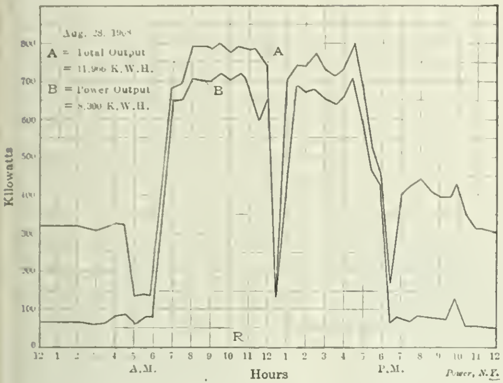

FIG. I

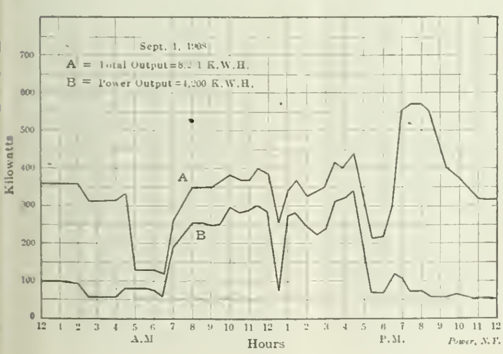

FIG. 2

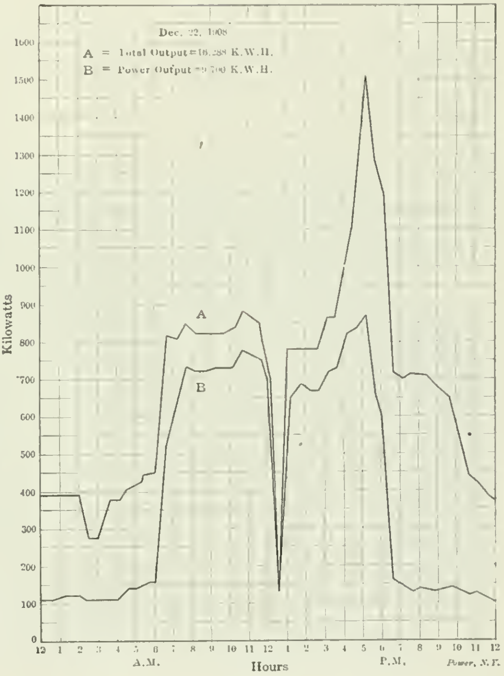

FIG. 3

load variation occurred it generally lasted long enough to enable the full benefit to be secured from the operation of whatever machine happened to be in service at the time, and consequently was an encouragement to the station staff to do all in its power to fit the machinery closely to the demands upon the whole plant. The station load factor for September 1, was about 17 per cent.

Fig. 3 shows the conditions of operation in the plant on December 22, 1908, the day on which the plant sustained its heaviest load for any day in the year. The large consumer who was shut down in September was doing business again in December, as was everyone else in the city who was taking current from the central station company. The noteworthy feature of this day's run is the tremendous peak which occurred at 5 p.m. The output was then 1500 kilowatts, and while it could have been carried on a pinch for a very short time by the 400- and the 600-kilowatt generators under 60 per cent. overload, the company wisely operated the 1000-kilowatt machine during the hours when the demand ran high. The station load factor for the day ran up to 34 per cent.; the power load was well sustained through the daytime; and the lighting load of the holiday season was excellent.

Bearing mind that a 50 per cent. overload capacity on the station rating is permissible for a short time, it is clear that the station could supply a temporary demand of 2500 kilowatts before new machinery would have to be purchased. It is also clear that the engineer in charge of the plant has a wider choice of machine combinations to meet the load as the size of the whole load grows, so that in a plant having two or three sizes of generators, it is advantageous in the direction of economy to obtain all the load that one can. This may not seem very pertinent to the operating engineer, who cannot go out and secure new business, but it is a fact that in the stations where the best all-around results are being obtained, all departments of the company coöperate in making all the conditions of the business clear to interested persons. The solicitor cannot go out into the commercial field and secure new, profitable business and keep it unless the power station is prepared to back up the contract with reliable and efficient service; the station engineer cannot operate the plant most efficiently unless he is familiar with the character of commercial business which it supplies, and unless he fits machines into the load schedule to the best advantage; and the plant owner cannot handle the situation as a whole in the broadest way without knowing how the station and the service required match. The load curve offers the quickest and most accurate means of analyzing the demands made upon the station and its personnel.

## Hydrogen in Producer Gas *

By H. F. Smith

One gas producer bugaboo that has been the cause of considerable anxiety in the past is now undoubtedly within the class of those things that are thoroughly understood. I refer to the hydrogen content of producer gas. Several years ago every manifestation in a producer gas-power plant that was not thoroughly understood was attributed to the presence of hydrogen in the gas. It has probably been held responsible for more different kinds of trouble than any other single element, and has in all probability been responsible for few, if any, of the various evils that have been laid at its door.

Several years ago back-firing was a very common fault in producer gas operation, and this was almost universally attributed to excessive hydrogen. It has, however, been fully demonstrated that the hydrogen in producer gas is never responsible for back-firing. This trouble may be produced by a number of defects, chief among which are unplugged indicator and relief cock openings communicating with the combustion space, or faulty location and timing of the ignition mechanism, or the overheating of either metal surfaces or carbonized oil within the combustion space, or a combination of some of these.

Pre-ignition of the compressed charge is another matter for which hydrogen was long held responsible. It was maintained that, owing to the extremely inflammable nature of hydrogen, it would frequently ignite during compression, causing excessive pounding and other unpleasant manifestation. I have yet to observe a single authentic case of pre-ignition that was due to the presence of hydrogen. I have personally observed the operation of engines on which the compression was run up, experimentally, as high as 220 pounds per square inch while running on gas containing 27 per cent. of free hydrogen, without any sign of pre-ignition. On the other hand, I have had violent pounding on engines with not over 125 pounds compression, when operating on gas containing not over 12 per cent. of hydrogen. When it is remembered that the ignition temperature of hydrogen is only a little more than 100 degrees lower than of carbon-monoxide, and that even with the most unfavorable condition of 212 degrees temperature of charge at the beginning of the compression stroke and strictly adiabatic compression (with no loss of heat) a pressure of something over 300 pounds per square inch would be required to reach the ignition temperature of hydrogen, the improbability of pre-ignition from this source is immediately apparent.

One characteristic of hydrogen, however, must not be lost sight of: flame propagation is very much more rapid through it than through carbon monoxide. In other words, an explosive mixture containing a high percentage of hydrogen will be completely burned in a very much shorter time after the occurrence of the igniting spark than one in which the hydrogen percentage is low and the combustible gas largely carbon monoxide. A sudden variation in the proportion of hydrogen in producer gas, therefore, may be the cause of violent pounding, not through spontaneous ignition of the charge during compression but on account of the more rapid rate of flame propagation having the effect of abnormally advancing the time of ignition.

A properly designed gas engine will handle producer gas with any possible continuous percentage of hydrogen without any irregularity in operation whatever. Whatever irregularities may be traced to the hydrogen content of the gas are due rather to the *variation* in the percentage of hydrogen than to the actual percentage present.

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*Extract from a paper recently read before the National Gas Engine Trades Association.

## Boiler Inspectors' Convention

As previously announced, there will b a meeting of State and municipal boile inspectors to be held in Detroit, Mich August 10, 11 and 12. This meeting ha been called for the purpose of formin a national organization of State an municipal boiler inspectors, which sha have for its main object the securing more uniform boiler construction and i spection throughout the country. At t same time the Boiler Manufacturers' A sociation will hold its twenty-second a nual convention in Detroit, and it is hop that the older organization will be rea to give the new association the bene of its experience in this same line of wor for much has already been done by t former association toward promoting t aims of the new organization.

In order that the new association m have a successful start, it is necessa that the attendance at the coming conv tion be large. Therefore, it is urged t every State and city boiler inspector the country make a special effort to in Detroit on August 10, 11 and 12, p pared to give his individual support to new association. Further information m be secured from J. C. McCabe, inspect Detroit, Mich.

An engineer might succeed in test out a cross in a private telephone cal and save his employer the pay of a te phone expert. Should he fail, howev it will hurt his feelings to hear it sa "It could have been repaired for 1 the money had it been left alone."

# A Practical Talk on the Economizer

## Good and Weak Points of the Scrapers; How to Handle an Economizer; Where and How It Should Be Located; Cost of Maintenance

### BY WARREN H. MILLER*

While one may well doubt that this apparatus is worth the trouble and expense in boiler plants under 500 horsepower, nevertheless the undoubted savng of about 6 per cent. on the coal bill can be realized with care in operation, and this amount is worth considering in plants of any considerable size. Briefly described, the economizer is a series of ube manifolds arranged so that the flue gases from the boilers pass through them on their way to the chimney. The boiler-feed pumps force water through these ubes against boiler pressure and the ter is heated up to temperatures rangg from 170 to 300 degrees, depending pon a variety of conditions; a rise of rom 60 to 100 degrees is good average ractice. Mechanical scrapers are proided which are worked up and down the ubes so as to scrape off the soot from ach pipe. With bituminous coal this peration must be continuous; with nthracite, 12 hours' scraping out of 24 s ample.

There are a number of fixed charges o be entered against the coal-saving account of the economizer which cannot be avoided in practical operation. To run the scraper equipment takes power. An economizer suitable for a 1000-horsepower plant requires about a 1½-horsepower engine or motor to drive the scrapers when anthracite is used. If bituminous coal, the power required gets larger each year until a motor of 10 horsepower is required to drive the scrapers. This is due to the design of the scraping mechanism. The scrapers are hung in balanced pairs by a chain which runs over a sheave driven by the operating shaft. Each scraper weighs some 50 pounds and scrapes four to six tubes at once. Of course the whole line of scrapers must reverse at the top and bottom of the tubes at the same time. If for any reason one scraper gets delayed by sticking, it will arrive behind the others on the descent and get there ahead of the rest on the ascent. Now, as it cannot go any higher, and the sheaves all continue to revolve, its own sheave *must* slip under the chain, which is exactly what it is not designed to do. The result is that that particular sheave will draw very hard for the brief time required to bring up all the rest of the scrapers and line them up at the reverse. If several of them are out of line, so that three or four sheaves are slipping, the strain on the reversing mechanism is so great as to cause it to bind, grind the edges off the sliding-clutch collars and finally release with a terrific shock, if it does not break the reversing lever altogether.

Now observe how beautifully this works with soft coal. You have a leak. Of course it is in an inner tube and you cannot get at it to calk it. The leak is reported and you shut down, take off the tube cap and expand it tight. Or if it is in the gasket take it out and replace with a new one. You start up again. The scraper starts to go up that tube, and the nearer the former leak it gets the more hard scale it encounters from its drip until it sticks, some 6 inches from the top of its run. It will go down again, but all the power in the mechanism cannot force it higher. If fine anthracite ash were on the tube this would not occur, as the scale would be soft mud, easily scraped off but any fireman knows how boiler leaks and soft-coal soot cake to a

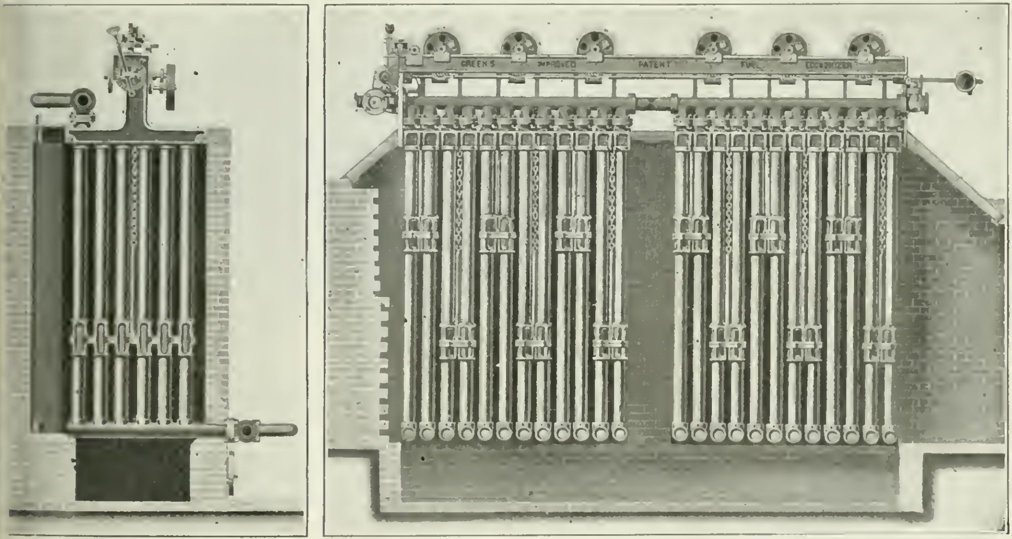

FIG. 1. CROSS AND LONGITUDINAL SECTIONS THROUGH A GREEN ECONOMIZER CHAMBER

hard s[illegible] the [illegible] around the boiler house.

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*Mechanical and electrical engineer, Standard Oil Company.

So from that time on that scraper stops six or more inches before the rest and its sheave has to slip under the chain, taking excessive power. There is one plant where they started seven years ago with a 2-horsepower motor and are now using one of 10 horsepower. No one cares to take the whole economizer apart because of these cakes from occasional leaks, so the condition is simply tolerated until extensive overhauling is needed on the entire economizer.

### Cleaning the Interior

Another charge on the economizer account is cleaning out the interior. Each make is provided with a blowoff cock, but a little study of the construction of the tube manifolds will explain what actually happens in practice. The feed water enters at one end of the bottom manifold or "wall box," enters each bottom header, ascends through a dozen or more parallel 4-inch tubes to the top header, and through each top header to the upper manifold, from which it flows to the boilers. Now, as all the feed water comes in through a 4-inch pipe (for a twenty-section economizer) and is supposed to flow through two hundred 4-inch pipes on its way to the upper manifold, its flow must be exceedingly slow. In fact it is largely due to the difference in temperature between the top and bottom of the economizer. Wherefore, when you open the blowoff valve, which is of $2\frac{1}{2}$-inch size, it is unreasonable to expect any great velocity of water in any of the 20 headers or their 200 tubes; certainly not sufficient to disturb the mud on the tubes. In point of fact, the entire blowoff is simply fresh feed water coming along the bottom manifold direct from the feed inlet, as you can convince yourself by feeling its temperature. Not only that, but if the blowoff is opened wide the feed pumps will race and the boiler checks become silent. The blowoff hardly cleans the wall box. Yet it is in the economizer that the major part of the mud is supposed to collect.

With good clean city water of about four grains of solids in the United States gallon, the tubes acquire nearly $\frac{1}{8}$ inch of dirt on hard scale in six months. This dirt is not greasy, but is fine earth loam on hard calcium and magnesium sulphate scale with some silica. It is now time to lay off the economizer and scrape out by hand each of the 200 tubes. Follow this with a hydraulic turbine tube cleaner to cut off the scale. The sludge will flush out with a good fire hose and all this water and mud must go somewhere, certainly not down the blowoff, as it would immediately choke up, so each bottom header must come off, and woe to you if the architect has not given you a suitable drain and pitched the floor to it. Each separate tube cap must be fished along the header until it can be passed out the master hole at the end and, in a metal joint economizer, they must all be carefully protected from rust while out and well cleaned before replacing. The whole job will take about a week with a 400-tube economizer, unless softened water has been used, with the softening compound put in before entering the economizer instead of before entering the boiler, as in most small plants.

### Leaky Joints—Attendance

One hears much of troubles from leaky joints in economizers, but if the equipment is properly erected there should be little trouble from this cause. One make used to have gaskets between the vertical faces of each header, and this arrangement gave endless trouble because it necessitated all the headers being exactly plumb and square. This has since been replaced by a metal joint which does away with the gasket entirely. This needed some sort of flexibility, as it would be quite hopeless to expect a whole set of rigid sections to make up at opposite corners into rigid wall boxes and all be exactly the same length across the diagonal, so the present arrangement is to come into the top manifold with an inverted U. Just what troubles from air-bound sections will result from this arrangement remains for practical experience to develop.

As regards attendance charges on the economizer, once every three hours is sufficient to feel bearings, swab the collars and gears with heavy oil, and see that the scrapers are not out of order. It is a good plan to see that the loft or cubby-hole or whatever it is that the architect has left above the economizer is well ventilated. Remember that the poor devil who has to repair it and watch over it is subjected to an inferno compared to which the tops of the boilers are solid comfort. It takes 15 minutes for the reversing horn to make one reverse, and the chances are that the reverse will not coincide with the arrival of the scrapers at the top of their run, or else the horn will try to get behind the re versing lever and break it, or the lever will refuse to throw the collar nicely. These things take hours to adjust, time enough to roast your machinist's feet to a crisp, burn all the cells out of his lungs, and sweat him as dry as Sahara. Of course, after it is once done—if the man is still alive—he will not have to endure it again until it gets out of order, which is about once in three months.

As all these contingencies may and do occur in a small equipment as well as in a large one, it is well to figure the actual value in thermal units of the saving due to the economizer and charge against it the actual earning value of its cost if put into manufacturing capital, the cost of cleaning, oil, attendance, repairs, renewal of driving belts (which do not last long in that temperature) and your technical man's or chief engineer's time in adjusting and starting up. The poin where the coal saving doubles this ac

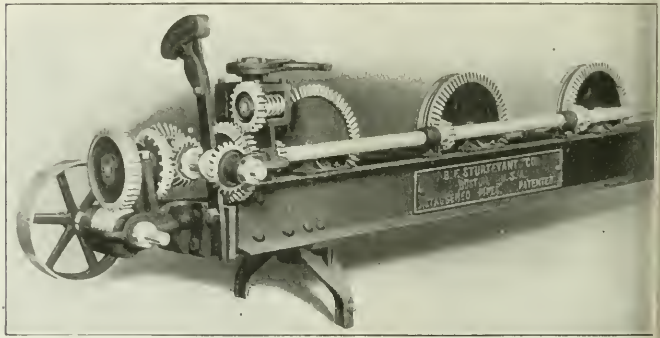


FIG. 2. THE STURTEVANT SCRAPER DRIVE

count, and is therefore a fair risk f manufacturing capital, will be found n much under 500 horsepower.

But in a large plant, particularly o vending power, there is no getting aw from the economizer. Its coal-savi represents such a big item in dollars a cents that its repair and maintenan charges become relatively small. Th is enough left over to pay for the eco mizer in about two years. It theref becomes the engineer's province to red the troubles of maintenance and cleani to a minimum, and the first step will the proper location of the economiz The usual arrangement proposed by architect or consulting engineer is ab the smoke flue, right up under the r with the back wall of the boiler ho blank and forming one side of economizer housing. This converts sweatshop behind the boilers into a dark tunnel, wherein are the boiler bl offs and all the back connections. T tunnel may be 300 feet long and is alw full of loose steam and hard feeling.

igeon loft above the economizer is also n much the same condition. There is ardly head room enough to get at the craper mechanism, much less to clean r take out the tubes.

This is all wrong. You are handling normous amounts of coal and water and rning out tons of steam, which is your ommercial product This economizer is s much a tool as the boilers, and to get aximum, or even reasonable, efficiency it must not be handicapped by being located n places hard to get at or work in. At east 10 feet of room is needed above the onomizer in order to clean and take tubes, and light and ventilation are eeded in order properly to care for the raping mechanism. You want light and ir behind the boilers as much as in front. ere are the blowoff valves and tube aps, if it is a water-tube boiler, and hese things must be plainly visible and asy to get at for cleaning and repairs. oo much slovenly work is done in dark unways behind the boilers, where the le illuminant is a smoky torch and nothing can be seen plainly. The men do not care—the owner did not when asked o spend money on this part of the plant. The results are half-cleaned boilers and leaky blowoffs. Enough money is lost in a year to pay for plenty of air and light behind the boilers twice over.

### Economizer Located Outside

In the design of a 10,000-horsepower plant, wherein all these misplaced schemes were proposed, the writer decided to cut loose from time-honored arrangements and put the economizer outside the boiler house entirely. It was not even banked up against the back wall of the boiler house (as is often done), because this would deprive the backs of the boilers of light that is worth more than the cost of an extra wall The boiler house was finished with plenty of windows, precisely as in front, and the economizers were placed on the opposite sides of the stacks and their housings completed to form a house over the scrapers, as shown in Fig. 3.

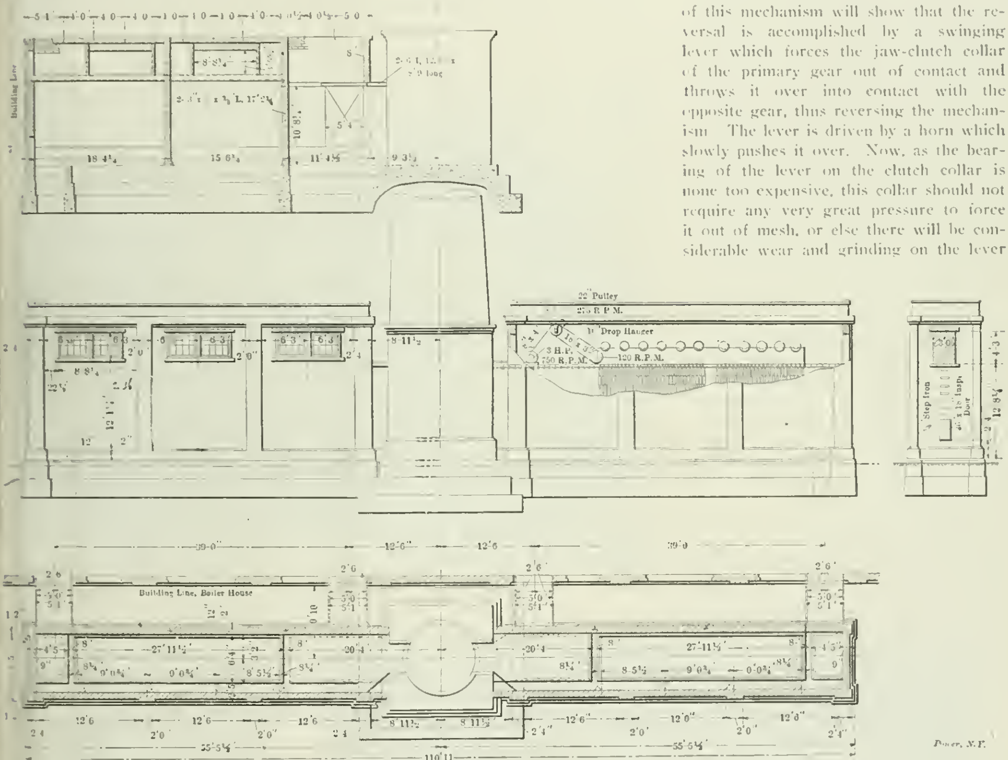


FIG. 3. SHOWING LOCATION OF ECONOMIZERS

To get the requisite 10 feet of room above the economizer would in this case make the building out of all proportion to the main boiler house, so a turbine cleaner was provided for cleaning out, and the head room cut down to 6 feet. To take out a tube this would necessitate cutting a hole in the roof, so this was made of concrete which is easily repaired. The economizer house was provided with ample light and ventilation from windows on both sides; these were made to swing horizontally, opening the lower side outwardly If made on the usual sliding-sash plan, there would be too much danger of their being left open during a thunderstorm, with consequent wetting of the economizer tops. The water that would thus leak down the tube would cake up just as surely as if it leaked from the inside of the tube.

To minimize operating charges, the first thing to look after is the reversing mechanism of the scrapers. A little study of this mechanism will show that the reversal is accomplished by a swinging lever which forces the jaw-clutch collar of the primary gear out of contact and throws it over into contact with the opposite gear, thus reversing the mechanism The lever is driven by a horn which slowly pushes it over. Now, as the bearing of the lever on the clutch collar is none too expensive, this collar should not require any very great pressure to force it out of mesh, or else there will be considerable wear and grinding on the lever and the collar flanges To obviate this wear is a matter of design. This reversing mechanism must of course be between the driving pulleys and the driven scraper sheaves. As the pulley must revolve at about 100 revolutions per minute or thereabout, and the scraper sheaves turn at about 2 revolutions per minute, a worm-and-wheel reducing gear must be put somewhere in the chain of speed reduction. If the worm gear is put next to the main driving pulley at 100 revolutions per minute, and the scraper sheaves are spur-driven by a common shaft, then the whole weight of all the scrapers is brought directly on the shaft and transmitted by it back to the gears driven by the clutch collar of the reversing mechanism. This pressure comes directly on the face of the jaw clutch, making the pressure to force the clutch out of mesh very great. It is not helped much by giving a slight "draw" on the faces of the clutch. If more than one or two scrapers are out of line with the rest, the whole affair becomes so tight as to grind the collar flanges very badly, and sometimes breaks the cast iron horn.

If, on the other hand, the worm and wheel gearing is placed directly at each sheave, then the weight of the scrapers comes on the driving shaft in end thrust instead of torque. If this end thrust is properly taken care of with collars running in oil boxes, then the torque on the shaft becomes only about one fortieth of the weight of the scrapers and, consequently, the pressure on the reversing mechanism is far less; but the speed is far higher as the total power delivered is the same with either mechanism. As high speed is simply a matter of lubrication, the wear on the reversing collar and lever can be much less than with slow speed and great pressure.

About the only practical drive for the scrapers is the electric motor, and if it is an induction alternating current machine, so much the better. It will require countershafting to get down to the speed of the driving pulley of the scraper, and should be located as near the economizer as possible. Avoid running the belt over the main boiler flue. Some day the economizer will be shut down, and the belt will be baked to a crisp where it has hung at rest over the flue.

In locating an economizer inside its housing, always set it close to the sectional coverings on one side and put the deflectors next the brick wall. This allows both sides of the economizer to be got at. It necessitates a very broad foundation wall on the deflector side, but it pays in the long run. If you tie up one side so it cannot be got at, rest assured that your first leak will be on that very side.

In selecting the size of the economizer allow 2½ horsepower per tube. They come eight and ten tubes wide per section, and in lengths of 9 and 10 feet from top to bottom of the tubes. One can get any desired number of sections to make up the requisite horsepower, but remember that the economizer is a pesky thing to enlarge, and get it big enough to provide at least for the immediate future. To keep down flue sizes it is well to divide it on opposite sides of the chimney, and the saving from this source alone is so great as to pay for the difference between four small chimneys and two large ones. The boiler house shown in Fig. 3 has one-half its ultimate capacity and was originally laid out with two 150x15-foot chimneys located at the end of the present building, which would be the center of the finished plant. But right there the economizer stepped into the problem and it was soon evident that four smaller chimneys would be better than the two large ones because the flues and bypasses were far cheaper divided on opposite sides of the stacks than if they all grew to two enormous flues centering in two chimneys on opposite sides of the boiler house.

### COST AND SAVING

The unit costs of economizers and fixtures figure out as follows for machines of from 1000 to 5000 horsepower: Economizer, $2.75 per horsepower; brickwork, 60 cents; dampers, 3 cents; sectional covers, 13 cents; sheet iron, 8 cents; total, $3.53 per horsepower. A 5000-horsepower economizer will figure complete about $18,000 and its saving may be estimated, with stack temperatures of 400 degrees and feed water at 200 degrees, as follows: Rise of feed temperature (70 degrees is the very best attainable), say 60 degrees. For each degree rise in feed water the evaporation gains 0.1 per cent., or 6 per cent. for 60 degrees. At 260 tons per day, 6 per cent. of the coal means 15 tons saved, which, at $3 per ton fired is $45 per day. As the actual boiler horsepower is seldom more than 75 per cent of the total capacity of the boilers, however, the actual saving would be about $33. This amounts to $12,045 in a year and will pay for the economizer in about two years, allowing for all cleanings and repairs and maintenance charges.

## Short Method for Determining Total Heating Surface of a Boiler

The determination of the total heating surface of a boiler with sufficient accuracy for ordinary purposes is not difficult. A short approximate method for any boiler is to figure the heating surface in the tubes and divide it by 0.85 for a return tubular boiler or by 0.90 for a water-tube boiler. In case the return tubular boiler has an arch over the top for gas passage, giving a so-called third return, it is necessary to add from 100 to 200 square feet to the result to obtain the total heating surface.

This short method may be proved by two examples, as follows:

1—Take a return tubular boiler which is 18 feet long and 6 feet in diameter, with 72 four-inch tubes. According to Kent, the square feet per foot length for a 4-inch tube equals 1.047; then,

$$1.047 \times 18 \times 72 = 1357$$

square feet in tubes.

$$3.1416 \times 6 \times 18 = 339$$

square feet in shell.

$$(3.1416 \times 9) - (72 \times 3.1416 \times 0.172) \times 2 = 44$$

square feet in tube sheets.

Hence the total effective heating surface is,

$$1357 + \frac{339}{2} + 44 = 1570;$$

but

$$\frac{1357}{1570} = 0.863,$$

hence approximately 85 per cent. of the total effective heating surface of a return tubular boiler is in the tubes.

2—Take a Heine water-tube boiler having 116 tubes 3½ inches in diameter and 18 feet long and a 42-inch drum 21 feet 6 inches long. According to Kent, the square feet per foot length for a 3½-inch tube = 0.916; then,

$$0.916 \times 18 \times 116 = 1912$$

square feet in tubes. The approximate dimensions of the water legs are 6 feet 6 inches by 4 feet = 26 square feet; the tube area in water legs = 8 square feet; and the heating surface in water legs =

$$(26 \times 2) - (8 \times 2) = 36$$

square feet. The effective heating surface in drum =

$$\frac{3.1416 \times 3.6 \times 21.5}{2} = 118$$

square feet. Thus, the total effective heating surface =

$$1912 + 36 + 118 = 2066$$

square feet; but,

$$\frac{1912}{2066} = 0.925,$$

hence approximately 92 per cent. of the total effective heating surface of a Heine water-tube boiler is in the tubes. In other types of water-tube boilers the ratio was found to be lower; but 90 per cent. may be assumed as a fair average ratio.

One of the largest overground pumping engines ever built was recently turned out by a British builder for the Pekin Syndicate, Limited. It is of the horizontal compound condensing type, with the engine erected on the surface and the pumps operated by means of "L" legs and balanced rods. The diameter of the high-pressure cylinder is 56 inches, the low-pressure, 110 inches, and the stroke, 10 feet. The two rams are 27 inches in diameter by 10 foot stroke, and the capacity of the installation, 174,000 gallons per hour from a depth of 1000 feet.

The engineer may be able to temper springs better than the average blacksmith but the best springs often break, reflecting upon his ability; so it would not pay the engineer to temper important springs, unless the blacksmith failed to make good.

To prevent the blast from a soot sucker eroding the feed-pipe and water-column connections, they can be protected with a sheet-iron sleeve.

# Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think,
Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

## The Patent Situation in the United States Respecting Alloys

A paper of C. H. Clamer, on "The atent Situation in the United States Respecting Alloys," was read by Dr. F. I. F. Stephenson before the Foundrymen's convention at Cincinnati. To me, this paper does not appear to be a discussion on the title chosen, but rather an epitome of their own personal situation. I believe Mr. Clamer claims letters of patent on alloys containing under 7 per cent. tin, and over 20 per cent. lead, the balance copper. To grant a patent on such alloys as late as 1900 to me seems absurd.

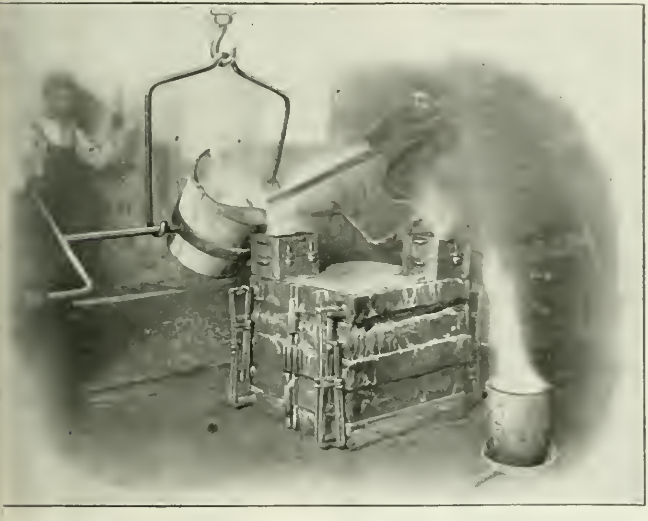


FIG. 1. FILLING MILL-PINION BEARINGS

The art of producing bearing metals, containing under 7 per cent. tin, and over 20 per cent. lead, the balance copper, was pursued long before the time claimed for patent rights by Mr. Clamer and his associate. Long before he and others tried to raise the lead percentage in copper-tin-lead alloys, Andrew Allan, Sr., of New York, invented a secret process by which copper and lead may be alloyed in any proportion with or without the use of tin and a perfectly homogeneous mixture obtained. Castings weighing 1000 pounds and over can be produced without the slightest signs of segregation.

It is generally believed that a certain per cent. of tin is necessary to assist in keeping the copper and lead homogeneously mixed. This is not the case. The introduction of tin into the alloy has no bearing whatever on keeping the lead from segregating from the mix, but rather to harden the alloy, and thus reduce proportionally its antifriction and wearing qualities.

The art of amalgamating copper and lead in any desired proportions with or without tin, was invented by Andrew Allan, Sr., in 1876; but it was not until 15 years later (1891) that he started to place various alloys on the market under

IG. 2. BUSHING FOR GUIDE BEARING ON TURBINE

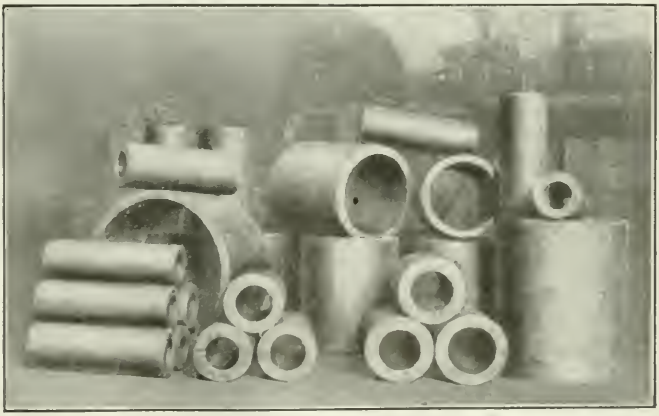


FIG. 3. ASSORTMENT OF BUSHINGS FOR METALLIC PISTON-ROD PACKINGS

the name of "Allan's Red Antifriction Metal," or "Allan Metals." Large quantities of these metals were used throughout the United States before the patentees were sold in Philadelphia prior to said date and bearing metal manufacturers were generally aware of their existence.

For years Andrew Allan, Sr., has claimed that no other metallurgist has mastered the art of amalgamating copper and lead with or without tin, and not until they can produce castings as illustrated, of alloys of copper and lead in any proportion, with or without tin and have same homogeneously mixed without the slightest sign of segregation have they the right to claim to be masters of the art.

Fig. 1 shows rolling mill pinion bearings. These bearings take 1000 pounds of metal to the cast. Fig. 2 shows a bushing for a guide bearing on an 8000-kilowatt Curtis steam turbine. Fig. 3 shows an assortment of bushings for metallic piston-rod packings. All of these casts are homogeneously mixed with not the slightest sign of segregation.

The claim may arise that Andrew Allan, Sr., is not, or has not been manufacturing a copper tin lead alloy. True, most of his formulas do not contain tin. This does not affect the case; if the patent in question is legal, then Allan Metals are infringements on said patent, as they contain less than 7 per cent. tin, and over 20 per cent. lead, the balance copper. "One object of the patent in question is to fill a recognized want and provide an alloy for journal bearings which shall hold up within itself more lead than was heretofore possible without the use of nickel." Andrew Allan, Sr., has been meeting these conditions for the past 18 years.

He learned from experience that tin, nickel or other metals added to the lead-copper mixture, were quite injurious to the antifriction and wearing qualities of the lead and without raising the melting point rendered the mixture hard and brittle and not adapted to high grade service, such as for locomotives, marine and stationary engine steam pistons, piston-rod packings for superheated service, bearings for mill pinions, rolling mill and central station engines, etc. Tin especially, because of its adhesive qualities, he found to be a very undesirable element in these alloys when a high grade antifriction metal was wanted.

This reply to Mr Clamer's paper is by no means prompted by malice. Its motives are to correct a false impression and to give credit where credit belongs for the invention of this art.

ANDREW ALLAN, JR.

New York City.

## Experience of Two Self-appointed Engineers

"Hey, 'Hen,' let's take this over to the forge and bend the offset."

"Great scheme," replied "Hen;" "come on."

This conversation took place between two pipers late one Sunday afternoon and, shouldering a piece of 4-inch pipe, they meandered over to the forge. As it was getting late and the doughty pipers were in a hurry to get home, they got quite a move on.

"Don," while bustling around the large engine told "Hen" to start up the 40-horsepower engine. This engine ran at 300 revolutions per minute and was a center-crank affair, built with a good large cylinder and fitted with a pair of heavy flywheels. As it had been shut
down about five hours it had filled up
its full capacity of condensation, due
a leaky throttle and closed cylinder dr
Therefore, when Henry ambled over
start up, he did not open the drip pip
and then things happened. "Hen" ga
the throttle one celebrated pipefitte
twist, which was followed by a chu
chung, crash, bang! and a deluge of
water and steam from a 3-inch pipe w
80 pounds steam pressure behind it.

"Hen" heard the crash and started
"beat it" for the back door, when
final bang came. This so befuddled h
that he got twisted, lost his bearings a
nearly knocked the door casing off. W
he came to, the excitement was over a
the fireman was engaged in wetting h
down with the hose.

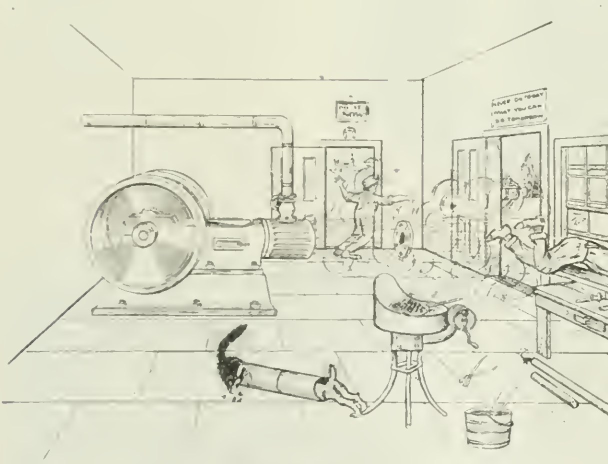
"Don" heard the bang and, thinkin
boiler had gone up, struggled to cr
under the forge, but failed. Then gath
ing all his energy he made one giga
leap, cleared the workbench and w
out through the window, head first.

While these circus stunts were be
enacted the fireman got busy and s
off the steam at the boilers. Inspect
showed that the connecting rod
snapped off and a lug at the crossh
end was badly bent. The cylinder h
was found outside near the front d
with some of the studs still in the hol
a piece of cylinder which spanned
port had taken "French leave" and co
not be found.

The pipers, convinced that the w
was over, shouldered their pipe
"hiked" it back to whence they ca
wondering how they could explain
the "old man" how that pesky old en
had wrecked itself without anyone b
near it.

A. R. HILBER

E. Rutherford, N. J.



EVERY ONE FOR HIMSELF

## Air Lift Installation

Replying to Felix Hagan, in the J
16 number, who asks for information
air-lift installation, I would advise hin
turn to Tulley's handbook, pages 807
808, where he will find the informatio
desires.

Although having three air compres
with a total capacity of 3400 cubic fee
free air per minute, and a constant
of 3000 cubic feet, we use a 6x36-
deep-well pump, which lifts all the w
required for boilers and other purp
Our tank is only 75 feet high and
depth of well is 62 feet, with an 8-
casing.

A good deep-well steam pump, of a
capacity, will be far more economical
the air lift, besides being on the job w
the compressors are shut down, so lon
steam is on the boilers.

W. D. RANNE

Columbus, O.

## A Homemade Whistle

In the accompanying sketches is own the construction of a whistle. will be seen that the whistle con-

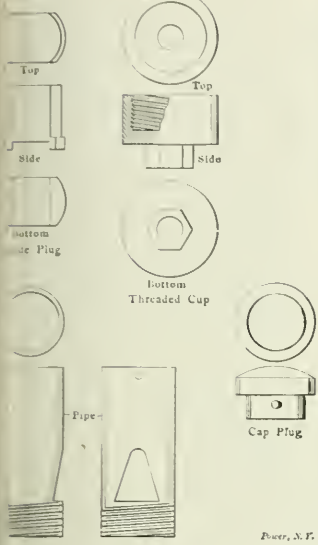


FIG. I. DETAILS OF WHISTLE

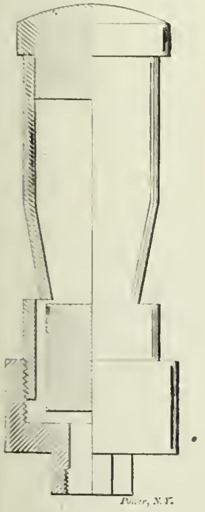


FIG. 2

sists of a piece of pipe, an inside plug, a readed cup or base and a plug cap fo the top.

he inside plug has two flat sides and a houlder at the bottom, upon which rests the lower end of the piece of pipe. In the lower end of the plug is a slot to allow the air or steam to flow from the base to the upper portion and through the holes to the outside. The plug is inserted in the pipe in such a way that the flat sides of the plug coincide with the holes in the pipe. The plug should be a snug fit for the inside of the pipe to insure its staying in proper position while screwing the pipe into the base.

Fig. 1 shows the parts in detail, and Fig. 2 the parts assembled. A small pipe from the source of supply leads into the bottom of the base, below which any whistle valve may be located. By varying the length of the pipe or the size of the openings in the pipe the volume of sound and tone of the whistle may be varied to suit.

The small opening in the bottom of the base is tapped to receive the supply pipe.

C. L. GREER.

Handley, Tex.

## Eccentric at Ninety Degrees

On page 1019 of the June 8 number, L. Roundy suggests that getting a three-quarter cutoff with the eccentric set at 90 degrees needs further explanation. Let us look at it from another viewpoint.

A piston, with a speed of 600 feet per minute, has an average speed of 1 foot in one-tenth of a second. As it stops twice per revolution, and as it runs slow near the centers, it is evident that it travels much faster than this at the center of the cylinder. On the outside of the cylinder is a valve gear traveling much slower, and when the piston is traveling at its highest speed in the center, the valve has been pulled one way, but is tripped and starts the other way. Doing this requires an interval of time, short it is true, but still an interval, and during this time the piston is making its highest speed.

If, as one examiner puts it, "When an engine cuts off, it cuts off and that is all there is about it," when the valve tripped it would be necessary for the piston to come to a stop for this short interval. With an early cutoff the valve has not been pulled open to its full extent and closes more quickly, and at the same time the piston is moving slower and there is no trouble in the cutoff taking place near the point indicated.

W. F. CRANE.

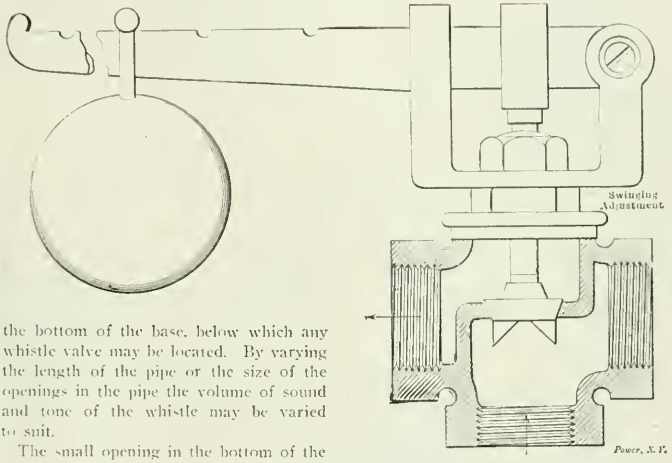
Broadalbin, N. Y.

## Partitioned Safety Valve

In the April 27 number, page 773, Ernest Hall refers to a safety valve having a partition. This kind of valve will be found throughout the oil and gas regions, but not so often as ten or fifteen years ago. They are all of the cheapest make I have seen. The sketch illustrates one of them. It will be noticed that the weight arm can be turned around to one side of the valve so as not to bother the piping.

ROY STAHL.

Rising Sun, O.



A PARTITIONED SAFETY VALVE

## Flat Crank Pins

Charles H. Taylor, in a recent letter says, "steam is admitted while the piston is at the end of the stroke, and carried, presumably, to one-quarter stroke before cutoff is obtained, consequently during this period of pin travel, it is subjected to the maximum pressure."

The only thing wrong with this statement is that it is not true, and in making it, Mr. Taylor seems to have disregarded everything except the steam forces acting on the piston.

If the reciprocating parts of his engine were entirely without weight his reasoning would not be wide of the mark, but the chances are that it is very much like the everyday engine that most engineers have to do with in that it re-

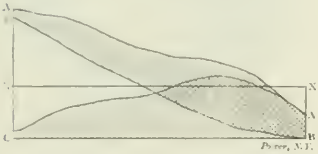
[illegible] power to impart motion to the reciprocating parts, which power or force is given off again in like amount when the moving parts come to rest.

That is to say, when starting from rest at the beginning of the stroke the piston, piston rod, crosshead and connecting rod, absorb a good share of the force exerted on the piston by the incoming steam, in acquiring the necessary motion to keep up with the crank pin. As the motion of these parts does not reach its maximum until about midstroke, it is obvious that in ordinary reciprocating engines the crank pin does not receive its maximum pressure until after midstroke.

The actual point of greatest pressure depends on the revolutions per minute, the initial pressure and steam distribution and the relative weight of the reciprocating parts.

The slow-moving engine having light reciprocating parts will receive the maximum pressure at the pin much earlier in the stroke than will be the case with the high-speed engine having relatively heavy parts.

As a matter of fact, the builders of some of our best engines deliberately add weight to the reciprocating parts of their engines in order to equalize the forces exerted on the crank pin.



MR. TILDEN'S "FORCE" DIAGRAM

Disregarding the distorting effect of connecting rod angularity we can assume that the piston, starting from rest at the beginning of the stroke, gradually increases its rate of motion until near midstroke, when acceleration of motion ceases and the motion acquired is gradually reduced until the parts again come to rest at the end of the stroke.

If, as has been stated, force is required to impart motion to matter, a measurable part of the steam force, acting on the piston during the first half of the stroke, is absorbed by the reciprocating parts, to be given off again during the last half of the stroke in gradually coming to rest.

In one case the force required to accelerate the motion of the reciprocating parts comes from and must be subtracted from the steam force; in the other case, the force required to bring the reciprocating parts to rest must be added to the force exerted by the expanding steam acting on the piston after midstroke. For this reason the general appearance of an indicator diagram tells us nothing concerning the *time* of maximum pressure at the crank pin, but the indicator diagrams' in conjunction with other factors, that is, revolutions per minute, weight of reciprocating parts, etc., enable us to calculate a force diagram that will tell us just what pressure is acting on the pin at all points in the stroke.

In the accompanying sketch, the distribution of steam forces is indicated by curve *A A*, the distribution of inertia forces by curve *B B*, and the distribution of pressures of the crank pin by curve *C A*, *X X* being the neutral line and *C B* the base line. It will be noted in this case that the pin did not receive its maximum pressure until quite a little past midstroke, the engine in question being a 19 x35x34 inch tandem compound, running at 132 revolutions per minute, with 90-pounds boiler pressure.

E. G. Tilden.

Downers Grove, Ill.

## Where Should the Throttle Be?

On page 1058 of the June 15 number, F. Webster propounds the question, "Where shall the throttle be?" One engine builder, now dead, who had had some experience with engines, made a practice of putting the wheel toward the head end of the cylinder. Placed in this position the engineer could reach it by reaching over the valve gear, over the end of the cylinder, or from the opposite side of the cylinder. He could take his choice.

W. E. Crane.

Breadalbin, N. Y.

## Thicken Metal at the Joint

The joint illustrated by A. H. Hale on page 890 of the May 18 number, may be all right in theory, but I do not believe such a plate could be rolled very well at the mills with the machinery now used, or handled by the boiler manufacturer with any degree of satisfaction. Regarding the grain of plates; iron is worked by the "grain," but steel plates are not so spoken of, or so worked, and the grain is not considered as having any bearing on the working of the plate.

J. F. Webster.

Canton, O.

## Timing Gas Engine Valves and Ignition

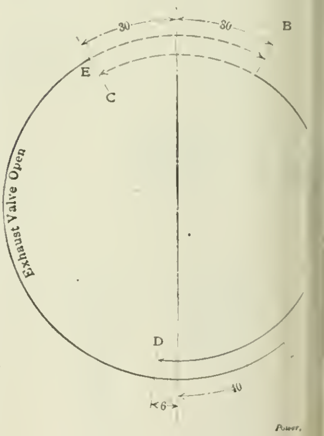
Harry A. Meixner's letter in the May 4 number, page 804, has the merit of definiteness, to say the least, but my conclusions in regard to gas-engine valve setting certainly do not "jibe" with his experience. The diagrams he shows, while truthful in the abstract, are misleading from the particular viewpoint.

Quartering a circle and calling ea division 180 degrees may *sound* all rig in discussing the functional events of four stroke cycle gas engine, but if stick to the old custom of calling one half of 360 and diagram our analy. on that basis, I think we will have clearer view and get nearer the truth.

The illustration shows the shaded p tion of Mr. Meixner's Fig. 1 laid out a true scale; that is, a piston stroke one half revolution equals 180 degrees

The exhaust valve opens at *A*, 40 grees before the end of the explosi stroke, and closes at *B*, 30 degrees af passing the end of the scavenging stro and 60 *degrees after the intake valve opened.*

When the crank has reached *E*, remaining unswept portion of the c inder is full of burned gas, at a li more than atmospheric pressure. If inlet valve is opened at this point, w prevents the outgoing waste gas fr



TIMING GAS-ENGINE VALVES

seeking a passageway by that r especially as both openings lead to the mosphere, and the intake pipe is the shorter usually?

Just what good purpose is served filling the intake passage back to mixer or carbureter with waste gas not been pointed out in Mr. Meix letter.

We cannot dispute his assertion tha got varying results from different erating conditions, but I am curiou to the conditions under which the en were operating previously if the setting shown effected an improveme

If Mr. Meixner is dealing with a stallation where the gas and air brought to the engine under pressure, reasoning does not apply, but that of gas engine is not under discussion

E. G. Tild

Downers Grove, Ill.

# Two Novel Installations

Some time ago I visited a small electric-ht station, and during conversation with y friend the chief engineer, he pro-unded an interesting exciter problem, ich, with his permission, I pass along the readers of POWER. To be brief, a w engine direct-connected to a 250-kilowatt alternator was installed in the plant about a year ago, and to supply the field current, a motor-generator set was furnished with it. Owing to frequent short-circuits on the line, and the absence of reliable circuit breakers, he is greatly bothered by the induction motor lying down on him, necessitating starting another engine that has a belted exciter. The plant has to a certain extent been modernized, and somewhere in the process was changed from single-phase to three-phase 2300-volt system, with the result that he has a small upright Shepherd engine on his hands lying idle. Now he proposes to connect this engine to the motor generator so that, in case the induction motor fails, the engine shall start automatically and drive both generator and motor and, at least, supply the station

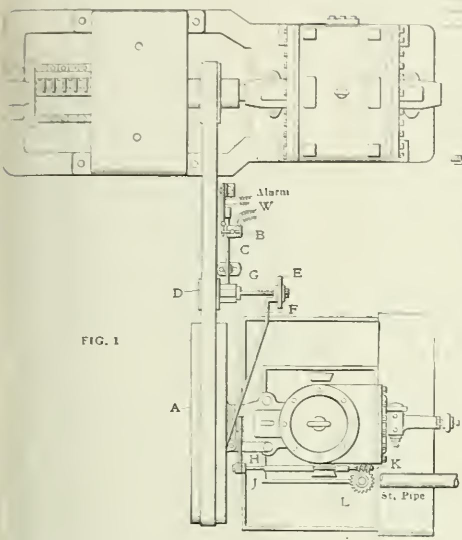


FIG. 1

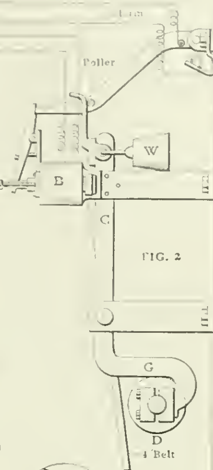


FIG. 2

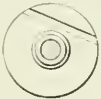


FIG. 3a

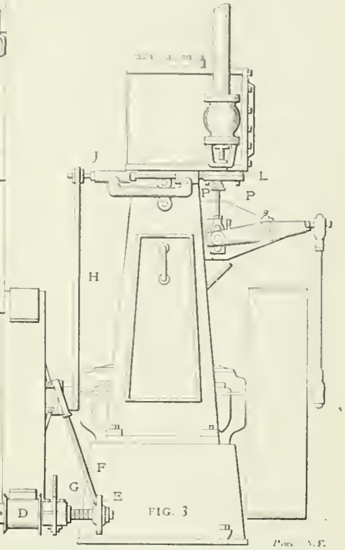
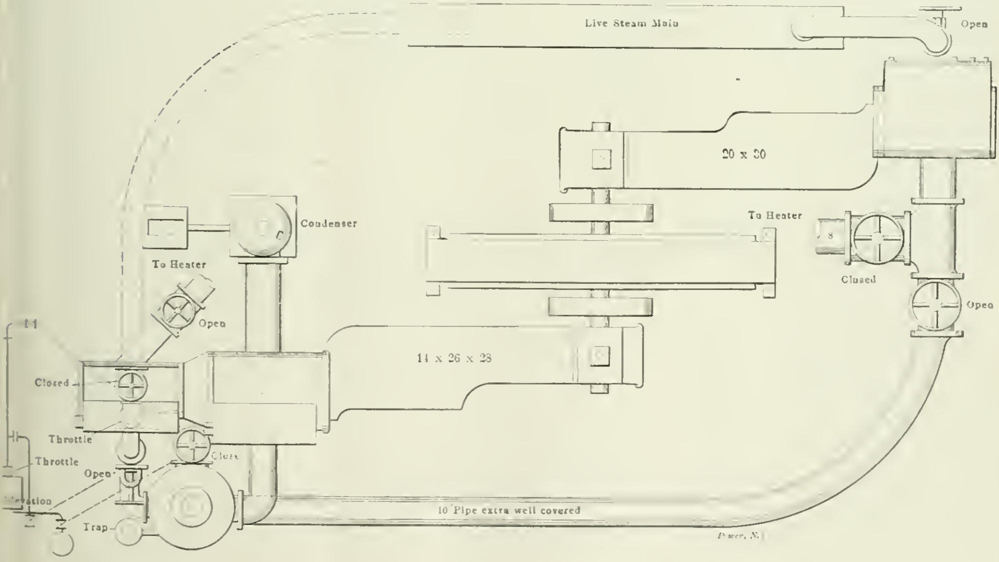


FIG. 3

Power, N.Y.



Power, N.Y.

FIG. 4

lights at night until the faulty circuit can be determined and cut out. The way he proposes to do this is shown in Figs. 1, 2 and 3. There are, no doubt, better ways of connecting the engine than shown, but it must be remembered that this engineer cannot go to any expense and must utilize such material as he has on hand, at least until the next appropriation is made at the town meeting. Fig. 1 shows a plan of the motor-generator set and engine, in which A is a Hunter clutch, the pulley of which is belted to the face of the coupling (12 inches in diameter, 4½ inches face) and B is an old low-voltage direct-current circuit-breaker release which, as shown in Fig. 2, is made to support the lever C and weight W. When the exciter voltage drops below a certain point, the device will release the lever, which by dropping will raise the idler D and bring it in contact with the belt, with such tension as the size and position of the weight W will give. The low-voltage release, in a manner easily understood but not shown, will also pull out the high-tension switch of the induction motor. Mounted on the shaft of the idler D is the disk E, Figs. 1 and 3. The end of the shipping lever F rests in a groove cut on the face of it (see Fig. 3a) which prevents the disk from turning with the idler and causes it to travel on the screw toward the journal G and throw the clutch into gear, at which time the shipping lever leaves the groove, allowing the disk to turn with the idler. It is now expected that the momentum of the motor generator will start the engine (which will always be kept warmed up), and that the flanges of the idler will prevent slipping off of the belt. Assuming this to be so, the small belt H, Fig. 3, will start running, causing the shaft J and worm K and the spur gear I to revolve, which gradually opens the throttle and brings the engine quickly to work. When the throttle is wide open the opening pins P attached to the spur gear will leave their hold of the handwheel, for the gear will be mounted on the stationary yoke screw of the valve, a special one to be made for the purpose. It will now be seen that all that remains for the engineer to do is to throw in the high-tension switch of the motor and shut down the engine, provided, of course, that the fuse on the affected circuit has melted. If not, then he will try pulling out feeder switches until he comes to it. In the latter case there is an admitted danger of burning out the generators, but this risk is assumed by the lighting commissioners in not furnish circuit breakers instead of fuses. What he would like to hear about is, is there any insurmountable mechanical or electrical reason why this will not work? The drawings shown are made from sketches and are not drawn to any scale.

The following is another proposed novel installation, the circumstances of which as detailed by the engineer are here briefly related. The plant at present consists of a tandem-compound condensing engine 14 and 20x28 built by the Fitchburg Engine Company and direct connected to a 325-kilowatt alternator. Haste which made them get what they could find ready for delivery put this comparatively large three-phase generator on this engine shaft, and also is responsible for the engine running at 120 revolutions per minute instead of 130 revolutions per minute, for which it was built. Now after five years growth of the mill, this engine is unable to deliver the power demanded of it, so that it is necessary to do something heroic to help it out. This mill was destroyed by fire six years ago but the engine, a 20x30-inch Buckeye, and two boilers were partially saved though the former at the time of rebuilding was deemed unsafe to run. It is now proposed to dig this engine up and install it in the present engine room, to help obtain the full power out of that generator. As both engines are right hand, it will be necessary to place the cylinder of the Buckeye on the opposite side of the shaft to the tandem (see Fig. 4). Very little difficulty is expected in fitting its main bearing and crank disk to the shaft of the Fitchburg, as the former, being equipped with an extra-large flywheel, has a shaft of a diameter within a fraction of an inch equal to that of the latter. By discarding the flywheel it is confidently expected that the engine bed and reciprocating parts will stand the speed of 120 revolutions per minute; the speed formerly was 110 revolutions per minute. In this plant considerable live steam is used for different purposes and in consequence a large quantity of feed water has to be heated. Now there is not sufficient exhaust steam from the auxiliaries to heat this water anywhere near what it ought to be, and to remedy this it is proposed to pipe the exhaust from the Buckeye engine so that both the high- and the low-pressure cylinders of the Fitchburg will draw on it; that is, there will be one high-pressure and two low-pressure cylinders. The exhaust from the smaller low-pressure cylinder, however, will flow to the heater and such other heating apparatus as can use it, while the exhaust from the regular low-pressure cylinder will flow to the condenser. The receiver pressure must necessarily be maintained as high as is practicable without looping the high-pressure indicator diagram, and it is proposed to add reheating coils in the present receiver and pass the steam for the air pump through them to obtain circulation. The size of the Buckeye exhaust pipe is made extra large so that it will act as part of the receiver. Space forbids going into discussion of the probable steam consumption. By slight calculation, you will see that what is proposed to be done is practically to change a 14 and 20x28 tandem compound into a 20 and 30 and 30x28-inch cross-compound. Aside from power developed, do the readers of POWER think that it is a wise move to change the engine in this manner?

R. O. RICHARDS.

Framingham, Mass.

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## Firing Boilers

The article under the above caption, by Victor White, in the April 6 number, and the replies by W. Bowden and others in the June 9 number were very interesting reading and contain many good points, but all the writers seem to lose sight of the fact that plants, boilers, fuel, etc., differ, and that a method of firing that will produce satisfactory and economical results in one plant will not do so in another or perhaps in the same plant with a different coal.

I have fired boilers in a street-railway power station where at the peak of the load five pounds loss of pressure meant pulling switches to ease up on the load. I used the wing method of firing with success and kept the pressure up so that thirty seconds after a circuit breaker came out on the switchboard, the pop safety valves would let go. This was with water-tube boilers carrying 125 pounds pressure. For twenty hours out of the twenty-four the load was comparatively light, from 7 to 9 a.m., the load was heavy, but from 5 until 7 p.m., it took every pound of steam that the boilers could make to keep the cars moving. We carried about 8 inches of fuel bed and did not break the fire with the slice bar but once an hour. We fired light and often, putting the coal where thin places showed in the fire.

The whole subject of firing may be simmered down to one fact, and that is, produce the largest amount of steam at a given pressure with the least amount of fuel, and that means dollars. It is just here that the fireman must use his brain and not tie himself down to any set method of firing simply because he was taught that way, or because someone has found it to be just the right thing for his particular plant conditions. The question of thick or thin fires, the amount of draft, kind, size and quality of coal, and the amount of forcing the boilers have to stand in order to furnish enough steam are all of importance, and a fireman who wants to do his work and do it right must find out what is best for his own particular conditions.

There is another criticism I wish to make of Mr. Bowden's article. In his method of firing, the fires are stirred too much. I never saw a fireman who was continually poking, spreading and stirring up his fires, produce economical results. It is also well to bear in mind that a fire man has other duties to perform besides looking after and running his fire, and no man from the farm or "anything in trousers" can learn the duties of a fireman in three days apprenticeship.

W. E. Sargent

Franklin, Mass.

## Why?

An electric station was fitted up with compound engines, capable of supplying a horsepower with from 13 to 14 pounds of water. At the time steam turbines came out several were installed. When the turbines were operated the station was run with one-half the boilers and one-half the coal required to drive the engines. Why?

A paper was read before a scientific society, showing the superior performance of a turbine over a vertical compound reciprocating engine, and made the performance of the latter appear ridiculous. It was admitted that the latter consumed 34 pounds of water per horsepower, which was attributed to leaks.

Why was this engine allowed to get into a condition where from 13 to 14 pounds of water was used in performing work and 20 pounds was wasted in leakage? Why was such a disreputable affair taken as a basis for comparing the economical performance of a reciprocating engine and a turbine?

A paper was read before the American Society of Mechanical Engineers, at the Scranton meeting in 1885, I think, giving the performance of an engine that was not creditable, and C. E. Emery inquired if the engine leaked. The author admitted that it did. "Then," said Mr. Emery, "that vitiates all experiments;" and there was no further discussion.

A paper was read before a society setting forth the great economy of the steam turbine, mentioning a prominent power station. It gave an elaborate description of the great savings that could be effected by the substitution of turbines for the reciprocating engines with which the station was equipped.

This station had as prime movers four-cylinder horizontal-vertical engines, excellently well managed, and careful records were kept of all expenses and the work done with each pound of coal.

The superintendent wrote the author, giving him the record of the work and advised him that if his company could make the economies as stated in his paper he might consider that letter as an order, and to commence at once to build the turbines and change the installation at the earliest possible moment.

The author owned up that he could not make good. Why?

On page 617, of the March 30 number, we read that a grist mill was equipped with a good automatic steam engine of 90 horsepower, and supplied with steam from an aggregate of 180 horsepower of tubular boilers. The internal surfaces were kept clean, the tubes scraped every day and the best grades of Georges Creek soft coal used. This engine could not always supply enough steam to keep the machinery at full speed. An 85 horsepower gas engine was installed and carried everything through without a hitch.

Here were 180 horsepower of tubular boilers in the pink of condition, fired with the best coal in the country and taxed to their utmost to furnish steam to a 90-horsepower automatic engine that could not do the work that an 85-horsepower gas engine found easy. Why?

W. E. Crane.

Broadalbin, N. Y.

## The Total Head Theoretically Produced by a Centrifugal Pump

It is often stated that when the discharge valve of a centrifugal pump is completely closed the head or pressure produced is equal to

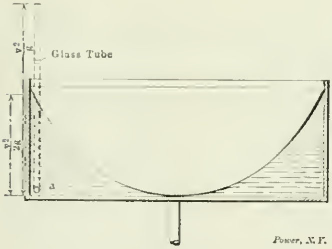


FIG. 1

$$\frac{v^2}{2g},$$

where $v$ is the peripheral velocity of the tip of the blades. It is intended in the following to show by simple apparatus that the theoretical head produced is not

$$\frac{v^2}{2g},$$

but

$$\frac{v^2}{g}.$$

With the discharge valve open, water is drawn in at the center of the impeller and thrown out toward the circumference, the pressure on the casing of the wheel being a minimum at the center and a maximum at the periphery. Let us first investigate the nature of the distribution of that pressure when the discharge valve is closed. Consider a pump with a vertical shaft, the upper part of the casing being removed and the surrounding vertical walls lengthened upward. Since there is no discharge there can be no suction, therefore let the suction opening in the center of the impeller be closed and a quantity of water poured into the inclosure. The pump will now be represented by the experimental apparatus shown in Fig. 1, in which the impeller and surrounding vertical walls are replaced by a cylindrical vessel mounted on a vertical shaft.

Let the vessel be rotated at such a speed that there is a small spot in the center just bare. The water will pile up against the walls due to centrifugal force having a magnitude of

$$\frac{v^2}{2g}.$$

At the periphery where the velocity is $v$ the water will stand at a level equal to

$$\frac{v^2}{2g}$$

from the bottom; at the center where the velocity is 0, the level will be 0; at a distance half-way out from the center where the velocity is $\frac{v}{2}$ the level will be

$$\frac{\left(\frac{v}{2}\right)^2}{2g} = \frac{v^2}{8g}.$$

The head due to centrifugal force will vary with the square of the distance from the center and the curve assumed by the surface of the water is that of a parabola.

In addition to the centrifugal force each particle of water has energy due to its velocity. At the periphery each unit mass has energy of

$$\frac{v^2}{2g}$$

and it is evident that this energy also varies with the square of the distance from the center.

The sum total of the energy in each unit mass of water at the bottom and at the periphery is

$$\frac{v^2}{g}.$$

Now if this vessel is shortened vertically to the normal thickness of the impeller and the casing replaced and it is again rotated these two energies are still present. The centrifugal force, however, does not manifest itself by producing a parabolic surface in the water, but a pressure is exerted on the upper and lower casings equal to the head previously produced. Plot these pressures at various distances from the center and the same parabolic surface is obtained as was actually obtained previously when the water was unconstrained. See Fig. 2.

In an actual pump the water is delivered from the blades into a vortex chamber, and the velocity of the water whirling about the axis may here be assumed to be also $v$.

When the discharge valve is opened the parabolic curve of pressures, shown in Fig. 2, is still present, but a part of the velocity head

$$\frac{v^2}{2g}$$

is used in moving the water through the discharge valve. The more the discharge valve is opened the more of the head

$$\frac{v^2}{2g}$$

is used until the area of valve opening equals the maximum cross-sectional area of the vortex chamber. If, now, the discharge pipe is enlarged and fashioned so that the velocity of water therein is gradually reduced from vortex velocity to a lower value the static head or pressure shown on the gage would be increased an amount proportionate to the decrease in velocity. Imagine an impossible case of the discharge pipe being increased to such a size that the velocity therein is zero, all the velocity head being converted into static head; the gage would now show a head of

$$\frac{v^2}{g}.$$

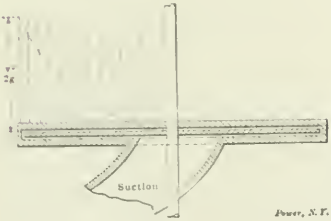


FIG. 2

The more nearly these impossible conditions are approached the more perfect it will be.

Consider the following case: A pump having a diameter of impeller of 45 inches and running 218 revolutions per minute has a peripheral velocity of 40 feet per second. It discharges through a pipe without valves directly into tanks for measurement, the suction and delivery heads being together 20.46 feet. The velocity head in the discharge pipe is 0.34 foot. The theoretical total head is

$$\frac{(40)^2}{32.2} = 50$$

feet, whereas the total actual head equals

$$20.46 + 0.34 = 20.8$$

feet. What causes the loss of head? The hydraulic efficiency of the pump, as shown by test, is 40 per cent. and

$$0.40 \times 50 = 20,$$

showing that at 218 revolutions per minute the velocity head was not fully utilized owing to slip and imperfect conversion from velocity head to static head.

A. H. ANDERSON.

Chicago, Ill.

## Power Required by Fans

I had a letter from Smithers the other day, who had a fan problem on his hands. It seems that a brick plant wished to use motors to drive an 8-foot and a 9-foot fan, at 200 revolutions per minute, used for exhausting heat from brick kilns.

Smithers wrote that they wanted about 15-horsepower motors, but he was not sure, and wished to know what power it would really take, and how I figured it out. I answered that it was a pretty hard matter to tell exactly what power the fans would take, as every bend, every obstruction and every foot of passageway through which the air had to travel reduces the total amount of air delivered, and also the horsepower required to drive the fans.

Another very important factor in the problem was the temperature of the air in the kilns; as, if he bought a motor with ample capacity to handle the air at 500 degrees and his customers should try to run it when the air in the kilns had dropped, say to 50 degrees, they would probably burn the motor. I wrote him that under his conditions probably the safest way to do would be to belt a motor to the fans and take readings. I gave him a couple of rules for the powers of fans, which err on the side of safety, but are handy for approximating the powers required by fans. The rules were as follows:

RULE 1. *Multiply the diameter of the wheel in feet by itself five times, and by the number of revolutions per minute three times. Divide this result by 10,000,000,000 and the answer will give the horsepower required to drive a fan handling air at 50 degrees Fahrenheit.*

RULE 2. *Divide 511 by the sum of 460 added to the temperature of the air in degrees Fahrenheit and multiply the horsepower, found by Rule 1, by this quotient. The result will give the horsepower required to drive a fan handling hot air.*

I worked out an example as follows:

What is the power required to drive an 8-foot wheel, 200 revolutions per minute, handling hot air at 50 degrees Fahrenheit?

$$\frac{8 \times 8 \times 8 \times 8 \times 8 \times 200 \times 200 \times 200}{10,000,000,000} = 26.21$$

horsepower required at 50 degrees Fahrenheit.

The second example was:

What power will this fan take at 500 degrees Fahrenheit?

$$\frac{511}{460 + 500} \times 26.21 = 13.9 \text{ or } 14$$

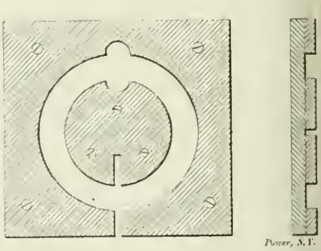
horsepower required at 500 degrees Fahrenheit. The fan makers used to allow but two thirds of the above horsepower to drive their fans, but with the advent of the electric motor it was found that a margin of 50 per cent. had to be allowed, and the rules as given above are approximately good, safe practice today.

WILLIAM SANGSTER.

Covington, Va.

## Packing Gage

Take a board to correspond with the thickness of the packing to be used and bore or cut with a keyhole saw a hole the size of the outside diameter of the stuffing box. Then make another piece the size of the piston rod and screw or nail these two on a third piece of board, placing the small round piece in the center of the hole and make a saw ker



A PACKING GAGE

large enough to admit the blade of knife. By placing the packing in the groove thus made wedge packing can b cut very nicely to an exact size.

IRA N. LEARN.

Stone Canon, Cal.

## Changed the Pipe Connections

The accompanying illustration present an example of how extraneous supervisio worked out in the remodeling of an ele vator system in a hotel building. Th elevator was a somewhat antiquated ap paratus, and had formerly been operate with a duplex steam pump supplied wit steam from a boiler plant located on th premises. This boiler plant was one o several isolated steam plants, by whic a number of buildings were provided wit power before the establishment of central power station; after which the in dividual steam plants were dismantled an all power was thereafter supplied elec trically from the central station.

A technical graduate, with no practica

training whatever, was employed by the rm of engineers who built the central ower station, and he was detailed to pervise the transformation from steam electricity in the hotel, which was acmplished, in the case of the elevator stem, by rigging up a motor-driven riplex pump to supersede the old steam mp. Aside from the introduction of an utomatically operated bypass from the scharge to the suction side of the new ump, to enable it to get up to speed fore beginning work against the comression-tank pressure, it was planned to ave all other details practically the same s before the change.

The supervising genius, however, ught he saw a chance to improve on he old method of returning the water scharged from the elevator cylinder to he surge tank; so he decided to connect he surge pipe to the suction pipe, as own at *A*, in the sketch, instead of rmitting it to open into the surge tank the manner indicated by the dotted es, as it had done before. He said would make a better-looking job and, sides, it would eliminate the surging, lashing sound of the water falling into tank.

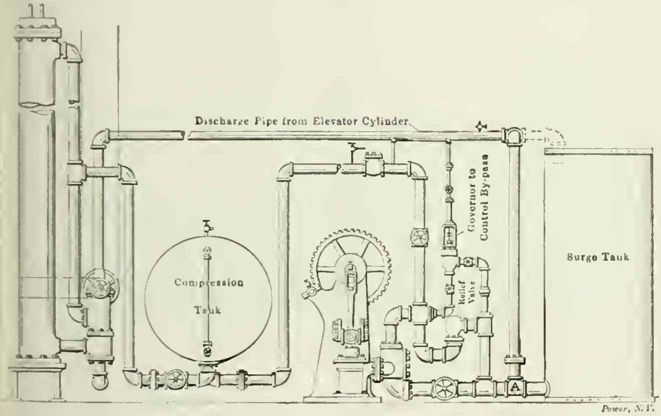
The practical operating engineer, who d successfully handled the plant for a mber of years previously, remonstrated a mild sort of way and gently intimated t trouble would surely ensue if the ter was returned to the pump in that y; but our technical friend could not ve seen this functionary with a magniing glass, nor heard him through a megaone, and, besides, would it not have en derogatory to his dignity as "conlting engineer" to seek advice or acpt suggestions from a rough-necked felw in overalls and jumper?

The connection was made, and the apratus started up. A day or two later, the elevator boy complained that the car kept bobbing up and down when he tried to stop it. The operating engineer maintained that it was not his job, and referred all complaints to the extraneous supervisor. The supervisor monkeyed around, and finally, when the car began bouncing up and down 5 or 6 feet at a bound, he concluded to solicit aid from the elevator people, who sent a man to investigate. This man relieved the cylinder of the air cushion which had formed above the piston, with comparative ease, but he spent the better part of a day getting rid of the cushion that had formed below. While he was attending to this, he also had a pipefitter industriously at work yanking out the supervisor's "improved" connection, and restoring the open discharge to the surge tank in the old way.

The cause of the trouble, which was all along plainly apparent to the old-timer who had run the plant for so many years, and which in fact was anticipated by him, lay in the fact that a goodly portion of the air which the water continually took up by absorption, had no chance to escape by bubbling out while the water of discharge was falling from the end of the surge pipe into the tank, as had formerly been the case. On the contrary, it was entrapped in the suction pipe and kept in the system while being constantly augmented by the further absorption of air from the external atmosphere, with the result that the water eventually became so impregnated with air bubbles as to liberate excessive quantities of air during each cycle in its passage through the elevator cylinder, thus forming air cushions more rapidly than would otherwise have been possible.

A. J. DIXON

Chicago, Ill.


Discharge Pipe from Elevator Cylinder
Governor to Control By-pass
Surge Tank
Compression Tank
Relief Valve
A
Power, N.Y.

CHANGE MADE IN PIPING OF ELEVATOR SYSTEM

## Receiver Pressure

In a recent issue, W. E. Crane states that "many engineers have learned that the highest economy in a compound engine is obtained by carrying the receiver pressure so that full atmospheric pressure shall be carried as near full stroke as possible in the low pressure cylinder." Does this imply that with a vacuum of 25 inches and a back pressure of 2.45 pounds, the receiver pressure should be carried at 2.45 pounds gage pressure? I generally carry from 7.5 to 9 pounds receiver pressure, which equalizes the load very nicely, but it may still be wasteful of steam. It seems to me that the ratio of the high-pressure piston area to the low-pressure piston area would govern, to some extent, the pressure carried in the receiver.

C. T. McKNIGHT.

San Antonio, Tex.

## Compound Engines

Following are the details of a peculiar experience I once had with a 16x26x20-inch compound engine, belted to a 250-volt direct-current generator, driving coal-cutting and haulage machinery. The load was very irregular sometimes. While the maximum load was on the circuit-breaker would fly out and leave the engine without any load whatever.

One day while everything was running smoothly, the engine suddenly stopped and "grunted," and the high-pressure cylinder head took a trip through the brick wall between the engine and boiler rooms. We made a head of boiler plate, doubling the plate to give it strength. The piston was also broken, and, having nothing with which to repair the piston, I removed the piston and rod, put a blind gasket over the stuffing box and disconnected the connecting rod on the high-pressure side, the low-pressure cylinder being in good pressure.

I opened the drain cocks on the high-pressure cylinder, turned the steam on, turned the engine off center and was ready for work the next morning.

As the engine was of the automatic cutoff type, I used the same governor, but it worked as a throttling governor instead of an automatic cutoff. The regulation was poor, owing to the existing conditions, i.e., the long pipe and condenser formed by the high-pressure cylinder between the cylinders and the governor; but we managed to run with it until a new engine of a different type was installed. The strange part of this experience was that the low-pressure cylinder did the work more satisfactorily and with a lower boiler pressure than was possible with both cylinders.

E. W. JACKSON.

Muddy, Ill.

## Operation of Steam Heating Plants

Some engineers seem to have an idea that the only remedy for a poorly working heating system is to increase the pressure, never realizing what effect the back pressure has on the running expenses of the plant. If there is poor circulation at 1 or 2 pounds pressure there will be poor circulation at 10, and increasing the pressure for the purpose of increasing the temperature of the steam has little effect on the radiation, but may have a tremendous effect on the coal bill at the end of the year.

The writer once took charge of a steam plant for a large apartment building containing 95 steam-heated flats, where conditions had been anything but satisfactory. The owner saw his profits going up the chimney, while tenants were constantly complaining of insufficient heat. The building was running its own electric-light and elevator service, and as a rule the exhaust under such conditions is ample to heat the building with little or no back pressure. The engineer previously in charge had carried 10 pounds and many of the tenants had acquired the habit of coming down in the engine room to look at the pressure gage on the heating main whenever they had reason to think they were not getting their money's worth. I made up my mind not to carry over 2 pounds at the most, but on cutting down the pressure there were so many threats and complaints that something had to be done. To remove the gage or refuse admittance would not do, so at the first opportunity we quietly ran the pipe from the steam main up a convenient shaft and in dropping down to the gage got a water leg of about 18 feet giving a false reading of 8 pounds, putting a drain cock in the lower bend to bring the pointer to zero when steam was shut off from the heating mains. This eased matters up a little.

I then went over the heating system, and in almost every case where there was real cause for complaint I found that the building and floors had settled to such an extent that there was, in some cases, absolutely no chance for the condensation to drain back from the radiators, thus making it necessary to raise some of them several inches from their original positions. There was also a heavy loss from condensation from the main pipes which were partly uncovered in the garret (this being an overhead system), in some places exposed to outside air running through open courts and air shafts. After these things had been attended to, there was no trouble to heat the building on less than 2 pounds pressure, and where the coal consumption had previously reached as high as 16 tons per day in zero weather, it dropped to less than 10 tons, and except in very severe weather the exhaust was found sufficient.

R. Cederblom.

Gary, Ind.

## Combination Fire and Water Tube Boiler

I submit the following description of a combination boiler for the benefit of companies building their boilers. The mud drum is 6 inches in diameter. The nozzles are riveted on and the water-circulating tubes are secured by flanges. The mud drum has a handhole for access to clean it out. The blowoff pipe is connected to this drum. (See sketch.)

E. H. Marzolf

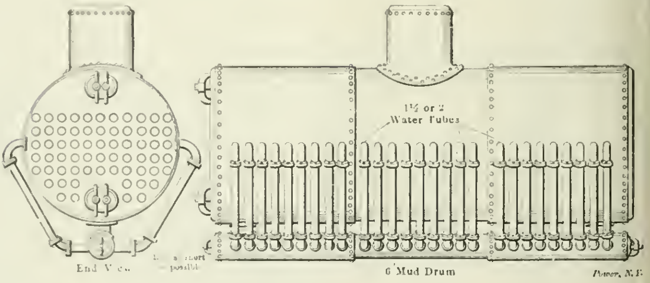
Bellaire, Ohio.

## Plugged Water Column Connection

Early during the past winter the lower connection to the water column of a boiler became clogged in some manner, although, owing to the use of all exhaust steam to heat the building, very little fresh water, with its load of impurities, was used. However, about 11 o'clock one cold night the engineer on watch noticed that the water in the gage glass was dead, and did not oscillate up and down. There being no valves between the water column and the boiler to close alternately to locate the trouble and remedy it if possible, he opened the blowoff under the column, connected to the ashpit, and after the first spasmodic bluster, the discharge announced only pure steam, and on closing the valve the glass began to fill, only slowly, by the condensation of the steam within it. The gage cocks also verified these facts. Knowing that there was movement of the water in the glass, announcing the true level, not more than 10 minutes before, and that the pump was in operation putting the returns back into the boiler, else the whistle on the receiver would have announced trouble in that direction, the engineer felt certain that there was no lack of an ample supply of water actually within the boiler itself.

Not wishing to take any risk, he at once banked the fire, threw the switch over into the city line, shut down the engine and turned the live steam on the house. The steam was allowed to escap from the boiler into the heating syster quite rapidly until the gage ceased t register. The system then formed a larg condenser, which created a partial vac uum. The plug in the cross connectio was removed, the vacuum preventing th water from coming out and scalding th engineer. When removed, the valv from the boiler to the heating system wa closed, thus cutting off the vacuum fro the boiler.

By means of a wire, the obstruction i the pipe connecting the column to th boiler was loosened, when the wate washed it out. This accomplished, th valve leading to the system was opene thus placing the boiler in communicatio with the vacuum created by the syster cooling off. This prevented the wate running out of the boiler at the cros while the plug was screwed in agai When the system valve was closed agai thus isolating the vacuum in the syster from the boiler, the water came up in th glass to the second gage, showing th there had not at any time been an danger.



COMBINATION FIRE- AND WATER-TUBE BOILER

The fires were "broke out," steam raise and in a short time the engine was starte

G. H. Wallace.

Racine, Wis.

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If the flues are leaky, and pretty we rolled out, and the engineer by great ca and skill rolls them tight, he will likel receive little credit. But should he fai his reputation will be jeopardized. Ha the average boilermaker made the san failure it would excite no comment.

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No one type of stoker is equall valuable for burning all kinds of co The plant which has an equipment prope ly designed to burn the cheapest co available will evaporate water at the lea cost.

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When practicable, a boiler can be cool more evenly by overflowing it to the sew over the top before taking the upper ma hole plate off.

# Supply Circuits for Electric Motors

## An Easy Method of Finding the Correct Size of Wire or the Loss in a Motor Circuit, Requiring Only the Simplest Arithmetic

BY CECIL P. POOLE

There are tables and charts in abundance by means of which one can ascertain the proper size of wire to be used for an electrical circuit after one has become familiar with the method of application. The accompanying tables, therefore, are not intended to supply any "long-felt want." They are presented, however, as an unusually simple means of arriving at the desired result and at the same time covering about the whole range of ordinary practice.

In order to deal with motor loads it is necessary to convert the horsepower of mechanical output into watts or kilowatts of intake since the power in electrical circuits is always measured in watts or kilowatts. Table 1 supplies the necessary equivalents to convert any number of horsepower, at any usual motor efficiency, into kilowatts.

TABLE 1. KILOWATTS OF MOTOR INTAKE CORRESPONDING TO OUTPUT IN HORSEPOWER.

| Efficiency | Output of Motor in Horsepower. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | ¼ | ½ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 60 | 0.3107 | 0.6214 | 1.243 | 2.486 | 3.728 | 4.971 | 6.214 | 7.457 | 8.699 | 9.942 | 11.185 |
| 61 | 0.3056 | 0.6112 | 1.222 | 2.445 | 3.667 | 4.890 | 6.112 | 7.334 | 8.557 | 9.779 | 11.001 |
| 62 | 0.3006 | 0.6013 | 1.203 | 2.405 | 3.608 | 4.811 | 6.013 | 7.216 | 8.419 | 9.621 | 10.824 |
| 63 | 0.2959 | 0.5918 | 1.184 | 2.367 | 3.551 | 4.734 | 5.918 | 7.101 | 8.285 | 9.469 | 10.652 |
| 64 | 0.2917 | 0.5825 | 1.165 | 2.330 | 3.495 | 4.660 | 5.825 | 6.990 | 8.156 | 9.321 | 10.486 |
| 65 | 0.2868 | 0.5736 | 1.147 | 2.294 | 3.441 | 4.589 | 5.736 | 6.883 | 8.030 | 9.177 | 10.324 |
| 66 | 0.2829 | 0.5649 | 1.130 | 2.260 | 3.389 | 4.519 | 5.649 | 6.779 | 7.908 | 9.038 | 10.168 |
| 67 | 0.2782 | 0.5565 | 1.113 | 2.226 | 3.339 | 4.452 | 5.565 | 6.677 | 7.790 | 8.903 | 10.016 |
| 68 | 0.2741 | 0.5483 | 1.097 | 2.193 | 3.290 | 4.386 | 5.483 | 6.579 | 7.676 | 8.772 | 9.869 |
| 69 | 0.2701 | 0.5403 | 1.081 | 2.161 | 3.242 | 4.323 | 5.403 | 6.484 | 7.565 | 8.645 | 9.726 |
| 70 | 0.2663 | 0.5326 | 1.065 | 2.130 | 3.196 | 4.261 | 5.326 | 6.391 | 7.457 | 8.522 | 9.587 |
| 71 | 0.2625 | 0.5251 | 1.050 | 2.100 | 3.151 | 4.201 | 5.251 | 6.301 | 7.351 | 8.402 | 9.452 |
| 72 | 0.2589 | 0.5178 | 1.036 | 2.071 | 3.107 | 4.143 | 5.178 | 6.214 | 7.249 | 8.285 | 9.321 |
| 73 | 0.2553 | 0.5107 | 1.021 | 2.043 | 3.064 | 4.086 | 5.107 | 6.129 | 7.150 | 8.172 | 9.193 |
| 74 | 0.2519 | 0.5038 | 1.008 | 2.015 | 3.023 | 4.031 | 5.038 | 6.046 | 7.053 | 8.061 | 9.069 |
| 75 | 0.2485 | 0.4971 | 0.9942 | 1.988 | 2.983 | 3.977 | 4.971 | 5.965 | 6.959 | 7.954 | 8.948 |
| 76 | 0.2453 | 0.4906 | 0.9811 | 1.962 | 2.943 | 3.924 | 4.906 | 5.887 | 6.868 | 7.849 | 8.830 |
| 77 | 0.2421 | 0.4842 | 0.9684 | 1.937 | 2.905 | 3.871 | 4.842 | 5.810 | 6.779 | 7.747 | 8.715 |
| 78 | 0.2390 | 0.4780 | 0.9560 | 1.912 | 2.868 | 3.824 | 4.780 | 5.736 | 6.692 | 7.648 | 8.604 |
| 79 | 0.2359 | 0.4719 | 0.9439 | 1.888 | 2.832 | 3.775 | 4.719 | 5.663 | 6.607 | 7.551 | 8.495 |
| 80 | 0.2330 | 0.4660 | 0.9321 | 1.864 | 2.796 | 3.728 | 4.660 | 5.592 | 6.524 | 7.457 | 8.389 |
| 81 | 0.2301 | 0.4603 | 0.9206 | 1.841 | 2.762 | 3.682 | 4.603 | 5.523 | 6.444 | 7.364 | 8.285 |
| 82 | 0.2273 | 0.4547 | 0.9093 | 1.819 | 2.728 | 3.637 | 4.547 | 5.456 | 6.365 | 7.275 | 8.184 |
| 83 | 0.2246 | 0.4492 | 0.8984 | 1.797 | 2.695 | 3.593 | 4.492 | 5.390 | 6.289 | 7.187 | 8.085 |
| 84 | 0.2219 | 0.4438 | 0.8877 | 1.775 | 2.663 | 3.551 | 4.438 | 5.326 | 6.214 | 7.101 | 7.989 |
| 85 | 0.2193 | 0.4386 | 0.8772 | 1.754 | 2.632 | 3.509 | 4.386 | 5.263 | 6.141 | 7.018 | 7.895 |
| 86 | 0.2167 | 0.4335 | 0.8670 | 1.734 | 2.601 | 3.468 | 4.335 | 5.202 | 6.069 | 6.936 | 7.803 |
| 87 | 0.2147 | 0.4285 | 0.8571 | 1.714 | 2.571 | 3.428 | 4.285 | 5.142 | 5.999 | 6.857 | 7.714 |
| 88 | 0.2118 | 0.4237 | 0.8473 | 1.695 | 2.542 | 3.389 | 4.237 | 5.084 | 5.931 | 6.779 | 7.626 |
| 89 | 0.2094 | 0.4189 | 0.8378 | 1.676 | 2.513 | 3.351 | 4.189 | 5.027 | 5.865 | 6.702 | 7.540 |
| 90 | 0.2071 | 0.4142 | 0.8285 | 1.657 | 2.485 | 3.314 | 4.142 | 4.971 | 5.800 | 6.628 | 7.456 |
| 91 | 0.2048 | 0.4097 | 0.8194 | 1.639 | 2.458 | 3.278 | 4.097 | 4.916 | 5.736 | 6.555 | 7.375 |
| 92 | 0.2026 | 0.4052 | 0.8105 | 1.621 | 2.431 | 3.242 | 4.052 | 4.863 | 5.673 | 6.484 | 7.294 |
| 93 | 0.2004 | 0.4009 | 0.8018 | 1.604 | 2.405 | 3.207 | 4.009 | 4.811 | 5.612 | 6.414 | 7.216 |
| 94 | 0.1983 | 0.3966 | 0.7932 | 1.586 | 2.380 | 3.173 | 3.966 | 4.759 | 5.553 | 6.346 | 7.139 |

TABLE 2. CIRCUIT FACTORS FOR DIRECT-CURRENT CIRCUITS.

Circuit Factor = 100,000 ÷ Voltage².

| Circuit Voltage.* | Factor. | Circuit Voltage.* | Factor. | Circuit Voltage.* | Factor. |
|---|---|---|---|---|---|
| 110 | 8.265 | 220 | 2.066 | 500 | 0.4000 |
| 115 | 7.562 | 230 | 1.891 | 550 | 0.3305 |
| 120 | 6.944 | 240 | 1.736 | 575 | 0.3024 |
| 125 | 6.400 | 250 | 1.600 | 600 | 0.2778 |

*The "circuit voltage" is that at the point where the kilowatts are reckoned.

Tables 2 and 2-A give what I have called the "circuit factor" corresponding to the voltage and power factor of the circuit under consideration. Since direct-current circuits have unity power factor, Table 2 specifies only the voltage.

Tables 3-A and 3-B give what I find it convenient to call the "transmission factor" of the problem. This is the product of kilowatts × distance × circuit factor. Knowing these three values, Table 3-A or 3-B will give the loss for a given size of wire or the size of wire for a given loss. For example, if the power is 4 kilowats, the distance 61 feet and the circuit factor 10.2, the transmission factor will be

4 × 61 × 10.2 = 2489.

If the circuit is direct current or single-

TABLE 2-A. CIRCUIT FACTORS FOR ALTERNATING-CURRENT CIRCUITS.

Circuit Factor = 100,000 ÷ E²p². E = Circuit Voltage.* p = Power Factor.

| Circuit Voltage* | Power Factor of the Circuit, Including the Load. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 80% | 81% | 82% | 83% | 84% | 85% | 86% | 88% | 90% | 92% | 94% | 96% | 98% |
| 100 | 15.625 | 15.242 | 14.87 | 14.52 | 14.17 | 13.84 | 13.52 | 12.91 | 12.35 | 11.81 | 11.32 | 10.85 | 10.41 |
| 104 | 14.445 | 14.092 | 13.75 | 13.42 | 13.28 | 12.80 | 12.50 | 11.94 | 11.414 | 10.923 | 10.463 | 10.032 | 9.627 |
| 110 | 12.913 | 12.596 | 12.291 | 11.997 | 11.713 | 11.139 | 11.171 | 10.672 | 10.203 | 9.761 | 9.353 | 8.968 | 8.605 |
| 200 | 3.906 | 3.810 | 3.718 | 3.629 | 3.543 | 3.460 | 3.380 | 3.228 | 3.086 | 2.954 | 2.829 | 2.713 | 2.603 |
| 208 | 3.611 | 3.523 | 3.438 | 3.355 | 3.276 | 3.199 | 3.125 | 2.985 | 2.851 | 2.731 | 2.616 | 2.508 | 2.407 |
| 220 | 3.228 | 3.149 | 3.073 | 2.999 | 2.928 | 2.860 | 2.794 | 2.668 | 2.551 | 2.441 | 2.338 | 2.242 | 2.151 |
| 400 | 0.9766 | 0.9526 | 0.9295 | 0.9072 | 0.8858 | 0.8651 | 0.8451 | 0.8071 | 0.7716 | 0.7384 | 0.7073 | 0.6782 | 0.6508 |
| 440 | 0.8071 | 0.7873 | 0.7682 | 0.7498 | 0.7320 | 0.7149 | 0.6984 | 0.6670 | 0.6377 | 0.6103 | 0.5846 | 0.5605 | 0.5378 |
| 500 | 0.6250 | 0.6097 | 0.5949 | 0.5806 | 0.5669 | 0.5536 | 0.5408 | 0.5165 | 0.4938 | 0.4726 | 0.4527 | 0.4340 | 0.4165 |
| 550 | 0.5165 | 0.5039 | 0.4916 | 0.4799 | 0.4685 | 0.4576 | 0.4470 | 0.4269 | 0.4081 | 0.3906 | 0.3741 | 0.3587 | 0.3442 |
| 1100 | 0.1291 | 0.1260 | 0.1229 | 0.1200 | 0.1171 | 0.1144 | 0.1117 | 0.1067 | 0.10203 | 0.09764 | 0.09353 | 0.08968 | 0.08605 |
| 1150 | 0.1181 | 0.1152 | 0.1124 | 0.1097 | 0.1071 | 0.1047 | 0.1022 | 0.09764 | 0.09335 | 0.08934 | 0.08558 | 0.08205 | 0.07873 |
| 2200 | 0.03228 | 0.03149 | 0.03073 | 0.02999 | 0.02928 | 0.02860 | 0.02794 | 0.02668 | 0.02551 | 0.02441 | 0.02338 | 0.02242 | 0.02151 |
| 2300 | 0.02951 | 0.02881 | 0.02811 | 0.02744 | 0.02679 | 0.02616 | 0.02556 | 0.02441 | 0.02331 | 0.02233 | 0.02139 | 0.02051 | 0.01968 |
| 6600 | 0.003587 | 0.003499 | 0.003414 | 0.003332 | 0.003254 | 0.003177 | 0.003104 | 0.002965 | 0.002834 | 0.002712 | 0.002598 | 0.002491 | 0.002390 |

*The "circuit voltage" is that at the end where the power is considered. Thus, if dealing with the kilowatts at the generator busbars, the "circuit voltage" is the busbar voltage; if considering the kilowatts taken from the line by a motor, the "circuit voltage" is that at the terminals of the motor.

phase alternating, it will have two wires (the neutral wire of the ordinary three-wire circuit is disregarded in this part of circuit layout). Table 3-A does not contain any numbers as small as 2480. In Table 3-B the nearest numbers are 2403, corresponding to 1 per cent. loss with No. 3 wire; 2471 corresponding to 1¼ per cent. loss with No. 4 wire; 2486 corresponding to 2 per cent. loss with No. 6 wire, and so on.

The "formula" to be applied, then, is simply

$$Kw. \times Feet \times ckt.\ fac. = Trans.\ fac.$$

and its transpositions

$$\frac{Trans.\ factor}{Kw. \times ckt.\ fac.} = Distance.$$

and

$$\frac{Trans.\ factor}{Distance \times ckt.\ fac.} = Kw.$$

It will be noted that Tables 3-A and 3-B contain two loss columns, one for all two-wire circuits and the other for two-phase and three-phase circuits. With all other conditions (kilowatts, distance, voltage, power factor and wire size) the same, the percentage of the applied or transmitted power lost in a two-wire circuit—either direct-current or single-phase—is exactly twice that in a two-phase, three-phase or any other polyphase circuit. Hence the ratio of 2 to 1 in the figures* in the two columns mentioned.

The loss percentages have been scaled closely enough for all practical purposes, but if anyone should wish to get closer results it is only necessary to remember that the transmission factor varies directly with the loss. For example, suppose that the transmission factor in a certain two-wire problem was *21,615* and the size of wire No. 000. The nearest numbers in the No. 000 column of Table 3-A are *20,662* and *22,251*; consequently, the loss in the actual circuit will be between 2.6 and 2.8 per cent., which is sufficiently informing ordinarily. But if the exact figure is desired, divide the actual transmission factor 21,615 by the 1 per cent. factor in the table, thus:

$$21615 \div 7947 = 2.72$$

which is the accurate percentage of loss.

Table 4 is the familiar one of wire properties, which is printed here merely for convenience; it is not necessary to use it in conjunction with the preceding tables, except to check up the carrying capacity of the wire selected. Tables 5, 6 and 7, giving the amperes per wire per kilowatt, are presented for the same purpose. They have no connection with Tables 1 to 3-B, which are used to determine the relation between wire size, loss, distance and power transmitted.

EXAMPLE I.

A 50 horsepower 250-volt direct-current motor of 90 per cent. efficiency must be supplied with not more than 3 per cent. loss at a distance of 250 feet. What size of wire must be used?

Referring to Table 1 it will be found that a 5 horsepower motor of 90 per cent efficiency would take 4.142 kilowatts from the line; a 50-horsepower machine would therefore take 41.42 kilowatts.

From Table 2, the circuit factor fo

TABLE 3-A. TRANSMISSION FACTORS, HEAVY WIRES.

TRANSMISSION FACTOR = KILOWATTS × DISTANCE IN FEET × CIRCUIT FACTOR.

| Per Cent Loss* | | Size of Wire in Circular Mils and B. & S. Gage. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| All 2-wire Circuits | Polyphase Circuits | 500M c.m. | 400M. c.m. | 300M. c.m. | 250,000 c.m. | 200,000 c.m. | No. 0000 | No. 000 | No. 00 | No. 0 | No. 1 | No. 2 |
| 1.0 | | 23,683 | 18,947 | 14,211 | 11,842 | 9,473 | 10,023 | 7,947 | 6,303 | 5,000 | 3,977 | 3,14 |
| 1.1 | | 26,051 | 20,841 | 15,632 | 13,026 | 10,421 | 11,025 | 8,741 | 6,934 | 5,500 | 4,375 | 3,45 |
| 1.2 | | 28,420 | 22,736 | 17,053 | 14,210 | 11,368 | 12,027 | 9,536 | 7,564 | 6,000 | 4,772 | 3,77 |
| 1.3 | | 30,788 | 24,630 | 18,474 | 15,391 | 12,315 | 13,030 | 10,331 | 8,195 | 6,500 | 5,170 | 4,08 |
| 1.4 | | 33,156 | 26,525 | 19,895 | 16,578 | 13,263 | 14,032 | 11,125 | 8,825 | 7,000 | 5,568 | 4,40 |
| 1.5 | | 35,525 | 28,420 | 21,316 | 17,762 | 14,210 | 15,034 | 11,920 | 9,455 | 7,500 | 5,966 | 4,71 |
| 1.6 | | 37,893 | 30,314 | 22,738 | 18,947 | 15,157 | 16,036 | 12,715 | 10,086 | 8,000 | 6,363 | 5,02 |
| 1.7 | | 40,261 | 32,209 | 24,159 | 20,131 | 16,105 | 17,039 | 13,509 | 10,716 | 8,500 | 6,761 | 5,34 |
| 1.8 | | 42,630 | 34,104 | 25,580 | 21,315 | 17,052 | 18,041 | 14,304 | 11,346 | 9,000 | 7,159 | 5,65 |
| 1.9 | | 44,998 | 35,998 | 27,001 | 22,499 | 17,999 | 19,043 | 15,099 | 11,977 | 9,500 | 7,556 | 5,97 |
| 2.0 | 1.0 | 47,366 | 37,893 | 28,422 | 23,683 | 18,947 | 20,045 | 15,894 | 12,607 | 10,000 | 7,954 | 6,28 |
| 2.2 | 1.1 | 52,103 | 41,682 | 31,264 | 26,051 | 20,841 | 22,050 | 17,483 | 13,868 | 11,000 | 8,750 | 6,91 |
| 2.4 | 1.2 | 56,840 | 45,472 | 34,106 | 28,420 | 22,736 | 24,055 | 19,072 | 15,128 | 12,000 | 9,545 | 7,54 |
| 2.6 | 1.3 | 61,576 | 49,261 | 36,949 | 30,788 | 24,631 | 26,059 | 20,662 | 16,389 | 13,000 | 10,340 | 8,17 |
| 2.8 | 1.4 | 66,313 | 53,050 | 39,791 | 33,156 | 26,525 | 28,064 | 22,251 | 17,650 | 14,000 | 11,136 | 8,80 |
| 3.0 | 1.5 | 71,050 | 56,840 | 42,633 | 35,525 | 28,420 | 30,068 | 23,840 | 18,910 | 15,000 | 11,931 | 9,42 |
| 3.2 | 1.6 | 75,786 | 60,629 | 45,475 | 37,893 | 30,315 | 32,073 | 25,430 | 20,171 | 16,000 | 12,727 | 10,0 |
| 3.4 | 1.7 | 80,523 | 64,418 | 48,317 | 40,261 | 32,209 | 34,077 | 27,019 | 21,432 | 17,000 | 13,522 | 10,6 |
| 3.6 | 1.8 | [illegible] | 68,208 | 51,160 | 42,630 | 34,104 | [illegible] | 28,609 | 22,693 | 18,000 | 14,317 | 11,31 |
| 3.8 | 1.9 | 89,995 | 71,997 | 54,002 | 44,998 | 35,998 | 38,086 | 30,198 | 23,953 | 19,000 | 15,113 | 11,94 |
| 4.0 | 2.0 | 94,733 | 75,786 | 56,844 | 47,366 | 37,893 | 40,091 | 31,787 | 25,214 | 20,000 | 15,908 | 12,57 |
| 4.2 | 2.1 | 99,469 | 79,576 | 59,686 | 49,735 | 39,788 | 42,095 | 33,376 | 26,475 | 21,000 | 16,704 | 13,2 |
| 4.4 | 2.2 | 104,206 | 83,365 | 62,528 | 52,103 | 41,682 | 44,100 | 34,966 | 27,735 | 22,000 | 17,499 | 13,8 |
| 4.6 | 2.3 | 108,943 | 87,154 | 65,371 | 54,471 | 43,577 | 46,105 | 36,555 | 28,996 | 23,000 | 18,294 | 14,4 |
| 4.8 | 2.4 | 113,679 | 90,943 | 68,213 | 56,840 | 45,472 | 48,109 | 38,144 | 30,257 | 24,000 | 19,090 | 15,08 |
| 5.0 | 2.5 | 118,416 | 94,733 | 71,055 | 59,208 | 47,366 | 50,114 | 39,734 | 31,517 | 25,000 | 19,885 | 15,71 |
| 5.2 | 2.6 | 123,153 | 98,522 | 73,897 | 61,576 | 49,261 | 52,118 | 41,323 | 32,778 | 26,000 | 20,681 | 16,34 |
| 5.4 | 2.7 | 127,889 | 102,311 | 76,739 | 63,945 | 51,156 | 54,123 | 42,913 | 34,039 | 27,000 | 21,476 | 16,97 |
| 5.6 | 2.8 | 132,626 | 106,101 | 79,582 | 66,313 | 53,050 | 56,127 | 44,502 | 35,299 | 28,000 | 22,272 | 17,6 |
| 5.8 | 2.9 | 137,363 | 109,890 | 82,424 | 68,681 | 54,945 | 58,132 | 46,091 | 36,560 | 29,000 | 23,067 | 18,2 |
| 6.0 | 3.0 | 142,099 | 113,679 | 85,266 | 71,050 | 56,840 | 60,136 | 47,681 | 37,821 | 30,000 | 23,862 | 18,8 |
| 6.2 | 3.1 | 146,835 | 117,469 | 88,108 | 73,418 | 58,734 | 62,141 | 49,270 | 39,082 | 31,000 | 24,658 | 19,4 |
| 6.4 | 3.2 | 151,572 | 121,258 | 90,950 | 75,786 | 60,629 | 64,146 | 50,859 | 40,342 | 32,000 | 25,453 | 20,1 |
| 6.6 | 3.3 | 156,309 | 125,047 | 93,792 | 78,155 | 62,524 | 66,150 | 52,449 | 41,603 | 33,000 | 26,249 | 20,7 |
| 6.8 | 3.4 | 161,046 | 128,837 | 96,635 | 80,523 | 64,418 | 68,155 | 54,038 | 42,864 | 34,000 | 27,044 | 21,3 |
| 7.0 | 3.5 | 165,782 | 132,626 | 99,477 | 82,891 | 66,313 | 70,159 | 55,627 | 44,124 | 35,000 | 27,839 | 22,0 |
| 7.2 | 3.6 | 170,519 | 136,415 | 102,319 | 85,260 | 68,208 | 72,164 | 57,217 | 45,385 | 36,000 | 28,635 | 22,6 |
| 7.4 | 3.7 | 175,256 | 140,205 | 105,161 | 87,628 | 70,102 | 74,168 | 58,806 | 46,646 | 37,000 | 29,430 | 23,2 |
| 7.6 | 3.8 | 179,992 | 143,994 | 108,003 | 89,996 | 71,997 | 76,173 | 60,395 | 47,906 | 38,000 | 30,226 | 23,8 |
| 7.8 | 3.9 | 184,729 | 147,783 | 110,846 | 92,364 | 73,892 | 78,177 | 61,985 | 49,167 | 39,000 | 31,021 | 24 |
| 8.0 | 4.0 | 189,466 | 151,573 | 113,688 | 94,733 | 75,786 | 80,182 | 63,574 | 50,428 | 40,000 | 31,817 | 25,1 |
| 8.2 | 4.1 | 194,202 | 155,362 | 116,530 | 97,101 | 77,681 | 82,186 | 65,163 | 51,689 | 41,000 | 32,612 | 25,7 |
| 8.4 | 4.2 | 198,939 | 159,151 | 119,372 | 99,469 | 79,576 | 84,191 | 66,753 | 52,949 | 42,000 | 33,407 | 26,4 |
| 8.6 | 4.3 | 203,676 | 162,940 | 122,214 | 101,838 | 81,470 | 86,196 | 68,342 | 54,210 | 43,000 | 34,203 | 27 |
| 8.8 | 4.4 | 208,412 | 166,730 | 125,057 | 104,206 | 83,365 | 88,200 | 69,931 | 55,471 | 44,000 | 34,998 | 27,6 |
| 9.0 | 4.5 | 213,149 | 170,519 | 127,899 | 106,574 | 85,260 | 90,205 | 71,521 | 56,731 | 45,000 | 35,794 | 28,2 |
| 9.2 | 4.6 | 217,885 | 174,308 | 130,741 | 108,943 | 87,154 | 92,209 | 73,110 | 57,992 | 46,000 | 36,589 | 28,9 |
| 9.4 | 4.7 | 222,622 | 178,098 | 133,583 | 111,311 | 89,049 | 94,214 | 74,700 | 59,253 | 47,000 | 37,384 | 29,5 |
| 9.6 | 4.8 | 227,359 | 181,887 | 136,425 | 113,679 | 90,944 | 96,218 | 76,289 | 60,513 | 48,000 | 38,180 | 30,1 |
| 9.8 | 4.9 | 232,095 | 185,676 | 139,268 | 116,048 | 92,838 | 98,223 | 77,878 | 61,774 | 49,000 | 38,975 | 30,8 |
| 10.0 | 5.0 | 236,832 | 189,466 | 142,110 | 118,416 | 94,733 | 100,227 | 79,468 | 63,035 | 50,000 | 39,771 | 31,4 |
| 10.4 | 5.2 | 246,305 | 197,044 | 147,794 | 123,153 | 98,522 | 104,236 | 82,646 | 65,556 | 52,000 | 41,362 | 32,6 |
| 10.8 | 5.4 | 255,779 | 204,623 | 153,479 | 127,889 | 102,311 | 108,246 | 85,825 | 68,078 | 54,000 | 42,952 | 33,9 |
| 11.2 | 5.6 | 265,252 | 212,202 | 159,163 | 132,626 | 106,101 | 112,255 | 89,004 | 70,599 | 56,000 | 44,543 | 35,2 |
| 11.6 | 5.8 | 274,725 | 219,780 | 164,847 | 137,363 | 109,890 | 116,264 | 92,182 | 73,120 | 58,000 | 46,134 | 36,4 |
| 12.0 | 6.0 | 284,199 | 227,359 | 170,532 | 142,099 | 113,679 | 120,273 | 95,361 | 75,642 | 60,000 | 47,725 | 37,7 |
| 12.4 | 6.2 | 293,672 | 234,937 | 176,216 | 146,836 | 117,469 | 124,282 | 98,540 | 78,163 | 62,000 | 49,316 | 38,9 |
| 12.8 | 6.4 | 303,145 | 242,516 | 181,901 | 151,573 | 121,258 | 128,291 | 101,719 | 80,684 | 64,000 | 50,906 | 40,2 |
| 13.2 | 6.6 | 312,618 | 250,095 | 187,585 | 156,309 | 125,047 | 132,300 | 104,897 | 83,206 | 66,000 | 52,497 | 41,4 |
| 13.6 | 6.8 | 322,092 | 257,673 | 193,269 | 161,046 | 128,837 | 136,309 | 108,076 | 85,727 | 68,000 | 54,088 | 42,7 |
| 14.0 | 7.0 | 331,565 | 265,252 | 198,954 | 165,782 | 132,626 | 140,318 | 111,255 | 88,249 | 70,000 | 55,679 | 44,0 |
| 14.4 | 7.2 | 341,038 | 272,831 | 204,638 | 170,519 | 136,415 | 144,327 | 114,433 | 90,770 | 72,000 | 57,270 | 45,2 |
| 14.8 | 7.4 | 350,512 | 280,409 | 210,323 | 175,256 | 140,205 | 148,336 | 117,612 | 93,291 | 74,000 | 58,861 | 46,5 |
| 15.2 | 7.6 | 359,985 | 287,988 | 216,007 | 179,992 | 143,994 | 152,346 | 120,791 | 95,813 | 76,000 | 60,451 | 47,7 |
| 15.6 | 7.8 | 369,458 | 295,566 | 221,691 | 184,729 | 147,783 | 156,355 | 123,969 | 98,334 | 78,000 | 62,042 | 49,0 |
| 16.0 | 8.0 | 378,931 | 303,145 | 227,376 | 189,466 | 151,573 | 160,364 | 127,148 | 100,856 | 80,000 | 63,633 | 50,2 |
| 16.4 | 8.2 | 388,405 | 310,724 | 233,060 | 194,202 | 155,362 | 164,373 | 130,327 | 103,377 | 82,000 | 65,224 | 51 |
| 16.8 | 8.4 | 397,878 | 318,302 | 238,745 | 198,939 | 159,151 | 168,382 | 133,506 | 105,898 | 84,000 | 66,815 | 52,8 |
| 17.2 | 8.6 | 407,351 | 325,880 | 244,429 | 203,676 | 162,941 | 172,391 | 136,684 | 108,420 | 86,000 | 68,406 | 54,0 |
| 17.6 | 8.8 | 416,824 | 333,460 | 250,113 | 208,412 | 166,730 | 176,400 | 139,863 | 110,941 | 88,000 | 69,996 | 55,3 |
| 18.0 | 9.0 | 426,298 | 341,038 | 255,798 | 213,149 | 170,519 | 180,409 | 143,042 | 113,463 | 90,000 | 71,587 | 56 |
| 18.4 | 9.2 | 435,771 | 348,617 | 261,482 | 217,885 | 174,308 | 184,418 | 146,220 | 115,984 | 92,000 | 73,178 | 57 |
| 18.8 | 9.4 | 445,244 | 356,195 | 267,167 | 222,622 | 178,098 | 188,427 | 149,399 | 118,505 | 94,000 | 74,769 | 59,1 |
| 19.2 | 9.6 | 454,718 | 363,774 | 272,851 | 227,359 | 181,887 | 192,437 | 152,578 | 121,027 | 96,000 | 76,360 | 60 |
| 19.6 | 9.8 | 464,191 | 371,353 | 278,535 | 232,095 | 185,676 | 196,446 | 155,756 | 123,548 | 98,000 | 77,951 | 61 |

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*Percentage of the power applied or transmitted, as the case may be

250 volts direct current is 1.6; multiplying his by the kilowatts and by the distance ives

41.42 × 1.6 × 250 = 16,568

as the transmission factor.

In Table 3-A, find 3 per cent in the two-wire column, follow this horizontal line of figures into the table until the nearest number larger than 16,568 is found. This is 18,910 and at the head of the column containing it is found No. 00, which is the smallest size of wire that can be used without exceeding 3 per cent. loss.

Before adopting this size, however, the limitations of the Underwriters' Rules must be considered. According to Table 5, the current per kilowatt in a 250 volt direct-current circuit is 4 amperes. The motor will take, therefore,

4 × 41.42 = 165.68

amperes at full load, and 25 per cent. excess must be allowed for starting and overloading. Therefore, the wire must be large enough to carry

165.68 × 1.25 = 207.1

amperes.

Reference to Table 4 shows that if the circuit is indoors, weatherproof wire must be used in order to come within the requirements. If the conditions are such that rubber-covered wire must be used, then the size must be No. 0000, and the loss in the circuit will come far within the prescribed loss of 3 per cent.

### Example II

A 20-horsepower three-phase motor with a full-load efficiency of 88 per cent. and power factor of 86 per cent. is to be supplied at 220 volts through a circuit of No. 2 wire at a distance of 300 feet. The wire is rubber covered, the circuit being in conduit. What will be the loss in the circuit at full load?

From Table 1, the kilowatts at full load are 16.95; from Table 2-A (assuming that the line itself is non-inductive, which should be true of an indoor line) the "circuit factor" is 2.794. The distance being 300 feet, the "transmission factor" is

16.95 × 300 × 2.794 = 14207.49

or practically 14208.

In the No. 2 column of Table 3-A the nearest number larger than 14,208 is 14,458. The number in the same line with this in the polyphase-circuit column is 2.3, which means that the loss will not exceed 2.3 per cent. of the transmitted power. Following it up a little more closely, as the actual factor 14,208 falls between 13,830 and 14,458, in the proper wire column, the loss will be between 2.2 and 2.3; the factor for 1 per cent. being 6286, the accurate calculated loss will be

14208 ÷ 6286 = 2.26

per cent.

Checking up the safety requirement, from Table 7 the current per kilowatt at 220 volts and 86 per cent. power factor is 3.05 amperes. The full-load current, therefore, will be

16.95 × 3.05 = 51.7,

or practically 52 amperes, and the wire must be large enough to carry 25 per cent. excess, making the required capacity

### TABLE 3-B TRANSMISSION FACTORS SMALLER WIRES

TRANSMISSION FACTOR = KILOWATTS × DISTANCE × CIRCUIT FACTOR.

| Per Cent Loss.* | | Sizes of Wire, Brown & Sharpe Gage. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Two-wire Circuits | Polyphase Circuits | No. 3. | No. 4. | No. 5. | No. 6. | No. 8. | No. 10. | No. 12. | No. 14. |
| 1 | 0.5 | 2,493 | 1,977 | 1,567 | 1,243 | 782.1 | 491.9 | 309.3 | 194.5 |
| 1.05 | | 2,617 | 2,076 | 1,646 | 1,305 | 821.2 | 516.4 | 324.8 | 204.2 |
| 1.1 | 0.55 | 2,742 | 2,175 | 1,724 | 1,367 | 860.3 | 541.0 | 340.2 | 213.9 |
| 1.15 | | 2,867 | 2,274 | 1,802 | 1,430 | 899.4 | 565.6 | 355.7 | 223.7 |
| 1.2 | 0.6 | 2,991 | 2,372 | 1,881 | 1,492 | 938.5 | 590.2 | 371.2 | 233.4 |
| 1.25 | | 3,116 | 2,471 | 1,959 | 1,554 | 977.6 | 614.8 | 386.6 | 243.1 |
| 1.3 | 0.65 | 3,240 | 2,570 | 2,037 | 1,616 | 1,016.7 | 639.4 | 402.1 | 252.8 |
| 1.35 | | 3,365 | 2,669 | 2,116 | 1,6 | 1,055.9 | 664.0 | 417.6 | 262.6 |
| 1.4 | 0.7 | 3,490 | 2,768 | 2,194 | 1,740 | 1,095.0 | 688.6 | 433.0 | 272.3 |
| 1.45 | | 3,614 | 2,867 | 2,273 | 1,802 | 1,134.1 | 713.2 | 448.5 | 282.0 |
| 1.5 | 0.75 | 3,739 | 2,965 | 2,351 | 1,865 | 1,173.2 | 737.8 | 464.0 | 291.7 |
| 1.55 | | 3,864 | 3,064 | 2,429 | 1,927 | 1,212.3 | 762.4 | 479.4 | 301.5 |
| 1.6 | 0.8 | 3,988 | 3,163 | 2,508 | 1,989 | 1,251.4 | 787.0 | 494.9 | 311.2 |
| 1.65 | | 4,113 | 3,262 | 2,586 | 2,051 | 1,290.5 | 811.6 | 510.3 | 320.9 |
| 1.7 | 0.85 | 4,237 | 3,361 | 2,664 | 2,113 | 1,329.6 | 836.2 | 525.8 | 330.6 |
| 1.75 | | 4,362 | 3,460 | 2,743 | 2,175 | 1,368.7 | 860.7 | 541.3 | 340.4 |
| 1.8 | 0.9 | 4,487 | 3,559 | 2,821 | 2,238 | 1,407.8 | 885.3 | 556.7 | 350.1 |
| 1.85 | | 4,611 | 3,657 | 2,899 | 2,300 | 1,446.9 | 909.9 | 572.2 | 359.8 |
| 1.9 | 0.95 | 4,736 | 3,756 | 2,978 | 2,362 | 1,486.0 | 934.5 | 587.7 | 369.5 |
| 1.95 | | 4,861 | 3,855 | 3,056 | 2,424 | 1,525.1 | 959.1 | 603.1 | 379.2 |
| 2 | 1 | 4,985 | 3,954 | 3,135 | 2,486 | 1,564.2 | 983.7 | 618.6 | 389.0 |
| 2.1 | 1.05 | 5,234 | 4,152 | 3,291 | 2,610 | 1,642.4 | 1,032.9 | 649.5 | 408.4 |
| 2.2 | 1.1 | 5,484 | 4,349 | 3,448 | 2,735 | 1,720.6 | 1,082.1 | 680.5 | 427.9 |
| 2.3 | 1.15 | 5,733 | 4,547 | 3,605 | 2,859 | 1,798.9 | 1,131.3 | 711.4 | 447.3 |
| 2.4 | 1.2 | 5,982 | 4,745 | 3,761 | 2,983 | 1,877.1 | 1,180.4 | 742.3 | 466.8 |
| 2.5 | 1.25 | 6,232 | 4,942 | 3,918 | 3,108 | 1,955.3 | 1,229.6 | 773.3 | 486.2 |
| 2.6 | 1.3 | 6,481 | 5,140 | 4,075 | 3,232 | 2,033.5 | 1,278.8 | 804.2 | 505.7 |
| 2.7 | 1.35 | 6,730 | 5,338 | 4,232 | 3,356 | 2,111.7 | 1,328.0 | 835.1 | 525.1 |
| 2.8 | 1.4 | 6,979 | 5,536 | 4,388 | 3,481 | 2,189.9 | 1,377.2 | 866.0 | 544.6 |
| 2.9 | 1.45 | 7,229 | 5,733 | 4,545 | 3,605 | 2,268.1 | 1,426.4 | 897.0 | 564.0 |
| 3.0 | 1.5 | 7,478 | 5,931 | 4,702 | 3,729 | 2,346.3 | 1,475.6 | 927.9 | 583.5 |
| 3.1 | 1.55 | 7,727 | 6,129 | 4,859 | 3,854 | 2,424.5 | 1,524.7 | 958.8 | 602.9 |
| 3.2 | 1.6 | 7,976 | 6,326 | 5,015 | 3,978 | 2,502.8 | 1,573.9 | 989.8 | 622.4 |
| 3.3 | 1.65 | 8,226 | 6,524 | 5,172 | 4,102 | 2,581.0 | 1,623.1 | 1,020.7 | 641.8 |
| 3.4 | 1.7 | 8,475 | 6,722 | 5,329 | 4,226 | 2,659.2 | 1,672.3 | 1,051.6 | 661.2 |
| 3.5 | 1.75 | 8,724 | 6,919 | 5,485 | 4,351 | 2,727.4 | 1,721.5 | 1,082.6 | 680.7 |
| 3.6 | 1.8 | 8,973 | 7,117 | 5,642 | 4,475 | 2,815.6 | 1,770.7 | 1,113.5 | 700.1 |
| 3.7 | 1.85 | 9,223 | 7,315 | 5,799 | 4,599 | 2,893.8 | 1,819.9 | 1,144.4 | 719.6 |
| 3.8 | 1.9 | 9,472 | 7,513 | 5,956 | 4,724 | 2,972.0 | 1,869.0 | 1,175.3 | 739.0 |
| 3.9 | 1.95 | 9,721 | 7,710 | 6,112 | 4,848 | 3,050.2 | 1,918.2 | 1,206.3 | 758.5 |
| 4.0 | 2 | 9,970 | 7,908 | 6,269 | 4,972 | 3,128.5 | 1,967.4 | 1,237.2 | 777.9 |
| 4.1 | 2.05 | 10,220 | 8,106 | 6,426 | 5,097 | 3,206.7 | 2,016.6 | 1,268.1 | 797.4 |
| 4.2 | 2.1 | 10,469 | 8,303 | 6,582 | 5,221 | 3,284.7 | 2,065.8 | 1,299.1 | 816.8 |
| 4.3 | 2.15 | 10,718 | 8,501 | 6,739 | 5,345 | 3,363.1 | 2,115.0 | 1,330.0 | 836.3 |
| 4.4 | 2.2 | 10,967 | 8,699 | 6,896 | 5,470 | 3,441.3 | 2,164.1 | 1,360.9 | 855.7 |
| 4.5 | 2.25 | 11,217 | 8,896 | 7,053 | 5,594 | 3,519.5 | 2,213.3 | 1,391.9 | 875.2 |
| 4.6 | 2.3 | 11,466 | 9,094 | 7,209 | 5,718 | 3,597.7 | 2,262.5 | 1,422.8 | 894.6 |
| 4.7 | 2.35 | 11,715 | 9,292 | 7,366 | 5,842 | 3,675.9 | 2,311.7 | 1,453.7 | 914.1 |
| 4.8 | 2.4 | 11,965 | 9,490 | 7,523 | 5,967 | 3,754.1 | 2,360.9 | 1,484.6 | 933.5 |
| 4.9 | 2.45 | 12,214 | 9,687 | 7,680 | 6,091 | 3,832.4 | 2,410.1 | 1,515.6 | 953.0 |
| 5.0 | 2.5 | 12,463 | 9,885 | 7,836 | 6,215 | 3,910.6 | 2,459.3 | 1,546.5 | 972.4 |
| 5.2 | 2.6 | 12,962 | 10,280 | 8,150 | 6,464 | 4,067.0 | 2,557.6 | 1,608.4 | 1,011.3 |
| 5.4 | 2.7 | 13,460 | 10,676 | 8,463 | 6,713 | 4,223.4 | 2,656.0 | 1,670.2 | 1,050.2 |
| 5.6 | 2.8 | 13,959 | 11,071 | 8,777 | 6,961 | 4,379.8 | 2,754.4 | 1,732.1 | 1,089.1 |
| 5.8 | 2.9 | 14,457 | 11,466 | 9,090 | 7,210 | 4,536.3 | 2,852.7 | 1,794.0 | 1,128.0 |
| 6.0 | 3.0 | 14,956 | 11,862 | 9,404 | 7,459 | 4,692.7 | 2,951.1 | 1,855.8 | 1,166.9 |
| 6.2 | 3.1 | 15,454 | 12,257 | 9,717 | 7,707 | 4,849.1 | 3,049.5 | 1,917.7 | 1,205.8 |
| 6.4 | 3.2 | 15,953 | 12,653 | 10,030 | 7,956 | 5,005.5 | 3,147.9 | 1,979.5 | 1,244.7 |
| 6.6 | 3.3 | 16,451 | 13,048 | 10,344 | 8,204 | 5,161.9 | 3,246.2 | 2,041.4 | 1,283.6 |
| 6.8 | 3.4 | 16,950 | 13,443 | 10,657 | 8,453 | 5,318.4 | 3,344.6 | 2,103.3 | 1,322.5 |
| 7.0 | 3.5 | 17,448 | 13,839 | 10,971 | 8,702 | 5,474.8 | 3,443.0 | 2,165.1 | 1,361.4 |
| 7.2 | 3.6 | 17,947 | 14,234 | 11,284 | 8,950 | 5,631.2 | 3,541.3 | 2,227.0 | 1,400.3 |
| 7.4 | 3.7 | 18,445 | 14,630 | 11,598 | 9,199 | 5,787.6 | 3,639.7 | 2,288.8 | 1,439.2 |
| 7.6 | 3.8 | 18,944 | 15,025 | 11,911 | 9,447 | 5,944.1 | 3,738.1 | 2,350.7 | 1,478.1 |
| 7.8 | 3.9 | 19,442 | 15,420 | 12,225 | 9,696 | 6,100.5 | 3,836.4 | 2,412.6 | 1,517.0 |
| 8.0 | 4.0 | 19,941 | 15,816 | 12,538 | 9,945 | 6,256.9 | 3,934.8 | 2,474.4 | 1,555.9 |
| 8.2 | 4.1 | 20,439 | 16,211 | 12,852 | 10,193 | 6,413.3 | 4,033.2 | 2,536.3 | 1,594.8 |
| 8.4 | 4.2 | 20,938 | 16,607 | 13,165 | 10,442 | 6,569.8 | 4,131.6 | 2,598.1 | 1,633.7 |
| 8.6 | 4.3 | 21,436 | 17,002 | 13,478 | 10,691 | 6,726.2 | 4,229.9 | 2,660.0 | 1,672.6 |
| 8.8 | 4.4 | 21,935 | 17,397 | 13,792 | 10,939 | 6,882.6 | 4,328.3 | 2,721.9 | 1,711.5 |
| 9.0 | 4.5 | 22,433 | 17,793 | 14,105 | 11,188 | 7,039.0 | 4,426.7 | 2,783.7 | 1,750.4 |
| 9.2 | 4.6 | 22,932 | 18,188 | 14,419 | 11,436 | 7,195.4 | 4,525.0 | 2,845.6 | 1,789.3 |
| 9.4 | 4.7 | 23,431 | 18,584 | 14,732 | 11,685 | 7,351.9 | 4,623.4 | 2,907.4 | 1,828.2 |
| 9.6 | 4.8 | 23,929 | 18,979 | 15,046 | 11,934 | 7,508.3 | 4,721.8 | 2,969.3 | 1,867.1 |
| 9.8 | 4.9 | 24,428 | 19,374 | 15,359 | 12,182 | 7,664.7 | 4,820.2 | 3,031.2 | 1,906.0 |

*Percentage of the power applied or transmitted, as the case may be.

65 amperes. Table 4 shows that No. 4 is allowed to carry 90 amperes, and is therefore well within the limit.

While the present tables (Nos. 3-A and 3-B) were prepared primarily to facilitate the work of figuring the relation between wire size and energy loss in the line, they can be used also to find the value of any other factor in the problem.

## EXAMPLE III

A service line of No. 4 wire extends 225 feet from a single-phase transformer to a small shop, carrying a load of 14 kilowatts in lamps and small motors. The voltage at the transformer is 220 and the present power factor is 94 per cent.; what is the present loss and how much more load can be added without exceeding 5 per cent. loss, if the power factor remains the same?

Present kilowatts = 14
Circuit factor (Table 2-A) = 2.338
Distance = 225

The transmission factor is

$$14 \times 2.338 \times 225 = 7497$$

In the No. 4 column of Table 3-B, the nearest number to 7497 is 7513, and the loss figure in this line and in the two-wire column is 3.8 per cent.; the present loss is not quite that much because the transmission factor is 7497 instead of 7513. But the load has been measured at the shop while the voltage was taken at the transformer, and this will tend to make up the difference because if the load at the shop is 14 kilowatts the load at the transformer will be greater by the amount lost in the line-wires.

As the voltage is that at the transformer the prospective load should be figured there. Since the power factor will remain practically unchanged by the increase in load, the circuit factor will remain 2.338. From Table 3-B the transmission factor for a two-wire circuit o No. 4 wire at 5 per cent. loss is 9885. As already explained,

$$Kw. = \frac{\textit{Trans. factor}}{\textit{Distance} \times \textit{ckt. fac.}}.$$

The distance is 225 feet, the circui factor 2.338 and the transmission facto 9885. Hence the load for 5 per cent. los will be

$$\frac{9885}{225 \times 2.338} = 18.79$$

kilowatts, *at the transformer*. Since 5 pe cent. of this is lost in the wires, the loa at the shop entrance will be

$$18.79 \times 0.95 = 17.85$$

kilowatts. Consequently 3.85 kilowatt may be added to the existing load of 1 kilowatts without carrying the line los above 5 per cent. of the load at the transformer terminals.

### TABLE 4. PROPERTIES OF COPPER WIRES.

Brown & Sharpe Gage.

| Wire Size, No. | Diam. in Mils | Area, Cir. Mils | Maximum Current.* | | Volts Lost per Foot per Amp |
|---|---|---|---|---|---|
| | | | Rubber Insul. | W. P. Insul. | |
| | 707.1 | 500,000 | 390 | 590 | 0.00002111 |
| | 632.5 | 400,000 | 330 | 500 | 0.00002639 |
| | 547.7 | 300,000 | 270 | 400 | 0.00003519 |
| | 447.2 | 200,000 | 200 | 300 | 0.00005278 |
| 0000 | 460.0 | 211,600 | 210 | 312 | 0.00004989 |
| 000 | 409.6 | 167,772 | 177 | 262 | 0.00006292 |
| 00 | 364.8 | 133,079 | 150 | 220 | 0.00007932 |
| 0 | 324.9 | 105,560 | 127 | 185 | 0.00010000 |
| 1 | 289.3 | 83,964 | 107 | 156 | 0.00012572 |
| 2 | 257.6 | 66,358 | 90 | 131 | 0.00015908 |
| 3 | 229.4 | 52,621 | 76 | 110 | 0.0002006 |
| 4 | 204.3 | 41,738 | 65 | 92 | 0.0002529 |
| 5 | 181.9 | 33,088 | 54 | 77 | 0.0003190 |
| 6 | 162.0 | 26,241 | 46 | 65 | 0.0004022 |
| 8 | 128.5 | 16,512 | 33 | 46 | 0.0006393 |
| 10 | 101.9 | 10,384 | 24 | 32 | 0.0010166 |
| 12 | 80.81 | 6,530 | 17 | 23 | 0.0016165 |
| 14 | 64.08 | 4,106 | 12 | 16 | 0.0025709 |

*For indoor wiring. For outdoor overhead circuits allow twice these figures.

### TABLE 5. AMPERES PER KILOWATT IN EACH WIRE OF A TWO-WIRE CIRCUIT.

Single-phase Alternating Current.

| Voltage.* | Direct Current. | Power Factor of the Complete Circuit, Including the Load. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 80% | 82% | 84% | 86% | 88% | 90% | 92% | 94% | 96% | 98% |
| 100 | 10.0 | 12.50 | 12.20 | 11.91 | 11.63 | 11.36 | 11.11 | 10.87 | 10.64 | 10.42 | 10.21 |
| 104 | | 12.02 | 11.72 | 11.44 | 11.19 | 10.93 | 10.68 | 10.45 | 10.23 | 10.02 | 9.81 |
| 110 | 9.09 | 11.36 | 11.09 | 10.82 | 10.57 | 10.33 | 10.10 | 9.88 | 9.67 | 9.47 | 9.28 |
| 115 | 8.70 | 10.87 | 10.61 | 10.35 | 10.11 | 9.88 | 9.66 | 9.45 | 9.25 | 9.06 | 8.87 |
| 120 | 8.33 | 10.42 | 10.16 | 9.92 | 9.69 | 9.47 | 9.26 | 9.06 | 8.87 | 8.68 | 8.51 |
| 125 | 8.0 | 10.00 | 9.76 | 9.53 | 9.30 | 9.09 | 8.89 | 8.70 | 8.51 | 8.33 | 8.16 |
| 200 | 5.0 | 6.25 | 6.10 | 5.95 | 5.81 | 5.68 | 5.56 | 5.43 | 5.32 | 5.21 | 5.10 |
| 208 | ... | 6.01 | 5.86 | 5.72 | 5.59 | 5.46 | 5.34 | 5.23 | 5.12 | 5.01 | 4.91 |
| 220 | 4.55 | 5.68 | 5.54 | 5.41 | 5.29 | 5.17 | 5.05 | 4.94 | 4.84 | 4.73 | 4.64 |
| 230 | 4.35 | 5.43 | 5.30 | 5.18 | 5.06 | 4.94 | 4.83 | 4.73 | 4.63 | 4.53 | 4.44 |
| 240 | 4.17 | 5.21 | 5.08 | 4.96 | 4.85 | 4.74 | 4.63 | 4.53 | 4.43 | 4.34 | 4.25 |
| 250 | 4.00 | 5.00 | 4.88 | 4.76 | 4.65 | 4.55 | 4.44 | 4.35 | 4.26 | 4.17 | 4.08 |
| 400 | 2.5 | 3.12 | 3.05 | 2.98 | 2.91 | 2.84 | 2.78 | 2.72 | 2.66 | 2.60 | 2.55 |
| 440 | 2.27 | 2.84 | 2.77 | 2.71 | 2.64 | 2.58 | 2.53 | 2.47 | 2.42 | 2.37 | 2.32 |
| 500 | 2.00 | 2.50 | 2.44 | 2.38 | 2.33 | 2.27 | 2.22 | 2.17 | 2.13 | 2.08 | 2.04 |
| 550 | 1.82 | 2.27 | 2.22 | 2.16 | 2.11 | 2.07 | 2.02 | 1.98 | 1.93 | 1.89 | 1.86 |
| 575 | 1.74 | 2.17 | 2.12 | 2.07 | 2.02 | 1.98 | 1.93 | 1.89 | 1.85 | 1.81 | 1.78 |
| 600 | 1.67 | 2.08 | 2.03 | 1.98 | 1.94 | 1.89 | 1.85 | 1.81 | 1.773 | 1.736 | 1.701 |
| 1100 | | 1.136 | 1.109 | 1.082 | 1.057 | 1.033 | 1.01 | 0.988 | 0.967 | 0.947 | 0.928 |
| 1150 | | 1.087 | 1.061 | 1.035 | 1.011 | 0.988 | 0.966 | 0.945 | 0.925 | 0.906 | 0.887 |
| 2200 | | 0.568 | 0.554 | 0.541 | 0.529 | 0.517 | 0.505 | 0.494 | 0.484 | 0.473 | 0.464 |
| 2300 | | 0.543 | 0.530 | 0.518 | 0.506 | 0.494 | 0.483 | 0.473 | 0.463 | 0.453 | 0.444 |

*Voltage at that part of the circuit where the kilowatts are reckoned.

### TABLE 6. AMPERES PER KILOWATT IN EACH WIRE OF A TWO-PHASE FOUR-WIRE BALANCED CIRCUIT

| Voltage.* | Power Factor of the Complete Circuit, Including the Load. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 80% | 81% | 82% | 83% | 84% | 85% | 86% | 88% | 90% | 92% | 94% | 96% | 98% |
| 100 | 6.25 | 6.17 | 6.10 | 6.02 | 5.95 | 5.88 | 5.81 | 5.68 | 5.56 | 5.43 | 5.32 | 5.21 | 5.10 |
| 104 | 6.01 | 5.93 | 5.86 | 5.79 | 5.72 | 5.66 | 5.59 | 5.46 | 5.34 | 5.23 | 5.12 | 5.01 | 4.91 |
| 110 | 5.68 | 5.61 | 5.54 | 5.48 | 5.41 | 5.35 | 5.29 | 5.17 | 5.05 | 4.94 | 4.84 | 4.73 | 4.64 |
| 200 | 3.12 | 3.09 | 3.05 | 3.01 | 2.98 | 2.94 | 2.91 | 2.84 | 2.78 | 2.72 | 2.66 | 2.60 | 2.55 |
| 208 | 3.01 | 2.97 | 2.93 | 2.90 | 2.86 | 2.83 | 2.80 | 2.73 | 2.67 | 2.61 | 2.56 | 2.51 | 2.46 |
| 220 | 2.84 | 2.80 | 2.77 | 2.71 | 2.71 | 2.68 | 2.64 | 2.58 | 2.53 | 2.47 | 2.42 | 2.37 | 2.32 |
| 400 | 1.562 | 1.543 | 1.524 | 1.506 | 1.488 | 1.471 | 1.433 | 1.420 | 1.404 | 1.389 | 1.374 | 1.359 | 1.344 |
| 440 | 1.420 | 1.403 | 1.386 | 1.369 | 1.353 | 1.337 | 1.321 | 1.291 | 1.263 | 1.235 | 1.209 | 1.184 | 1.159 |
| 500 | 1.250 | 1.235 | 1.219 | 1.205 | 1.191 | 1.177 | 1.163 | 1.136 | 1.111 | 1.087 | 1.064 | 1.042 | 1.021 |
| 550 | 1.136 | 1.122 | 1.109 | 1.095 | 1.082 | 1.070 | 1.057 | 1.033 | 0.010 | 0.988 | 0.967 | 0.947 | 0.928 |
| 1100 | 0.568 | 0.561 | 0.554 | 0.548 | 0.541 | 0.535 | 0.529 | 0.517 | 0.505 | 0.494 | 0.484 | 0.473 | 0.464 |
| 1150 | 0.543 | 0.537 | 0.530 | 0.524 | 0.518 | 0.511 | 0.506 | 0.494 | 0.483 | 0.473 | 0.463 | 0.453 | 0.444 |
| 2200 | 0.284 | 0.280 | 0.277 | 0.274 | 0.271 | 0.268 | 0.264 | 0.258 | 0.253 | 0.247 | 0.242 | 0.237 | 0.232 |
| 2300 | 0.272 | 0.268 | 0.265 | 0.262 | 0.259 | 0.256 | 0.253 | 0.247 | 0.242 | 0.236 | 0.231 | 0.226 | 0.222 |
| 6600 | 0.0947 | 0.0935 | 0.0924 | 0.0912 | 0.0902 | 0.0891 | 0.0881 | 0.0861 | 0.0842 | 0.0824 | 0.0806 | 0.0789 | 0.077 |

*Voltage at that part of the circuit where the kilowatts are reckoned.

# Some Useful Lessons of Limewater

## An Interesting Chapter on Nitric Acid and the Nitrates; Simple Tests Which Serve to Make the Subject Very Clear; The Iron Salts

### BY CHARLES S. PALMER

Nitric acid is the most important of the binations of oxygen and nitrogen. u can read up in the books how nitric id is made from saltpeter, by the action sulphuric acid. The name, saltpeter, refer to either one of two salts: assium nitrate, which is saltpeter prop- r sodium nitrate, the so-called "soda ltpeter;" but it is nitric acid itself which are going to study—its tests and its tion on metals. We have seen that both rochloric acid and sulphuric acid have ir tests where one can precipitate them soluble salts, the one with silver, and other with barium. But, as already rked, nitric acid does not form in- ble salts with any common metals; t all the nitrates are soluble. So one st turn to some of the things which ric acid does with the common metals rder to identify it; and here there is lack of material to study.

ABLE 7. AMPERES PER KILOWATT IN EACH WIRE OF A THREE-PHASE, THREE WIRE BALANCED CIRCUIT.

| | Power Factor of the Complete Circuit, Including the Load. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 80% | 81% | 82% | 83% | 84% | 85% | 86% | 88% | 90% | 92% | 94% | 96% | 98% |
| 100 | 7.22 | 7.13 | 7.04 | 6.95 | 6.87 | 6.79 | 6.72 | 6.56 | 6.41 | 6.28 | 6.14 | 6.01 | 5.89 |
| 104 | 6.94 | 6.85 | 6.77 | 6.69 | 6.61 | 6.53 | 6.46 | 6.31 | 6.17 | 6.04 | 5.91 | 5.78 | 5.67 |
| 110 | 6.56 | 6.48 | 6.40 | 6.33 | 6.25 | 6.18 | 6.11 | 5.96 | 5.83 | 5.71 | 5.58 | 5.47 | 5.36 |
| 200 | 3.61 | 3.56 | 3.52 | 3.48 | 3.44 | 3.40 | 3.36 | 3.28 | 3.21 | 3.14 | 3.07 | 3.01 | 2.95 |
| 208 | 3.47 | 3.43 | 3.39 | 3.34 | 3.30 | 3.27 | 3.23 | 3.15 | 3.08 | 3.02 | 2.95 | 2.89 | 2.83 |
| 220 | 3.28 | 3.24 | 3.20 | 3.16 | 3.12 | 3.09 | 3.05 | 2.98 | 2.92 | 2.85 | 2.79 | 2.73 | 2.68 |
| 400 | 1.81 | 1.782 | 1.76 | 1.739 | 1.718 | 1.698 | 1.678 | 1.64 | 1.604 | 1.569 | 1.536 | 1.503 | 1.473 |
| 440 | 1.64 | 1.620 | 1.60 | 1.581 | 1.562 | 1.544 | 1.526 | 1.491 | 1.458 | 1.426 | 1.396 | 1.367 | 1.339 |
| 500 | 1.443 | 1.425 | 1.408 | 1.391 | 1.375 | 1.358 | 1.343 | 1.312 | 1.283 | 1.255 | 1.228 | 1.203 | 1.178 |
| 550 | 1.312 | 1.296 | 1.280 | 1.265 | 1.250 | 1.235 | 1.221 | 1.193 | 1.166 | 1.141 | 1.117 | 1.093 | 1.071 |
| 1100 | 0.656 | 0.648 | 0.640 | 0.633 | 0.625 | 0.618 | 0.611 | 0.596 | 0.583 | 0.571 | 0.558 | 0.547 | 0.536 |
| 1150 | 0.628 | 0.620 | 0.612 | 0.605 | 0.598 | 0.591 | 0.584 | 0.571 | 0.558 | 0.546 | 0.534 | 0.523 | 0.512 |
| 200 | 0.328 | 0.324 | 0.320 | 0.316 | 0.312 | 0.309 | 0.305 | 0.298 | 0.292 | 0.285 | 0.279 | 0.273 | 0.268 |
| 300 | 0.314 | 0.310 | 0.306 | 0.303 | 0.299 | 0.295 | 0.292 | 0.285 | 0.279 | 0.273 | 0.267 | 0.262 | 0.256 |
| 600 | 0.109 | 0.1080 | 0.1067 | 0.1054 | 0.1042 | 0.1029 | 0.1017 | 0.0994 | 0.0972 | 0.0951 | 0.0931 | 0.0911 | 0.0893 |

*Voltage at that part of the circuit where the kilowatts are reckoned.

NOTE—The above table belongs to the preceding article.

f you will look at the oxidation table itrogen given in the last lesson, it is r that this acid lies at the oxidized reme of nitrogen and oxygen com- ds, and as nitric acid is just as active oxidizer as it is an acid, that means nitric acid in oxidizing other things t be itself reduced. The oxidation le shows that there are several stages llow the nitric-acid stage into which the d can fall, such as nitric oxide, a color- s gas, NO, and nitrogen dioxide or per- ide, $NO_2$, which is a reddish-brown gas, colored ingredient of the so-called ric fumes." Some of the other oxides nitrogen are present also when nitric d is disturbed, but we will study two oxides of nitrogen, nitric oxide, NO, and nitric dioxide, $NO_2$.

The colorless gas, nitric oxide, NO, turns red in the air by absorbing oxygen from the air and passing to nitric dioxide, $NO_2$. Hence, it often happens that one is led to suppose that he has first obtained nitric dioxide, $NO_2$, by the action of metals on nitric acid, whereas in reality he has got nitric acid, NO, first, which then turns red or brown by the oxygen of the air, which is always ready to step in with its oxidation whenever it gets the chance; but, as the reduction of nitric acid to the colorless gas, nitric oxide, NO, and the partial reoxidation of this colorless gas to the colored gas, nitric dioxide, $NO_2$, take place so quickly right after each other that they seem almost to be one action, and it is common to speak as though nitric acid were reduced to the brown fumes, which are usually a mixture of nitric oxide, NO, and nitric dioxide, $NO_2$. So when nitric acid is allowed to act on metals, such as iron or copper, or zinc, in the air, one gets these brown fumes. Further, if one lets nitric acid act on any ready reducers, such as sugar, starch, paper, charcoal, wood, or other organic matter, one gets the same brown fumes; and now you will see that the appearance of these brown fumes indicates one of two things: either nitric acid or some of its salts is present, or else the acid has been reduced. That is one reason why it is almost impossible to keep a bottle of nitric acid clear and colorless like it is when it is first opened. The dirt which falls into the bottle in microscopic quantities reduces the acid, that is, a small part of it, to the brown fumes, which stain the rest of the acid yellowish brown.

#### THE SALTS OF IRON

Further, if any metal which can exist in two or more distinct forms of salt, such as iron for example, acts on nitric acid, starting with the lower form, some of the reduced forms of nitric acid will be produced. Later on when we get to the chemistry of iron, we will find that that metal has the two sets of salts, ferrous, or the lower oxidation, and ferric, or the higher oxidation. The ferrous oxide can be oxidized to ferric oxide; and ferric oxide can be reduced to ferrous oxide. These two sets of iron salts, ferrous and ferric, are for the time as distinct from each other as any two metals, say for example, zinc or calcium, on the one hand, and aluminum, on the other hand.

But the ferrous and the ferric oxides are alike in that both are salts of iron, that the one can be changed to the other, or to iron, and iron can be changed to either. Our friend, calcium, the metal at the base of lime and of all the calcium salts, has no such doubleness as iron shows, but is always plain calcium, without any "ous" or "ic" termination added to show different states of oxidation; and, if comparison were to be made, you would find that calcium is much more like ferrous iron than it is like ferric iron. But we are using ferrous iron to test for nitric acid; and we will keep to that trial.

Now, if you will make a solution of common green vitriol, which is nothing more than sulphate of ferrous iron, $FeSO_4$, and then add a little nitric acid and warm the mixture, you will be oxidizing the ferrous iron to ferric iron; and you will soon have a mixture of ferric sulphate and ferric nitrate; but you cannot fail to note the dark color which comes while the oxidation is still in progress, and which lasts as long as there is any unoxidized ferrous iron still in solution. This dark color is due to a compound of the colorless gas, nitric oxide, NO (which came from the reduction of the nitric acid) with some of the ferrous sulphate. This dark color has been used in all sorts of pigment work, and it is of great value for making the common test of nitric acid. It should be mentioned here that this is also good for nitrous acid;

but the acid and the salts (the nitrates) are so rare as stable compounds that it is not worth while to consider them separately, and we will talk as though we had only nitric acid to consider.

### THE COMMON TEST OF NITRIC ACID

To get a notion of the test, you perform it in the following manner: Take a test tube half full of warm water and make a solution of common saltpeter, potassium nitrate $KNO_3$. It is not necessary to use more than a mere crumb of saltpeter, about the size of a common pea. As soon as this has dissolved, add to the solution of saltpeter a pinch of green vitriol (sulphate of ferrous iron, $FeSO_4$). As soon as this has nearly all dissolved, tip the test tube as shown in Fig. 1, and pour about half a teaspoonful of strong concentrated sulphuric acid down the side of the test tube, keeping the tube tilted for a minute until all the acid has settled to the bottom of it, which it will do by virtue of its greater specific gravity. As soon as this has taken place, hold the test tube straight up and place it before any white surface, as a sheet of paper, when you will see clearly a brown streak or layer in the unmixed liquids, just above the sulphuric acid, and just below the solution of saltpeter and green vitriol, as shown in Fig. 2. In this test, the vitriol sets nitric acid free from the nitrate, and then the green vitriol reduces the nitric acid. You will want to try it several times with fair quantities of saltpeter and then with smaller quantities, until you can get the test with the merest fragment of saltpeter.

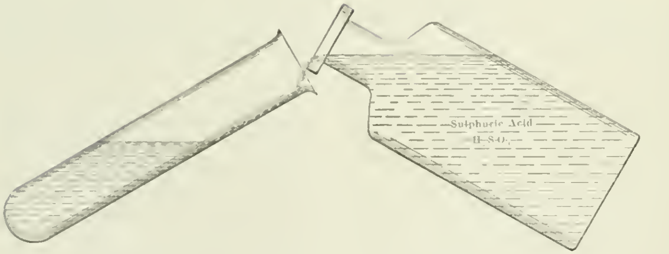

FIG. 1

Then you want to try it with other nitrates, nitrate of silver, or nitrate of copper, nitrate of ammonium, or any handy salts of nitric acid. You can try some of your hydrant water, evaporating some of it down to dryness, with a bit of sodium carbonate to hold any nitric acid that might happen to be free, and adding the residue, evaporated to dryness, to a half or a quarter test tube of water, then the green vitriol and then the sulphuric acid, with the tube tilted as shown in Fig. 1. I do not mean that you are likely to find any nitric acid in your drinking water, but you *may*; the chances are that in the long run you will find nitric acid where you did not expect to find it. If the nitric acid test, (and it is of course good for nitrites also), should ever show any acid in your drinking water, it would be a good thing to call the attention of the board of health to the fact, for nitric acid stands at the oxidation end of the nitrogen scale; and, as a rule, that means that the water has been contaminated with some organic matter which is pretty well consumed. All this means that while the small trace of nitric acid which one can find in some drinking waters is not of itself harmful, yet there may be some germs, as of typhoid fever for example, which are not yet oxidized, but which are lying hidden in the water ready to get in their work on some fever victim. So much for the health test for nitric acid.

But this lesson of the test for nitric acid, and the nitrates, is good for much general work in chemical analysis, which is the main object of all these lessons. The test for nitric acid, with green vitriol for the indicator, is sometimes called the "ring" test, or the "cold" test, because if the test tube showing the brown (or violet, or red) ring is heated, the liquids mix and the ring disappears, partly owing to the oxidation of the ferrous iron, and partly to the mingling of the layers of liquid.

### NITRIC-ACID STAINS

There are several other tests for nitric acid, and one of them is the way that it stains organic matter, the skin of your fingers for example; you can hardly handle the bottle of nitric acid without getting some of that yellow stain on your hands to remind you what nitric aci will do. You will also often get a dr of the acid on your clothing; and course, you know enough to wash ac stains with some harmless alkali, such ammonia or sodium carbonate; but y will soon note quite a difference betwe the various kinds of acid stains; tl stains from hydrochloric acid and su phuric acid, if treated in time, will usual come out almost entirely; but the sta from nitric acid is a horse of anoth color; you cannot easily take it o especially from dark cloth, and especial from anything which has any wool in i because the nitric acid makes a so-call "nitro" compound with the chemical su stance of the fabric; and this compou is a sort of a permanent dye; hence alk lies will not remove the yellow or oran stain made by nitric acid, as they will the cases of most of the other comm acids.

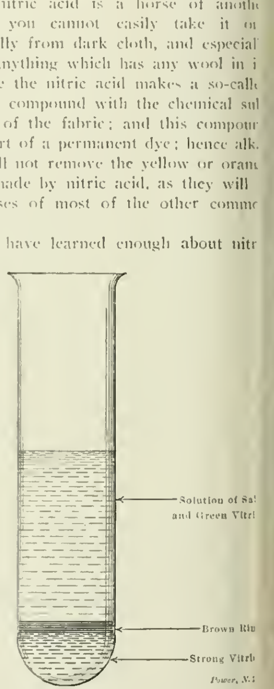

FIG. 2

You have learned enough about nitr acid to see that it is an acid, an oxidiz and a thing which makes "nitro" co pounds; but one or two experiments show just what it will do as an oxida are in order. There is that green vitri ferrous sulphate, or sulphate of iron. long as it is kept dry, it remains gree though it may turn almost white fro drying chemically, losing some of "water of crystallization." If kept d green vitriol will not turn red or brow but just make up a clean solution this same green vitriol and let it sta in a bottle with the cork out for a d or two and you will see that some the iron has turned red or brown, rust in fact, according to the following equ tion.

$$12\,FeSO_4 + 6\,H_2O + 3\,O_2 = 4\,Fe_2(SO_4)_3 + 4\,Fe(O$$

**Ferrous Iron Sulphate + Water + Oxygen =**
**Ferric Iron Sulphate + Ferric Iron Hydroxi**

Now this ferric-iron hydroxide is t long name for iron rust; and though y need not learn the equation, yet you c see that it is the exact and concise way of saying that when sulphate of ferrous iron rusts to sulphate of ferric iron, only one-third of the iron shows up as rust, the other two-thirds being hidden away in solution as ferric sulphate. You can do this rust test with nitric acid without getting the rust at all, and by a few drops of nitric acid.

TESTING FOR FERROUS AND FERRIC IRON

But first test for the difference between ferrous and ferric iron, by adding a single drop of that colorless solution of potassium (or ammonium) sulphocyanate which you have probably picked up by this time (also called sulphocyanide). This colorless solution will not affect the pure green vitriol, while it will turn any ferric iron blood red. The test is almost startling in the way in which it makes ferric iron bleed itself out to open confession. Now having got the difference between ferrous and ferric iron clear as to the action of this potassium sulphocyanate on the latter, start with a solution of green vitriol again; you note that potassium sulphocyanate hardly shows any color in the test tube; but add a drop or two of nitric acid to some of the same green vitriol in another test tube, warming for a moment to let the nitric acid oxidize the iron, and you will at once get the blood-red test for ferric iron, showing what the nitric acid has done to the ferrous iron as it was a moment ago. You will want to try this test over again several times till you see what it can do, and how much it will tell you.

You remember that when we were studying hydrogen, in the earlier lessons, mention was made of the fact that nitric acid is not used for making hydrogen; and the reason given was that the acid would eat up the hydrogen as fast as it was formed, or rather as fast as it tried to form. You can now see that the reason is, that for every two atoms of hydrogen which are ready to appear, there is the oxygen in the nitric acid ready to "burn" the hydrogen into water; but that means that if the nitric acid gives up oxygen, it must itself be reduced to some lower stage, showing of course the nitric fumes; and that is the reason why combination with almost any of the metals will make nitric acid break down to some lower form of oxidation, always with the presence of those brown fumes. Thus, take iron, copper, lead, zinc, brass, silver—it hardly matters what metal is taken—and you will get some of the metal dissolved as a nitrate and at the same time the hydrogen, which would come off under other conditions, simply burns, by moist combustion, to water, and that part of the nitric acid which makes the "sacrifice hit" of taking care of this hydrogen, breaks down to the nitric fumes; that part of the acid which forms the nitrate of the metal stays up in the oxidized form

Of course, you will be asking about "royal water," aqua regia, the mixture of nitric and hydrochloric acids which can dissolve gold and platinum; and though it is expensive to get much gold, one can easily find a bit of platinum by breaking up some of the old incandescent-lamp globes which usually have metallic platinum leading-in wires at the base. But this takes us to our next subject, hydrochloric acid and chlorine; and now we are beginning to get a handful of trumps so that we can begin to tackle some of the real questions of real analysis.

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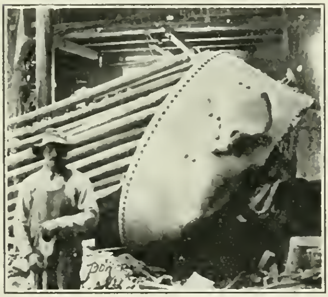
## The Denver Boiler Explosion

Since the publication of the article on the Denver boiler explosion in the July 6 number, the accompanying photograph has been sent to this office, and is of interest as it shows the lower, or mud drum, and the method of failure of the shell plate at the lower row of rivets. This photograph was taken shortly after the explosion, and while the boiler was still lying in the engine room. It will be noted that the tubes are still hanging to the drum, and farther back than is shown in this photograph is the steam drum, which was left intact and with all the tubes still secured to the tube plate.



RUPTURE OF PLATE AT LOWER SEAM OF MUD DRUM

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## Combined Associations' Outing

The combined associations of engineers of the borough of Brooklyn, N. Y., held their second outing on Sunday, July 18. Two special trains conveyed the members and guests, amounting to more than eleven hundred. One of the features of the day was the baseball game between the Engineers and Company D, Fourteenth Regiment, which after a close and interesting contest resulted in favor of Company D by the score of 11 to 8. There were also several other outdoor events, a handsome prize being awarded to the winner of each case by Frank Martin, chairman of the Games Committee. Refreshments of all kinds were constantly on tap. The occasion proved a most delightful one, and the various committees are to be congratulated.

---

## A Fine Outing

Protective Association No. 23, N. A. S. E., of New York, held its annual outing at Grant City, Staten Island, on Sunday, July 18, and was the largest the association has yet had, it numbering among the attendance many prominent engineers and representatives of supply houses. At eleven o'clock, after a hearty breakfast had been partaken of, the baseball game between the engineers and the "Bunch" was played, which resulted in a victory for the "Bunch" by the score of 20 to 14, after a most exciting contest. Then followed outdoor sports of every kind, the first and second in each event being presented with a valuable prize. At the close of the contests, dinner was served, after which the members of No. 23 and their guests departed for home, having spent a most enjoyable occasion.

---

## Manhattan Association's Installation

Manhattan Association No. 25, N. A. S. E., of New York, held a public installation of officers at its rooms in the Lexington opera house, on Saturday evening, July 17. The following officers were installed by National Vice-President W. J. Reynolds, assisted by Past National President Joseph F. Carney: L. S. Everson, president; Ebenezar Whittaker, vice-president; William Downs, recording secretary; James R. Coe, corresponding secretary; J. T. Koener, financial secretary; John T. Mahr, treasurer; J. H. Moran, conductor; Owen Williams, doorkeeper; J. C. Davidson, Harry J. Marks and William Johns, trustees.

At the close of the installation ceremony the members and guests were escorted to the large reception hall, where an appetizing collation was served. Toastmaster Everson introduced as speakers: National Vice-President J. W. Reynolds, Past National Presidents Joseph F. Carney and Herbert E. Stone, Charles Schabecker, Wilson Van Buren, Fred Felderman, J. D. Taylor, Samuel Schaff, John T. Mahr, Harry Marks, John R. Coe, William Downs and Brothers Wilson Baer and Barr. Nearly every N. A. S. E. association in Greater New York and vicinity was represented, and the meeting will long be remembered as one of the most enjoyable in the history of No. 25. Interspersed between the speakers the "Bunch" entertained.

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## Phoenix Outing

Phoenix Association No. 24, N. A. S. E., of New York, will hold its Nineteenth Annual Outing on Sunday, August 22, at Donnelly's Boulevard Hotel, College Point, L. I. Extensive preparations are in progress and the usual merry time is guaranteed.

POWER
AND THE ENGINEER

DEVOTED TO THE GENERATION AND
TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

John A. Hill, Pres. and Treas. Robert McKean, Sec'y.

505 Pearl Street, New York.
355 Dearborn Street, Chicago.
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of Power solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "Powpub," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During 1908 we printed and circulated 1,836,000 copies of* Power.

*Our circulation for June, 1909, was weekly [illegible] more than 36,000.*

| | |
|---|---|
| *July* 6 | 42,000 |
| *July* 13 | 33,000 |
| *July* 20 | 33,000 |
| *July* 27 | 33,000 |

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*

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## Reading the Paper

Did you ever, in looking over some back numbers of your paper, come across an article or a letter, or perhaps even an editorial, which interested you immediately and which you did not remember having seen before? Many of you must have had this experience if you refer to back numbers frequently. It is due to one of two things: either you don't read the paper thoroughly, or else you were not much interested at the time in the subject of the article which appealed to you later. In most cases, however, it is hasty reading of the paper; the interest of a practical engineer does not change widely or often, as a rule.

Occasionally, we receive letters from regular subscribers in which they ask for information which they could have found in a back number of the paper less than a month old. The one sure remedy for this unnecessary pen exercise is to read each number of the paper carefully, record in a card index the title and general character of each article of interest to you, and keep your back numbers in a temporary binder. This sounds like a lot of red tape and trouble, but it isn't after you get the habit. The card index can be kept in a little box about five inches wide and fifteen inches long.

At any rate, whether you are inclined to keep an index or not, read the paper carefully and then go through it again page by page and see if you have skipped anything relating to your own class of work. You will be surprised at the increase in your interest in the paper and in its helpfulness to you. It certainly can't do you much good if you don't read it properly.

## The Massachusetts Inspection and License Laws

If a manufacturer of gunpowder, nitroglycerin or any other thing that might by any carelessness or neglect cause loss of life or destruction of property attempted to erect a factory for the production of his particular commodity in the heart of any community however small, no uncertain or dilatory measures would be taken to put a stop to the project. If a man is found to be afflicted with a contagious disease that is neither necessarily fatal nor dangerous, he is promptly isolated.

If highways, bridges or buildings (either public or private) are discovered to be even potentially unsafe for traffic or habitation, their use is at once forbidden. But over the greater part of the country and in centers of dense population a steam boiler, which in the hands of an ignorant or incompetent attendant and without proper appliances is potentially as dangerous as a powder mill, and more so than smallpox, scarlet fever or leprosy, may b installed and operated by anyone who de sires and has the price. And the public which is supposed to be safeguarded fron everything that can even in the remotes degree be regarded as jeopardizing lif limb or property, is helpless in the matte To be sure some States have taken up th matter of boiler-inspection legislation some enacting general laws making cer tain boilers subject to periodic inspectio and the attendant required to show som fitness for the position he holds Some other States allow municipalities o certain specified minimum population t pass ordinances requiring steam-boiler in spection and engineer's licenses, and thes are more or less conducive to publi safety, according to the intelligence of th successful city politicians.

As a State, Massachusetts has long oc cupied an advanced position in this mat ter. New boilers of the lap-seam typ above forty-two inches in diameter ar forbidden use or installation in the State Massachusetts legislated wisely in th matter of lap-seam boilers, in that the in stallation of new boilers of this type i prohibited, but fell far short of manifes duty when neglecting to provide for th immediate retirement of the old boiler admittedly unsafe. This neglect was mad a basis for several attempts on the par of those more or less interested in th manufacture and sale of boilers to weak en the license and inspection laws, an provide for the installation of lap-sean boilers of all sizes and the granting o licenses to incompetent men.

During the earlier weeks of the ses sion of the Legislature, no less than four teen bills bearing on the license and in spection were introduced, but happily, wit one exception, none which had any ten dency to weaken the law were passed, an the exception was nullified by the recom mendation of the chief of the boiler in spection department to the several in spectors regarding the factor of safety t be used in fixing the allowable workin pressure on all boilers which are not u to the Massachusetts standard, but whic owing to the fact that they were in th State prior to May 14, 1908, may be in stalled, and operated, but with a factor o safety which will practically prohibit thei use for any service except that of low pressure heating.

No changes were made in the engineer' license law and the minor changes in th boiler inspection law, three in number provide as follows:

> 1—A boiler in this commonwealth a the time of the passage of this act, whic does not conform to the rules of constru tion formulated by the board of boil rules may be installed after a thoroug internal and external inspection and hy drostatic pressure test by a member o the boiler inspection department of th district police, or by an inspector holdin a certificate of competency as an inspecto of steam boilers, as provided by sectio six of chapter four hundred and sixty-fiv of the acts of the year nineteen hundre and seven, and employed by the compan insuring the boiler. The pressure allowe

on such boilers is to be ascertained by rules formulated by the board of boiler rules.

2. The board of boiler rules shall hold public hearings on the first Thursday in May and November of each year, and at such other times as the board may determine, on petitions for changes in the rules formulated by said board. If the board, after any such hearing, shall deem it advisable to make changes in said rules, it shall appoint a day for a further hearing, and shall give notice thereof and of the changes proposed by advertising in at least one newspaper in each of the cities of Boston, Worcester, Springfield, Fall River, Lowell and Lynn, at least ten days before said hearing. If the board on its own initiative contemplates changes in said rules, like notice and a hearing shall be given and held before the adoption thereof. Changes made in the rules which affect the construction of new boilers shall take effect six months after the approval of the same by the governor: *provided, however*, that the board may, upon request, permit the application of such change in, or additions to, rules, to boilers manufactured or installed during said six months. When a person desires to manufacture a special type of boiler the design of which is not covered by the rules formulated by the board of boiler rules, he shall submit drawings and specifications of such boiler to said board, which, if it approves, shall permit the construction of the same.

3. The provisions of this act relative to the inspection and operation of boilers within the commonwealth shall not be held to apply to steam fire engines brought into the commonwealth for temporary use in times of emergency, for the purpose of checking conflagrations.

While the boiler inspection laws of Massachusetts are not all that could be desired by one who sees only the right of the public to protection from possible danger, they are far in advance of those of other States, and her example in this respect could be emulated elsewhere to great public advantage.

## Furnace Draft

In speaking of a position which had been tendered to him and declined an engineer said, "I could not take that job, much as I would like to if conditions were only a little bit different. The engines are new and in first-class working order. The boiler room is airy and conveniently arranged, but there is no draft. I have held down two or three good jobs in the city and have made good records in all of them, but there was a good draft in all cases and that had more to do with my success than any ability or fitness. If you have a good draft you can make hot fires and hot fires will make cheap steam, while if the draft is poor you cannot get any life into the fire and it will lie on the grates and mull away with a dull red glow without life, making lots of smoke and only about half as much steam as it should.

"That kind of a fire takes all of the ambition out of a man. He may have the best engines in the world with a load just right to make economical operation as easy as rolling off a log. Everything in the plant may be first-class, and all keyed to concert pitch so that it would seem almost like going on a vacation to take a job there.

"But if the draft is poor every pound of steam will cost twice as much as it should and all the extra refinement in the engine room will only make the loss in the boiler furnaces the more apparent.

"I would rather promise to get results out of a plant with slide-valve engines and a good draft than from one with the most economical engines built if I have to make steam in boilers with no more draft than there is at the plant I just turned down."

There was much common sense embodied in the remarks of the engineer. The significance of draft in steam making has been given much less attention than it deserves in steam-power plant design. Economical steam making is possible only with boiler furnaces in which the proper amount of air for combustion can be forced through the fuel bed. The greater the temperature difference between the furnace and the water in the boiler, the greater will be the heat transfer.

Where the fuel burns with an insufficient air supply, the combustion is incomplete and the heat available for steam making is much less than with the proper air supply. Too large a grate area for the work to be done will produce the same effect as insufficient air supply. In fact, it makes restriction of air a necessity. In one plant the engineer, noticing that the damper was closed most of the time, reduced the grate area under the boilers about one-third with a resultant saving of over five per cent. in the amount of coal used.

Not all of the factors of draft control are in the hands of the operating engineer and in some plants none of them are. But there are many places where an investigation of the draft and its relation to the work done will indicate changes that will increase the economy and improve the operating conditions of the plant.

## Speaking of Boiler Scale

"An ounce of prevention is worth a pound of cure." This adage is equally true whether used in connection with domestic life or the everyday work in the power plant, and might be aptly applied to the question of boiler scale. The water that does not leave a deposit of some kind, when raised to the temperature of steam under pressure, does not exist for power-plant use, and the inevitable result, when the water has not been subjected to previous treatment, is the formation of scale on the tubes or plates of the boiler shell. This, of course, means a loss in efficiency due to the added thickness through which the heat must be transmitted, and usually a loss of some magnitude on account of the low heat-conducting qualities of the scale. Nor is this all. The formation of scale almost invariably means an increase in the repair and maintenance expense and at frequent intervals necessitates a shutdown for cleaning. Unequal expansion of the metal and corrosion resulting in leaky joints must also be laid at the door of scale formation.

It is evidently of great importance to keep the scale out of the boiler, but just how it is to be done will depend a great deal on the size of plant and the amount of money it would be profitable to spend for this purpose. No great amount of reasoning is necessary to be convinced that prevention is better than cure, and it would also seem evident that preventing scale-forming matter from ever getting into the boiler were better than allowing it to enter and then washing it out. The boiler is installed for the purpose of evaporating water and should be kept in the best possible condition for that purpose. It is not designed or intended to be used as a purifier or collector of sludge, and when impurities are to be removed from the water, it would be better to conduct the operations necessary outside of the boiler shell. This would mean the installation of a purifying system, the adoption of some form of heater best fitted to the requirements, or possibly the use of boiler compounds and special tanks for treating. The quality of the water and the amount of scale-forming ingredients would largely determine the method of treatment.

There are plants where the water is exceptionally pure or where only a small amount of steam is generated, in which it might be cheaper to endure the conditions imposed by scale than to incur the expense of a special apparatus, but in the great majority of cases it would undoubtedly pay to purify the water before it enters the boiler, or at least prevent scale formation by the use of compounds.

For eight nights during the Hudson-Fulton celebration this fall, New York will be the most brilliantly lighted city in the world, according to the plans of the Hudson Fulton Celebration Commission. The illumination will begin at 6:30 nightly, and continue until 12:30 a.m. Estimates place the number of lights to be used, in addition to the regular lighting, at between 1,000,000 and 1,500,000 incandescent, 7000 arc lights, 3000 flare arcs, one battery of four searchlights of 100,000 candlepower each, and one battery of twelve searchlights, aggregating 1,700,000 candlepower. It is calculated that the total candlepower of lights will reach 26,260,000.

To break a section of vertical, cast-iron sewer pipe, without danger of dropping pieces down the inside, drill a small hole and split the pipe with a drift pin. The lower portion of the pipe can then be stuffed until the whole section can be broken out.

## The "True" Waste Press

The "True" waste press illustrated herewith rests on four legs in a cast metal tank, on the inside of which, a short distance from the bottom, is a cast ledge, on which rests a steel grate. A galvanized steel cylinder, a little smaller than the tank inside of which it sets, rests on the grate, and is nearly twice as high as the tank. It is perforated with several lines of holes all around and nearly to the top of the tank. It is also fitted with a perforated removable bottom to hold the waste when the cylinder is removed to be discharged.

"TRUE" WASTE PRESS

From opposite sides of the tank is hinged a yoke, through the center of which passes a large screw with a fine thread to the cast follower inside the cylinder below. Secured firmly to the top of the screw is a crosshead through which slides the long lever which operates the press.

The grate, upright, yoke, screw and crosshead are all of cast steel and sufficiently large to resist the strain of the immense pressure which the large screw and long lever can be made to give. The open grate and perforated cylinder, allow a free escape of oil from the waste, and the cylinder may be taken to a convenient place and discharged without handling the waste.

The press takes the place of the waste can required by the fire-insurance companies.

When using, pack the waste in the cylinder, and after placing the follower in position, screw down with the lever and let the press stand all night, if convenient, and then set up harder. This press is manufactured by Adams True Peirce, Dover, N. H.

## Goubert Closed Multipass Feed Water Heater

This apparatus is guaranteed to heat feed water from ordinary temperature to within 10 degrees of the temperature of the exhaust steam. As illustrated, the Goubert heater consists essentially of two cast-iron water chambers connected by a cluster of small straight brass tubes, which in turn are inclosed within a cylindrical cast iron shell extending from one water chamber to the other. The ends of the tubes are rolled into steel tube plates in the same manner as boiler tubes are rolled into the manifold. The cast-iron shell surrounding the tubes merely provides an envelop for the exhaust steam, and is of larger diameter than the water chambers, to form an annular belt from which the steam may enter among the tubes from all directions.

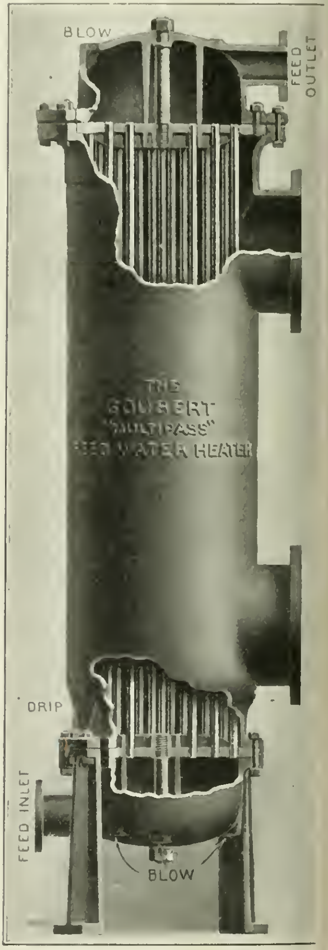
The exhaust steam enters the shell by the upper opening shown at the right, and what does not condense passes out the lower opening. That which is condensed on the tubes flows to the bottom of the shell and passes out through a drip pipe. It is a peculiarity of this construction that oil or grease in the steam is removed as in an oil separator and passes off with the drip, leaving the remainder of the exhaust steam in the best possible condition for heating systems and other purposes where live steam is sometimes used.

One great advantage of having the water within the tubes, is that the scale may be removed without taking down the heater. By removing the top chamber the tube interiors can be examined and cleaned out with little difficulty. Any sediment which falls, either during cleaning or operation, goes down into the bottom of the lower water chamber, from which it may be drawn out through the bottom blowoff openings.

The greatest advantage claimed for this heater is the multipass feature. As will be noted, there are baffles so placed in the upper and lower chambers that the feed water entering at the bottom must travel back and forth through several sets of tubes, and be subjected to the heat of the steam several times before it can reach the outlet at the top.

This heater is provided with an expansion joint between the upper chamber and the shell. The upper chamber is supported entirely by the tubes and left free to move up and down. The expansion joint is fitted with a flexible ring gasket composed of layers of soft copper and special packing with wire interwoven. The inner edge is clamped between the shell and an annular ring. The only purpose of this gasket is to prevent steam from escaping into the room, and as it is subjected to no other pressure than atmospheric, the gasket will last for years. Its renewal amounts to nothing more than the replacing of a cylinder head or steam-pipe gasket.

The vertical construction as described is preferable, but for installations where there is not sufficient head room as in the cellars of city buildings, the horizontal heater can be used. It has the same essential features as the vertica type, and is also useful in connection wit condensing engines. If it is desired t suspend the horizontal heater from th ceiling, the feet may be replaced by strap lugs or bolts. The heater is built by th Goubert Manufacturing Company, 9 West street, New York City.



GOUBERT CLOSED FEED-WATER HEATER

The annual convention of the Canadian Association of Stationary Engineers, July 27 to 30, inclusive, is to be held at London, Ont., and bids fair to excel all previous conventions.

## Personal

F. W. Hollmann has resigned as steam engineer for the Maryland Steel Company o become assistant mechanical engineer r the Carborundum Company, Niagara alls, N. Y.

## Business Items

George A. Stocker, of St. Louis, Mo., has just t out an attractive catalog upon cooling towers tich contains a lot of interesting information pon this little-understood subject.

Squires & Byrne, 52 Stewart street, San rancisco, Cal., carry a full stock of assorted s of "Selden" packings and can fill all requirements of engineers on the Pacific coast.

On June 30, 1909, Ellot Wadsworth became partner in the firm of Stone & Webster, oston, Mass., formerly consisting of Charles Stone, Edwin S. Webster, Russell Robb and enry G. Bradlee.

Benjamin Whittaker has resigned as treasurer J. H. Williams & Co., Brooklyn, N. Y., and l now give his entire time to the exporting siness for the same company, and others, h headquarters at 17 State street, New York ty.

Glen M. Porter has succeeded W. M. Owen manager of the New York office of the Liberty anufacturing Company, at 90 West street. r Porter will have full charge of the business the New York territory and will be assisted C. S. Roosa.

The Foster Engineering Company, of Newark, J., has appointed the Cotton States Belting l Supply Company, of Atlanta, Ga., general ents for the sale of its specialties in Georgia d Alabama. They will carry a good stock Foster specialties in order to make prompt pments.

The American Wire Brush Company, 277 reenwich street, New York, has issued a new aflet, No. 42, illustrating and describing its er-tube brushes, giving prices on various es, etc. The company also sends blotters ntaining useful information to any engineer, on application.

W A. Reichert, for the past three years vertising manager for the Fort Wayne Elec- Works, Fort Wayne, Ind., has resigned to pt a similar position with the Power and minating Engineering Company, of Allice, Ohio. This company is a commercial nization coöperating with central stations lncrease the day load on their plants.

Shipments of Murray-Corliss engines by the rray Iron Works Company, at Burlington, a, for the first six months of this year exceed number those for any previous corresponding riod. This company has just exported a comte power plant for a flourishing mill in Tsingingpu, China. The shipment incudes a Corliss gine, tubular boiler, etc., all of the Murray ike.

The Adams River Lumber Company, Shusp, B. C., has placed an order with the Minneahs Steel and Machinery Company for a x42 heavy-duty Twin City Corliss engine, gether with boiler-feed pump and feed-water ater. This engine will drive the new planing ll now being built. The Minneapolis Steel and Machinery Company is also furnishing the transmission machinery for the planing mill.

In speaking of lubricants, Adam Cook's Sons, 313 West street, New York City, call attention to the fact that Albany grease, besides being suitable for every purpose of lubrication, is a clean lubricant to use, inasmuch as there is no dripping on the floor or along the bearing supports. It is a neutral grease of uniform quality, having comparatively low melting points, and has been on the market more than forty years.

At the July directors' meeting of the Crocker-Wheeler Company, held at the New York office of the company, Dr. Schuyler Skaats Wheeler was continued in office as president and the following other officers were elected for the ensuing year: Vice-president, Gano Dunn; second vice-president, A. L. Doremus; chief engineer, Gano Dunn; secretary, Rodman Gilder; treasurer, W. L. Brownell; assistant treasurer, G. W. Bower.

The C. A. Dunham Company, Marshalltown, Iowa, manufacturer of the Dunham steam trap, has opened an office at 503 Fisher building, Chicago, Ill., in charge of George W. Best. This company reports that the sales of traps for the first six months of this year exceed the sales for the same period last year by 100 per cent. Plans are now being drawn for a new factory and power plant to be built in the near future at Marshalltown.

The National Exhibitors' Association has sent out notices regarding the mechanical exhibit at the Columbus convention of the N. A. S. E., to be held during the week of September 13. As the demand for space is large, intending exhibitors should secure such space as may be needed as early as possible. Full particulars will be furnished by the secretary, William D. Purcell, care of Quaker City Rubber Company, Philadelphia, Pa.

The Minneapolis Steel and Machinery Company has received the contract for a large irrigation plant which is to be installed at Mission, Texas, by Conway & Holt. It will consist of a 14x30x36-inch heavy-duty cross-compound Twin City Corliss engine, 36-inch centrifugal pump, which will be mounted direct on the engine shaft, 300-horsepower boiler, boiler feed pump and heater. This plant will have a capacity of 35,000 gallons per minute.

An interesting and instructive booklet, entitled, "The Story of Some Friction Tests," is being distributed by the Quaker City Rubber Company, 409 Market street, Philadelphia, Penn. In this little booklet mechanical engineers of prominence give the results of scientific investigation of the relation of piston packings to friction. It is printed on fine paper, attractively bound in rich red, and is illustrated with many diagrams, test sheets and packing specimens. A postal card request will bring a free copy to any one.

At the Bernon Mills of the Manville Company, Georgiaville, R. I., a 300-kilowatt Westinghouse low-pressure turbine is being installed to take steam at atmospheric pressure from the exhaust of a Corliss engine, driving a three-phase, 60-cycle, 600-volt alternator to supply additional power and lighting for the mills. The turbine is operated without superheating and exhausts into a condenser maintaining a vacuum of 27 inches. Besides the lighting service for the mills, the distribution system supplies a synchronous motor direct-connected to mill line shaft.

Greene, Tweed & Co., 109 Duane street, New York City, is sending out gratis an interesting little booklet entitled, "History of the Marathon Races." This book was written by W. S. Farnsworth, a member of the sporting staff of the *New York Evening Journal*. A brief outline is given of the historic origin of the race from the plain of Marathon to Athens, also a short review of the sport from the Olympic games in Athens in 1906 up to the present date. Marathon records and photo-engravings of the prominent runners are given in the booklet.

For the purpose of enlarging its New York interests and developing the engineering end in connection with large steam power-station installations, the E. Keeler Company, of Williamsport, Penn., has associated with it T. R Brown as chief engineer, with headquarters at 29 Broadway, New York. Mr. Brown is an engineer of wide practical and theoretical experience He was formerly connected with the Pennsylvania railroad as master mechanic of the Juniata shops at Altoona; also with the Westinghouse interests and lately with the American Car and Foundry Company.

The Lagonda Manufacturing Company, Springfield, Ohio, has just issued a 48-page booklet describing its Weinland boiler-tube cleaners. Full description is given of the various types of cleaners manufactured by this company and the scale condition for which each is best suited is pointed out. Among the new types developed are the air- and steam-driven turbine and also a line of cleaners for use in condenser and economizer tubes. A description is also given of the different styles of cutter heads which are adapted for different conditions of scale. Their new device for cleaning Stirling boilers is also described.

During the past week the C. O. Bartlett & Snow Company, Cleveland, Ohio closed contracts through F. C. Greene, mining engineer, for complete coal-mine equipments for the McGillveary Coal and Coke Company, at Coleman, Alberta, and the West Canadian Colliers Company, at Bellevue, Alberta. The contracts include a steel tipple, with all the necessary machinery, including the Greene patent transfer dump, type 4, for each plant, as well as a complete power-plant equipment and haulage system for each. The plants will be entirely electrically operated and are to be in operation by November 1 of this year.

"How to Save Coal" is discussed from the point of view of recovering waste heat in the chimney flue gases in a neat little booklet which is being distributed by the Green Fuel Economizer Company, of Matteawan, N. Y. The booklet further describes the construction of the Green economizer, illustrating the new extended top header, the new bottom header especially designed to avoid choking from soot, the new sectional covering and other improved features. There are several illustrations of large plants, such as the Delaware, Lackawanna & Western terminal power plant, which have recently been equipped with Green economizers and Green mechanical draft fans.

A single boiler of unusual capacity, 2274 horsepower, has been placed in the Delray power station of the Detroit Edison Company. This boiler, a Stirling special, has a 150-inch by 11-foot grate, and is served with bituminous coal by four Roney stokers installed underneath the one boiler. This exceptional installation is in the first section of the Detroit Edison Company's No. 2 power house at Delray, and in the construction of the plant allowance has been made for extending the outfit with similar units as the station's lighting load increases. George W. Cate is superintendent of the plant. The engineering design and construction was carried out by Westinghouse, Church, Kerr & Company.

That the iron and steel business is improving is indicated by the large number of inquiries being sent out to Corliss-engine builders by the steel mills and the large number of contracts lately placed. The Wisconsin Engine Company, Corliss, Wis., reports live inquiries in excess of $2,000,000 for Corliss engines. This company recently closed a contract with the River Furnace and Dock Company, Cleveland, Ohio (a Corrigan-McKinney interest) for three large blowing engines, 46 and 84 and 84 by 60 These engines will be of the vertical, long-crosshead type and the order is the largest one of [illegible] plant [illegible]. A [illegible] [illegible] will be [illegible].

H. M. [illegible] & Co., consulting engineers, of Chicago, Ill., have acquired the [illegible] Gas power property at [illegible] W[illegible]. In the [illegible] with [illegible] J. Gilmore, of San Diego, Cal., [illegible] of the [illegible] Los Angeles, and [illegible] of the [illegible] on the [illegible] Los Angeles Mountains. Other [illegible] are the following: H. A. [illegible], a Chicago engineer, has been [illegible] of the [illegible] [illegible], and W. B. [illegible] for the New York [illegible] and [illegible] [illegible] & Co., has been appointed [illegible] to the [illegible] with headquarters at Chicago.

Last November we referred in our columns to the fact that the Lunkenheimer Company, Cincinnati, Ohio, had received from the Panama Canal Commission a very large order for their "Renewo" globe, angle and cross valves. The order at that time covered upward of 7000 valves. Within the past two weeks this company received an additional order for the "Renewo" valves, amounting, in all, to upward of $7000. The "Renewo" valve has a renewable, self-cleansing seat, and the disk can also be replaced when worn. It is not necessary in every case to replace these parts, as the regrinding feature is also embodied in the "Renewo" valve, so that if desired the seating faces can be reground and made tight without removing the valve from the connecting pipes.

The condition of improvement which the Westinghouse companies find their business has undergone during the past month maintains the same steady rate of advance noted during the previous months of the present year, assuring, before the close of 1909, a repetition of the busy times of 1907. In June the Westinghouse Electric and Manufacturing Company, East Pittsburg, Penn., enjoyed an improvement of 25 per cent. over its business of May. A large order for railway motors secured from the New York Elevated Company is noteworthy since these motors had previously been furnished by the Westinghouse company's most important competitor. Switchboards and auxiliary supplies amounting approximately to $500,000 have also been ordered by the Pennsylvania Tunnel and Terminal Company for the New York terminals and tunnels of the Pennsylvania railroad. In line with the encouraging improvement noted by the Westinghouse Machine Company, the Philadelphia Rapid Transit Company has recently placed orders for two steam-turbine equipments, one of 6000 and one of 12000 kilowatts capacity.

The problem of balancing high-speed steam engines is discussed in a clear and exhaustive manner in a pamphlet that is being distributed by the American Engine Company, Bound Brook, N. J. It is pointed out that balancing the ordinary simple engine is an impossibility without the use of "bob-weights;" that is, reciprocating weights moving at right angles to the piston; further that any attempt at balancing in one direction introduces equal unbalancing forces in a direction at right angles. The author then proceeds to show how an engine can be balanced perfectly if two cylinders be suitably arranged, and gives a brief description of the American Ball angle compound engine in which this idea is incorporated. It is pointed out that the perfect balance obtained makes it feasible to install this engine upon upper floors and in other places where vibration would be objectionable, also that the even turning moment incidentally secured makes it possible to use lighter flywheels and results in less pressure upon bearing surfaces, besides giving more satisfactory operation of alternating-current generators. Copies of the pamphlet will be sent [illegible] [illegible] interested in the subject.

When the [illegible] Acheson Graphite Company at Niagara Falls [illegible] always be [illegible] to be [illegible] the extended and [illegible] [illegible] [illegible] customers in all parts of the world [illegible] to [illegible] [illegible] of its remarkable [illegible] was demonstrated [illegible] fact that [illegible]. Between 1 and [illegible] on the afternoon of Friday, July 2, a telegraphic order came for the shipment of [illegible] electrodes [illegible] by express, [illegible]. [illegible] and an express company [illegible] notified. At [illegible] p.m. an express car was [illegible] on the track in front of their products building. At 5:30 p.m. a locomotive on the Niagara Junction railroad [illegible] away with the loaded car for delivery to the Michigan Central Railroad. It left Niagara Falls about 6 p.m., Buffalo about 8 p.m. and [illegible] on Saturday morning the electrodes were delivered to the consignee in Chicago, Ill. The regular shipments of the day were not interrupted, there was no overtime and the consignees were made happy by the prompt shipment. The value of the service to the customer is more apparent when it is known that if the business judgment of the Acheson Graphite Company had not been such as to have these very large electrodes in stock, a delay of from 10 to 12 weeks would have resulted. Regular and prospective customers should always anticipate their wants as much as possible, for, ordinarily, the time period specified is consumed in getting the carbons and graphitizing them.

A process for softening boiler-feed water at the same time that it is heated is described in a 36-page booklet sent out by the Harrison Safety Boiler Works, Seventeenth and Clearfield streets, Philadelphia, Penn. In the process advantage is taken of the fact that heating water in an open spray drives off free and combined carbonic-acid gas, resulting in the precipitation of carbonates, and by further treating the water with a single reagent sulphates, chlorides, nitrates and acids can be counteracted, giving a perfectly softened water which will not corrode nor form hard scale in the boilers. The simplicity and inexpensiveness of this treatment are contrasted with the repeated chemical analyses and expert attention required where two reagents must be proportioned, as in the ordinary cold-process system. It is also pointed out that the cost of the apparatus for the hot-process treatment is much less than the combined cost of the feed-water heaters and water softeners required to give the same ultimate results in the boiler with the cold process. The pamphlet contains much valuable information for the owners, designers and operators of steam plants, as well as descriptions and illustrations of various installations; and in view of the fact that the steam-boiler inspection and insurance companies find over 50 per cent. of the boilers in use defective in ways which can be traced to impure feed water, it will doubtless find a large number of interested readers. Copies are distributed gratis upon application.

The Ashton Valve Company has recently occupied its new plant at 169 to 171 First street, East Cambridge, Mass. The main building is 200 feet long and 50 feet wide, three stories and basement. The basement contains a fireproof pattern storage room, blacksmith department and general stock room for rough brass and iron castings. The office, toolroom, pattern shop and shipping department are on the first floor while the second floor is given over to the valve manufacturing department and valve buffing room. This floor opens to the second floor of the boiler house where the work of valve testing is done. The third floor is devoted entirely to gage making, including buffing and nickel plating. The foundry measures 60x30 feet and the boiler house is 30 feet long and 50 feet wide. The latter is equipped with two water-tube boilers, one especially for testing purposes and capable of carrying 400 pounds steam pressure. All the buildings are of brick and concrete slow-burning mill construction. All machinery is driven by electric motors operated on the group-drive plan, and the buildings are all lighted by electricity. Special attention has been given to the lighting in the daytime working hours, all buildings having been fitted with as many windows as strength would permit. The most improved sanitary arrangements have been installed on a liberal scale. The business of the Ashton Valve Company was established in 1872. The plant of the company at 27 Franklin street, Boston, has been dismantled but one floor has been retained for a city office. The company makes muffler and open pop safety valves, blowoff valves, locomotive steam gages, duplex air gages, gage testers, air-brake inspector's test gages, locomotive chimes, whistles and dynamometer recording gages.

## Help Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

WANTED—Experienced draftsman on Co liss engine work. Address Box 82, POWER.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

ENGINEERS—A leading manufacturer wants to make arrangements with an engineer in every city who can use his spare time looking after their interests and by so doing add greatly to his income. Address "Manufacturers," Bo 24, South Stillwater, Minn.

WANTED—A good live agent in every shop or factory in the U. S., to sell one of the best known preparations for removing grea and grime from the hands without injury the skin. Absolutely guaranteed. An agent can make from $5.00 to $25.00 over and abo his regular salary. This is no fake. Wri for free sample and agents' terms. The Klezola Co., Erie, Pa.

## Situations Wanted

*Advertisements under this head are insert for 25 cents per line. About six words ma a line.*

WANTED—Position as constructing engineer on power plant work by young man us to responsible charge of such work. Box POWER.

FIRST-CLASS LICENSED electrical engineer desires position in manufacturing pla or power house. No objection to small plac Box 77, POWER.

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ASSOCIATE A. S. M. E. MEMBER wa position. American, 29, single, with techni education; nine years' experience in pow plant design, construction and tests. B 79, POWER.

MECHANICAL ENGINEER, graduate, w several years' experience in general machine gas engines, automobiles and pumping mach ery, desires responsible position. Age 28. 70, POWER.

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## Miscellaneous

*Advertisements under this head are ins for 25 cents per line. About six words m a line.*

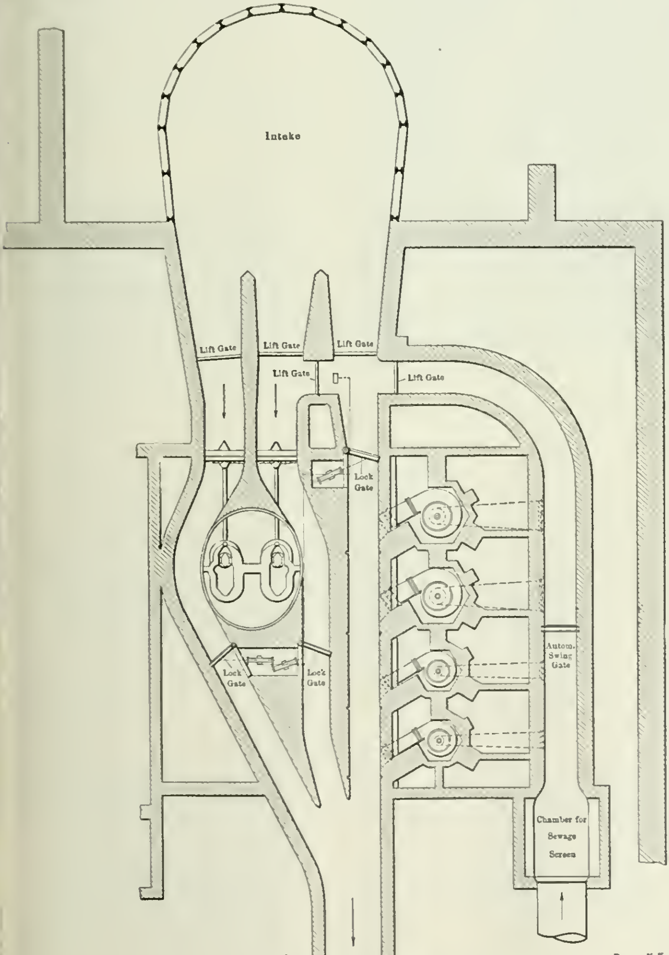
PATENTS secured promptly in the Uni States and foreign countries. Pamphlet instructions sent free upon request. C. Parker, Ex-examiner, U. S. Patent Of McGill Bldg., Washington, D. C.

# Test of Large Sewage Pumping Station

## Methods of Unusual Interest Employed to Determine Volume of Sewage and Water Pumped and Average Head in 2,100,000,000 Gallon Station

### BY SIMPSON RICE

The Thirty-ninth street pumping station, established jointly by the Sanitary District and the municipality of Chicago, has a capacity rated at 1,206,000,000 gallons per 24 hours; but the pumps installed there are capable, as shown on trial, of delivering fully 2,100,000,000 gallons, thus making the capacity of this plant the largest of any in the world. A general plan of the arrangement of the units in the station is outlined in Fig. 1. In the following article are described 24-hour continuous tests of the two-screw pumps and of one of the four centrifugal units, which were conducted by a board of experts to decide whether or not the pumps and engines had met the guarantees made by the builders.



Power, N.Y.

FIG. 1. GENERAL PLAN OF STATION

Each of these tests resolved itself into three parts:

1—The determination of the volume of sewage and water pumped.

2—The determination of the average head.

3—The determination of the quantity of steam supplied to the engine.

In measuring each of these, independent apparatus had to be employed. For ascertaining the steam consumption usual practice was followed; but for the two other factors in the test no such standards were available; hence some of the following details have more than ordinary interest and value from an engineering standpoint.

### THE CENTRIFUGAL PUMPING UNITS

Consider first the centrifugal unit, the arrangement of which is clearly indicated by Fig. 2. Its engine is of the horizontal, triple-expansion type, direct-connected to a vertical-shaft, submerged, single-suction, centrifugal pump. The rotation is in a horizontal plane, the three steam cylinders, 12x22x32x30-inch stroke, being horizontally disposed and arranged at an angle of 120 degrees from each other; the three connecting rods transmit power to the shaft through a single crank pin. The steam cylinders are equipped with valve gear of special Reynolds-Corliss design, with separate eccentrics for operating the steam and exhaust valves. The high-pressure cylinder has a long-range cutoff gear to allow a large overload capacity, the cutoff being controlled by a centrifugal flyball governor provided with hand adjustment, so that the speed of the engine can be varied, while running, to suit changes in conditions of head and capacity. The rated speed is 128 revolutions per minute, although it was not found necessary to run as high as this to deliver the rated capacity. The engine frames are of the horizontal girder pattern and span the pump pit. The crosshead slides are separate and are bolted to the frames. The main bearing is also capable of adjustment while the engine is running and a thrust bearing is located between the engine and the pump. The capacity of the pump was specified to be not less than 75 cubic feet of sewage per second.

### TESTS ON CENTRIFUGAL PUMP

*Measurement of Water*—After a care-

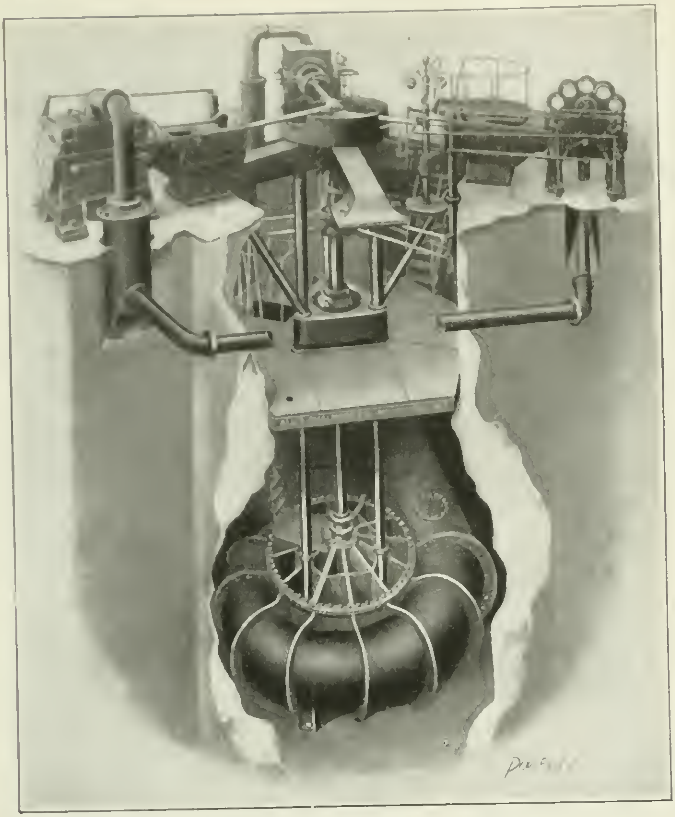


FIG. 2. TRIPLE-EXPANSION CENTRIFUGAL PUMPING UNIT

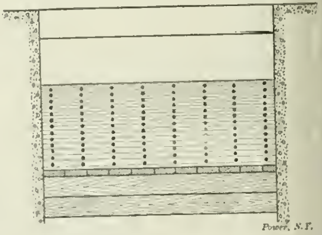


FIG. 3. CROSS-SECTION OF DISCHARGE CHANNEL AT CURRENT METER STATION

ful study of the conditions, it was decided that the greatest accuracy would be obtained by using current meters to measure the capacity of the pump. Fig. 3 shows a cross-section of the channel where observations to determine the capacity were made. The channel at this place was carefully calibrated both in width and depth, and the current meter rack was located here. This calibration enabled the cross-sectional area of the flowing stream to be accurately and easily determined for any water level. Each dot shows the spot at which the velocity of the flowing water was taken with the current meters.

*Current Meters*—Four current meters were used. They were of the Price type, as manufactured by W. and L. E. Gurley, Troy, N. Y., and were carefully calibrated and rated at Chevy Chase, Maryland. To insure the meters being properly and rigidly placed for each set of observations, a special rig was constructed, as shown in Fig. 4. A steel frame securely held the four meters. Each end of the frame projected beyond its adjacent meter about 12 inches. This projection extended into a planed cast-iron bulkhead guide 6 inches deep, thus bringing the end meters within 6 inches of the side of the channel. To keep the frame at right angles to the line of the flow, two wrought-iron pipes were secured to this frame and arranged to travel up and down in the cast-iron bulkhead guides. The frame was suspended by two wire ropes traveling over duplicate drums secured to a common shaft. On this shaft was a hand wheel provided with a hand brake. In about the center of the shaft was fastened a third drum of diameter equal to that of the two drums above mentioned, on which was wound a wire rope of the same thickness as those suspending the meter rack. This rope passed over a pulley and was attached to a counterweight, whose weight equaled that of the four current meters including the frame to which they were secured. A steel tape line was connected to this counterweight, and led over suitable pulleys, having its zero set to correspond to zero at the bottom of the channel. By means of this arrangement, the distance from the bottom of the channel to the plane of the current meters could be read directly from the tape.

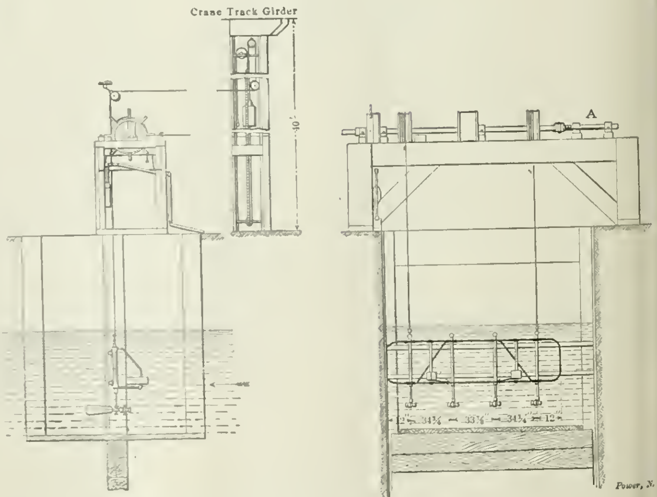


FIG. 4. CURRENT METER RIG USED IN CENTRIFUGAL PUMP TEST

By again referring to the cross section f the channel in Fig. 3, it will be seen at there were eight vertical and thirteen orizontal positions or a total of 104 oints at which readings were taken. One bserver, provided with a stop watch, was ationed at each meter. Each meter was nnected to an electric buzzer in such a nner that each turn of the meter would duce one buzz, the circuit being opened al closed once every revolution by a ing coming in contact with a cam on shaft of the meter bucket wheel.

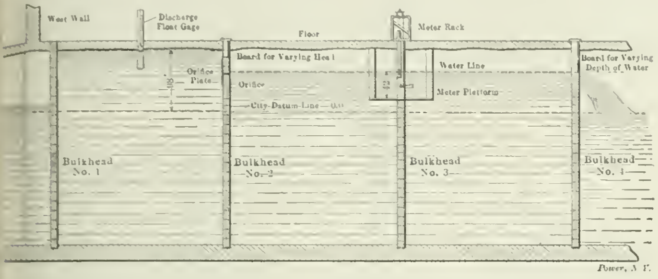


FIG. 5. VERTICAL SECTION THROUGH DISCHARGE CHANNEL

TABLE 1. CURRENT METER SUMMARY CENTRIFUGAL PUMP TEST.

| Bottom, Ft. | Velocity, Foot Seconds. Distance South Wall, Feet. 0 5 | 1.93 | 3.36 | 4.79 | 6.22 | 7.65 | 9.08 | 10 45 |
|---|---|---|---|---|---|---|---|---|
| 3 | 1 41 | 1 48 | 1 58 | 1.72 | 1 81 | 1 54 | 1.28 | 1 20 |
| 6 | 1 46 | 1 61 | 1 60 | 1 68 | 1.87 | 1.50 | 1.30 | 1.23 |
| 9 | 1 45 | 1 73 | 1.61 | 1.69 | 1.98 | 1 53 | 1.28 | 1.24 |
| 2 | 1 44 | 1 75 | 1.64 | 1.71 | 2.15 | 1.56 | 1.31 | 1.31 |
| 5 | 1 38 | 1 80 | 1.68 | 1 72 | 2 24 | 1.63 | 1.34 | 1.33 |
| 8 | 1.38 | 1 86 | 1.72 | 1 78 | 2 35 | 1.68 | 1.46 | 1.38 |
| 1 | 1 35 | 1 87 | 1 78 | 1.84 | 2 43 | 1.78 | 1 54 | 1.49 |
| 4 | 1 39 | 1 87 | 1 81 | 1.89 | 2 50 | 1 89 | 1 61 | 1 48 |
| 7 | 1 41 | 1 83 | 1 87 | 1.87 | 2 55 | 2 00 | 1 76 | 1 60 |
| 3 0 | 1 48 | 1 92 | 1.92 | 1.91 | 2 60 | 2.02 | 1 81 | 1 66 |
| 3 | 1 59 | 1 88 | 1 92 | 1.94 | 2 60 | 2.11 | 1 86 | 1.80 |
| 3 6 | 1 70 | 1 82 | 1 95 | 1.98 | 2 54 | 2.14 | 1.93 | 1.95 |
| 3 9 | 1.64 | 1 75 | 1.95 | 2.01 | 2 36 | 2.10 | 1 85 | 2.04 |

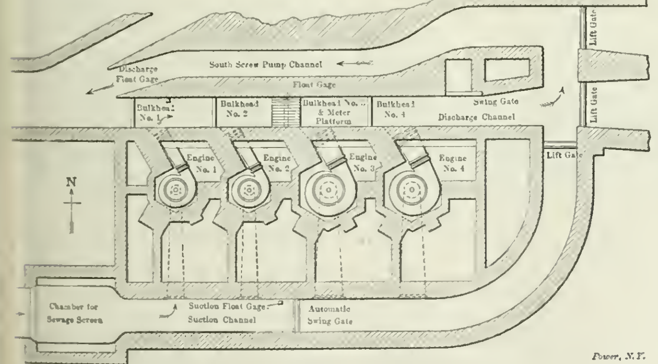


FIG. 6. PLAN OF CENTRIFUGAL PUMP INSTALLATION

n taking readings, the observer, having hand of his stop watch set at zero, ld start his watch at the beginning of a buzz and, after a period approximating one minute, would stop his watch at the beginning of a buzz. The buzz at the time of starting was counted zero, the next buzz being counted one. On finishing the count, the number of revolutions of the meter and the reading of the watch in seconds and fractions thereof were recorded on the log sheet. All stop watches were compared before and after the test with a standard timepiece and found to read accurately to 0.2 second. This method was used in preference to depending upon automatic registers, owing to the liability of the latter to jump or miss.

When the four observers had finished the observations on a given horiontal plane, the meters were raised to the next horizontal plane, and similar observations taken as described, this process being continued until the 13 horizontal observations were complete. The frame with its four meters was then shifted to the opposite side of the channel and lowered to the bottom and observations taken in the same way. By this arrangement, to make one full set of observations the meter rack was moved but once horizontally, which was accomplished by a horizontal shifting lever, shown at *A* in Fig. 4. The observers were easily enabled to make one complete set of observations per hour.

TABLE 2. OFFICIAL DUTY TEST CENTRIFUGAL PUMP NO. 1.

| | | |
|---|---|---|
| Tripie expansion engine, size, in. . . . | | 12x22x32x30 |
| Pressures. | | |
| | Gage. | Abs. |
| Steam at boiler, lb. per sq.in. | 175 19 | 189 70 |
| Steam at engine, lb. per sq. in. . . . . . . . . . . . . . . . . | 165 40 | 179 91 |
| 1st receiver, lb. per sq.in . | 23.70 | 38.21 |
| 2d receiver, lb. per sq.in . | 2.30 | 12 21 |
| Barometer, in. Hg. . | 29.56 | 14.51 |
| Vacuum, in. Hg . . . | 26 13 | 1.685 |
| Calorimeter, in Hg . . . | 4 29 | 16.616 |
| Suction head, feet below datum . . . . . . . . . . . . . | | 14.01 |
| Discharge head, feet above datum . . . . . . . . | | 10.05 |
| Total head pumped against, feet of water. . . . . . . . . . | | 24.06 |
| Temperatures. | | |
| External air, deg. F. . . | | 77.0 |
| Engine room. . . . . . . . | | 77.0 |
| Boiler room. . . . . . . . | | 85 9 |
| Exhaust steam . . | | 120.7 |
| Circulating water. . | | 71.2 |
| Hot well. . . . . . . . . | | 76.3 |
| Boiler feed at pump | | 132.5 |
| Sewage. . . . . . . . . . . | | 72.2 |
| Calorimeter. . . . . . . . . | | 290.7 |
| Steam at engine. . . . . . | | 372.92 |
| Efficiencies. | | |
| Average r.p.m., main engine | | 110.6 |
| Average r.p.m., circ. engine. . | | 325.8 |
| Pump horsepower. . . . . . | | 217.7 |
| I.H.P., main engine. . . . . . . . . . . . . | | 278.6 |
| I.H.P., circ. engine . . . . . . . . . . . . . | | 11.9 |
| Total I.H.P. . . . . . . . . . . . . . . . . . | | 290.5 |
| Combined mechanical efficiency, per cent . . . . . . . . . . . . . . . . . . . . . . . . | | 74.9 |
| Moisture in steam, per cent . . . . . . . | | 1.5 |
| Steam used by engine, lb. per hour. | | 3,698.92 |
| Steam used by engine, lb. per I.H.P. per hour. . . . . . . . . . . . . . . . . . . . . | | 12.73 |
| Duty. | | |
| Feed water per 24 hr. (corrected for boiler level) lb . . . . . . . . . . . . . . . . | 101,176 | |
| Discharge of traps and separator, lb. | 7,554 | |
| Discharge of calorimeter, lb. . . . . . . | 1,416 | |
| Boiler leakage, lb. . . . . . . . . . . . . . . | 3,432 | |
| Total deduction, lb . . . . . . . . . . . . . | 12,402 | |
| Saturated steam used by engine per 24 hours, lb . . . . . . . . . . . . . . . . . | 88,774 | |
| Width of channel at measured section, ft. . . . . . . . . . . . . . . . . . . . . . . | | 10.92 |
| Depth of water at measured section, ft. . . . . . . . . . . . . . . . . . . . . . . . . . | | 4 177 |
| Discharge area at measured section, sq.ft . . . . . . . . . . . . . . . . . . . . . . . | | 45 613 |
| Mean velocity at measured section, ft.sec . . . . . . . . . . . . . . . . . . . . . . | | 1 749 |
| Capacity, cu.ft. sec . . . . . . . . . . . . . . | | 79 78 |
| Weight of sewage per cu.ft. . . . . . . . | | 62 37 |
| Ft.-lb. of work done per 24 hr. | | 10,343,776,820.00 |
| Duty per 1000 lb. saturated steam, ft.-lb. . . . . . . . . . . . . . . . . . . . . . . | | 116,518,088.85 |
| Duty guaranteed . . . . . . . . . . . . . | | 90,000,000.00 |

Table 1 shows the summary of the current-meter observations and represents the average of each of the 104 positions in the cross-section of the channel for the complete 24 hours duration of the test. From this summary sheet thirteen velocity curves, one of each horizontal level above the bottom of the measured section, and eight velocity curves, one for each vertical plane, were plotted The area under each curve was obtained by the use of a polar planimeter and the mean velocity for each of the thirteen sections found by dividing the area by the depth of the water. The eight mean velocities were then plotted as abscissas, with the width of the channel as ordinates, and a curve drawn showing the lateral variation in mean vertical velocities. This mean curve was integrated and the mean velocity in the channel thereby found.

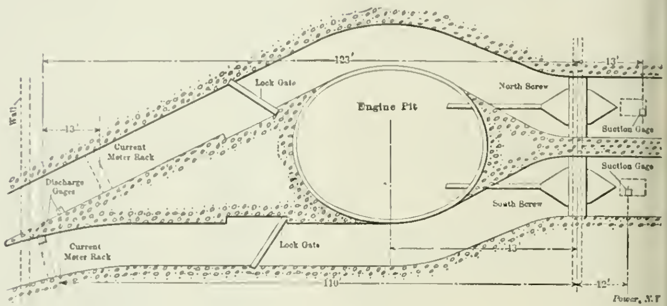
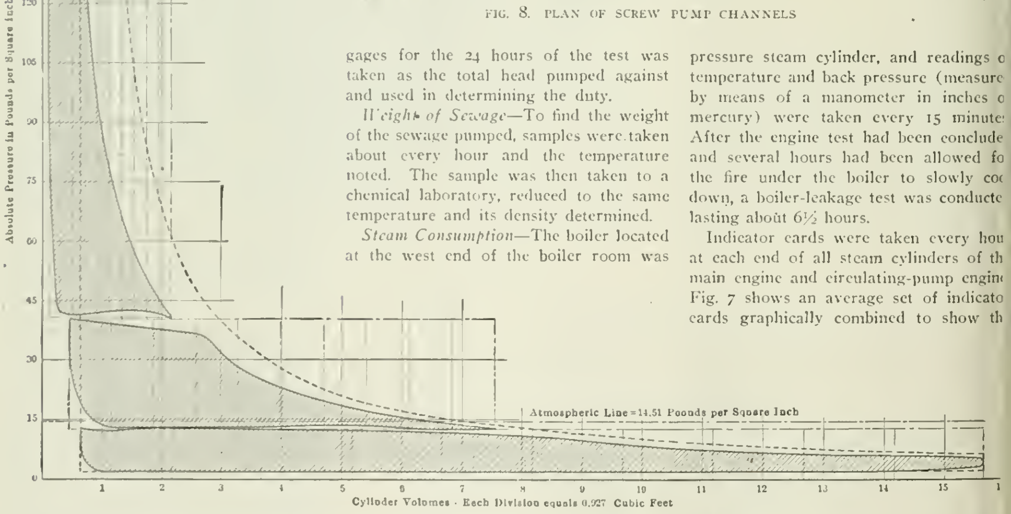


FIG. 8. PLAN OF SCREW PUMP CHANNELS



| | | | | | |
|---|---|---|---|---|---|
| Engine | Triple Expansion | Clearance, H.P. 4.85%, I.P. 6.2%, L.P. 4.4% | | Ratio Actual Card to Ideal Card | 83.4% |
| Cylinders | 12" x 22" x 32" x 30" | Average R.P.M. | 110.0 | No. of Expansions, Actual | 1:24.10 |
| Piston Rods | Dia. 2 $\frac{3}{16}$" | I.H.P. | 278.6 | Combined Mech. Eff. | 74.9% |
| Cranks at | 120° | Referred M.E.P. | 20.85 | | |

Power, N.Y.

FIG. 7. COMBINED INDICATOR DIAGRAM FROM CENTRIFUGAL PUMPING UNIT

*Determination of Head*—At the outset it should be understood that all horizontal planes were referred to city datum; a common bench mark on a window sill, situated just outside the west wall of the building, being used in making all observations of levels.

*Level Gages*—One level gage was situated in the suction channel, and one in the discharge channel, as shown by the vertical elevation in Fig. 5 and plan view in Fig. 6. These were float gages with large metal floats, to the tops of which were connected steel rods with horizontal pointers passing before a vertical scale marked in hundredths of feet. The zero of the scales were carefully set by level observations referred to the bench mark previously mentioned. Readings of both discharge- and suction-level gages were taken every 15 minutes. The sum of the average of the readings of the two gages for the 24 hours of the test was taken as the total head pumped against and used in determining the duty.

*Weight of Sewage*—To find the weight of the sewage pumped, samples were taken about every hour and the temperature noted. The sample was then taken to a chemical laboratory, reduced to the same temperature and its density determined.

*Steam Consumption*—The boiler located at the west end of the boiler room was entirely disconnected from the rest of the steam-generating plant, all flanges being properly blanked. This boiler was connected with the engine by a separate steam line, also blanked where connected with the main header. All steam used by the engine under test and its auxiliaries was taken from this one boiler. The duty guaranteed by the builders in contract was based on commercially dry steam, containing not more than 2 per cent. of moisture. Only 1.5 per cent. of moisture was found in steam used during this test. Al drips from the steam separators and mai steam piping were led through a con denser and then weighed. The weight c the drips, plus the weight of water du to boiler leakage, and that used by th calorimeter was deducted from th amount of feed water supplied to th boiler, giving the net quantity of stear supplied to the engine during the test.

A throttling calorimeter was placed be tween the steam separator and the high pressure steam cylinder, and readings o temperature and back pressure (measure by means of a manometer in inches o mercury) were taken every 15 minute After the engine test had been conclude and several hours had been allowed fo the fire under the boiler to slowly coo down, a boiler-leakage test was conducte lasting about 6½ hours.

Indicator cards were taken every hou at each end of all steam cylinders of th main engine and circulating-pump engin Fig. 7 shows an average set of indicato cards graphically combined to show th expansion of steam in the three cy inders. The indicator springs used ha been previously calibrated by the make and found to be accurate. The mechan cal efficiency was determined by calibr tions based upon steam indicator car taken throughout the test. The revolu tions of the main engine were recorded l a positively operated revolution count connected to the high-pressure valve gea The revolutions of the circulating-pun engine were taken at stated intervals wi a portable speed indicator, and also by a positively operated revolution counter.

Temperature readings were taken every 15 minutes of the exhaust steam at condenser, circulating water, hot well, engine room, external air, boiler room and feed water. The temperature of sewage pumped was recorded at the time of taking each sample. Barometer readings in inches of mercury were taken every 15 minutes from a barometer located in the engine room.

Gage readings were taken every 15 minutes of the boiler pressure, steam pressure at engine throttle, steam pressure in first and second receivers, and in first and second receiver heating coils. The vacuum in the exhaust pipe from the engine was taken at the condenser and read every 15 minutes in inches of mercury from a mercury column.

### The Screw Pumps

The two screw pumps installed in the Thirty-ninth street station have each a capacity of 666 cubic feet per second and operate against a head varying from 7 to 10 feet. Each consists of a hub surmounted by six blades or impellers set in a direction contrary to that of a boat's propeller. It revolves in a cylindrical casing 16 feet long, with ¼ inch clearance at the side, which has been built into the tunnel lining. A cone is placed concentric with the wheel on each side and directs the flow to and from the blades. A second casing placed just beyond the wheel contains stationary deflector blades which reduce the swirling motion given to the water from the wheel. The shaft on which the wheel is mounted is carried by an outboard bearing in the center of the second casing, where it is supported by the deflector blades. The pull on the shaft is taken up by a thrust bearing placed inside the engine pit.

The engines operating these pumps are of the triple-expansion type. They have cylinders 22x38x62x42-inch stroke, and the speed of each engine is 55 revolutions per minute. They are placed side by side in a single open pit and each is direct connected to its screw pump. Each engine is supported by a massive cast-iron bedplate to which are secured heavy round column frames with bored guides for the crossheads. The frame of each engine nearest the screw carries the high pressure and intermediate pressure cylinders set in tandem. The other frame carries the low-pressure cylinder. This arrangement is more compact than that of the original type of triple-expansion engine, and there are but three main shaft bearings to be kept in alinement when six would ordinarily be required. The valve gear is of the standard Reynolds pattern, with the exception of the low-pressure exhaust valves, which are of the single-beat poppet type. The steam and exhaust valves on all cylinders are operated by separate eccentrics, and the high-pressure cutoff is controlled by a regulator so designed that the speed may be adjusted to suit the head while the engine is running. All valves are located in the cylinder heads.

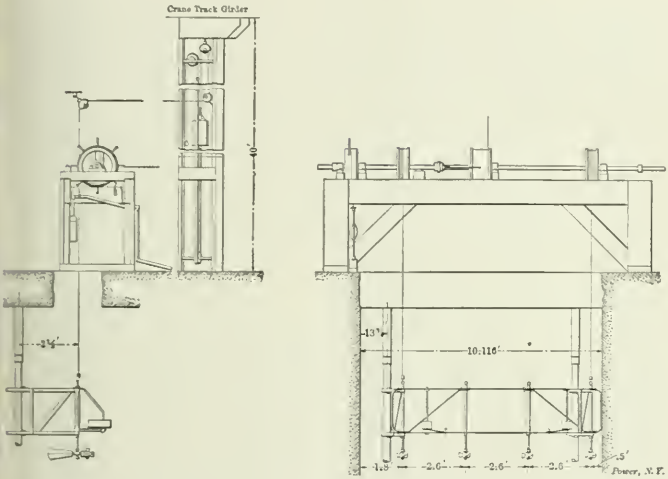


FIG. 9. CURRENT METER RIG USED IN SCREW PUMP TESTS

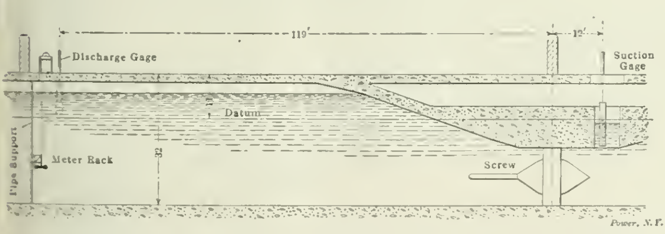


FIG. 10. ELEVATION OF SOUTH SCREW PUMP CHANNEL

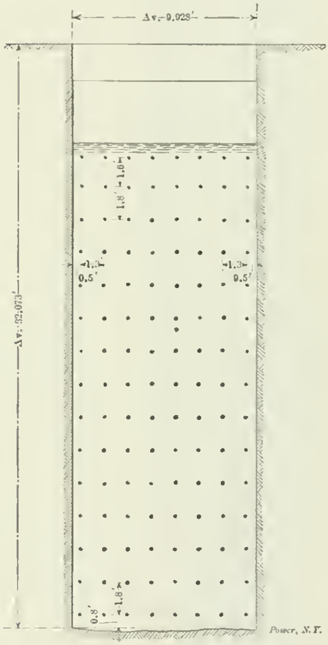


FIG. 11. POINTS AT WHICH VELOCITY OF FLOW WAS OBSERVED IN NORTH SCREW PUMP CHANNEL

### Screw Pump Tests

As the duty guaranteed by the builders was based upon the same conditions that obtained in the test of the centrifugal pumping unit previously described, there was no essential difference in the methods of conducting the trials of the screw pumps than those already detailed, except as noted below.

*Measurement of Water*—For measuring the water, current meters were used in practically the same manner as related above. Fig. 8 shows a plan of the screw-pump channels, and in Fig. 9 is illus-travel the meter rig used. The difference between this and the one employed for the centrifugal pump tests due to the much greater volume of water flowing, will be readily noted. These channels at the position of the current meter racks, as indicated in the plan view Fig. 8, were carefully calibrated both in width and depth. The obtaining of this data enabled the cross-sectional area of the stream to be easily determined for any water level.

*Current Meter Summary*—Table 3 shows a summary of the current meter observations, giving averages for the 24 hours of the observations on each of the 120 positions in the cross-section of the north screw pump channel. From this summary sheet were plotted 15 horizontal velocity curves, with reference to average discharge water level, and eight vertical velocity curves.

*Level Gages*—One level gage was situated in the discharge channel and one in the suction channel, as shown by the vertical view, Fig. 10. The zeros of the scales were carefully set by level observations referred to the bench mark, and readings of the discharge level gage were taken at the time of completing each set of meter observations. Readings of the suction level gage were made about every two minutes. The differences between the averages of the two gages for the 24 hours of the two tests, corrected by gage level observations, were the heads used in determining the final duties.

*Weight of Water*—To determine the actual density of the water pumpe samples were taken every hour and th temperature noted. Following is a chem cal report of the results obtained fro such samples.

*Steam Consumption*—Two of the boile in the station were entirely disconnecte from the rest of the steam generati plant, all flanges being properly blanke

TABLE 3. CURRENT METER SUMMARY ON NORTH SCREW PUMP.

| Meter Above Bottom Ft. | Velocity, Foot Seconds. Distance from Wall—Feet. 0 | 1.7 | 3.05 | 4.32 | 5.59 | 6.86 | 8.13 | 9.40 |
|---|---|---|---|---|---|---|---|---|
| 1.15 | 1.28 | 1.39 | 1.82 | 1.63 | 1.71 | 1.62 | 1.27 | 1.18 |
| 3.00 | 1.56 | 1.73 | 2.11 | 2.26 | 2.03 | 1.88 | 1.50 | 1.28 |
| 4.85 | 1.75 | 2.08 | 2.34 | 2.48 | 2.30 | 2.16 | 1.67 | 1.46 |
| 6.70 | 2.21 | 2.28 | 2.66 | 2.34 | 2.27 | 1.97 | 1.66 | 1.44 |
| 8.55 | 2.33 | 2.61 | 2.54 | 2.53 | 2.30 | 1.96 | 1.62 | 1.42 |
| 10.40 | 2.68 | 2.62 | 2.82 | 2.62 | 2.24 | 1.99 | 1.74 | 1.41 |
| 12.25 | 2.72 | 2.87 | 2.83 | 2.80 | 2.36 | 2.06 | 1.58 | 1.50 |
| 14.10 | 2.82 | 2.96 | 2.97 | 2.76 | 2.38 | 2.13 | 1.70 | 1.41 |
| 15.95 | 3.07 | 3.15 | 3.13 | 3.03 | 2.48 | 2.37 | 1.79 | 1.54 |
| 17.80 | 3.18 | 3.26 | 3.08 | 2.77 | 2.29 | 2.15 | 1.60 | 1.42 |
| 19.65 | 3.33 | 3.30 | 3.08 | 2.87 | 2.42 | 2.26 | 1.64 | 1.46 |
| 21.50 | 3.36 | 3.27 | 3.34 | 2.86 | 2.57 | 2.32 | 1.87 | 1.66 |
| 23.35 | 3.51 | 3.51 | 3.47 | 3.13 | 2.70 | 2.47 | 2.05 | 1.86 |
| 25.20 | 3.58 | 3.59 | 3.57 | 3.40 | 3.10 | 2.90 | 2.83 | 2.37 |
| 27.05 | 3.35 | 3.65 | 3.83 | 3.81 | 3.57 | 3.50 | 3.10 | 3.20 |

TABLE 5. OFFICIAL CAPACITY TESTS O SCREW PUMPING ENGINES.

| | North Screw Pump. | Sout Scre Pum |
|---|---|---|
| Duration of test, 3 hours. | | |
| Steam press, lb. gage | 170.2 | 171.6 |
| Average r.p.m. of main engine | 58.91 | 57.5 |
| Average i.h.p. of main engine (from indicator cards) | 913.77 | 937.4 |
| Suction head, ft. below datum | 2.975 | 3.4 |
| Discharge head, ft. above datum | 7.136 | 6.6 |
| Total head in feet | 10.111 | 10.1 |
| Depth of water at measured section, ft. | 28.146 | 26.8 |
| Width of channel at measured section, ft. | 9.929 | 10.1 |
| Discharge area for obtaining capacity, sq.ft. | 279.462 | 271. |
| Average capacity, C.F.S. | 673.223 | 664. |

TABLE 4. RESULTS OBTAINED FROM SAMPLES OF LAKE WATER.

| | |
|---|---|
| South Screw Pump Test. | |
| Temp. C. | 10.0 |
| Specific gravity | 0.9998 |
| Wt. per cu-ft | 62.4192 |
| North Screw Pump Test. | |
| Temp. C. | 10.4 |
| Specific gravity | 0.9983 |
| Wt. per cu.ft | 62.4159 |

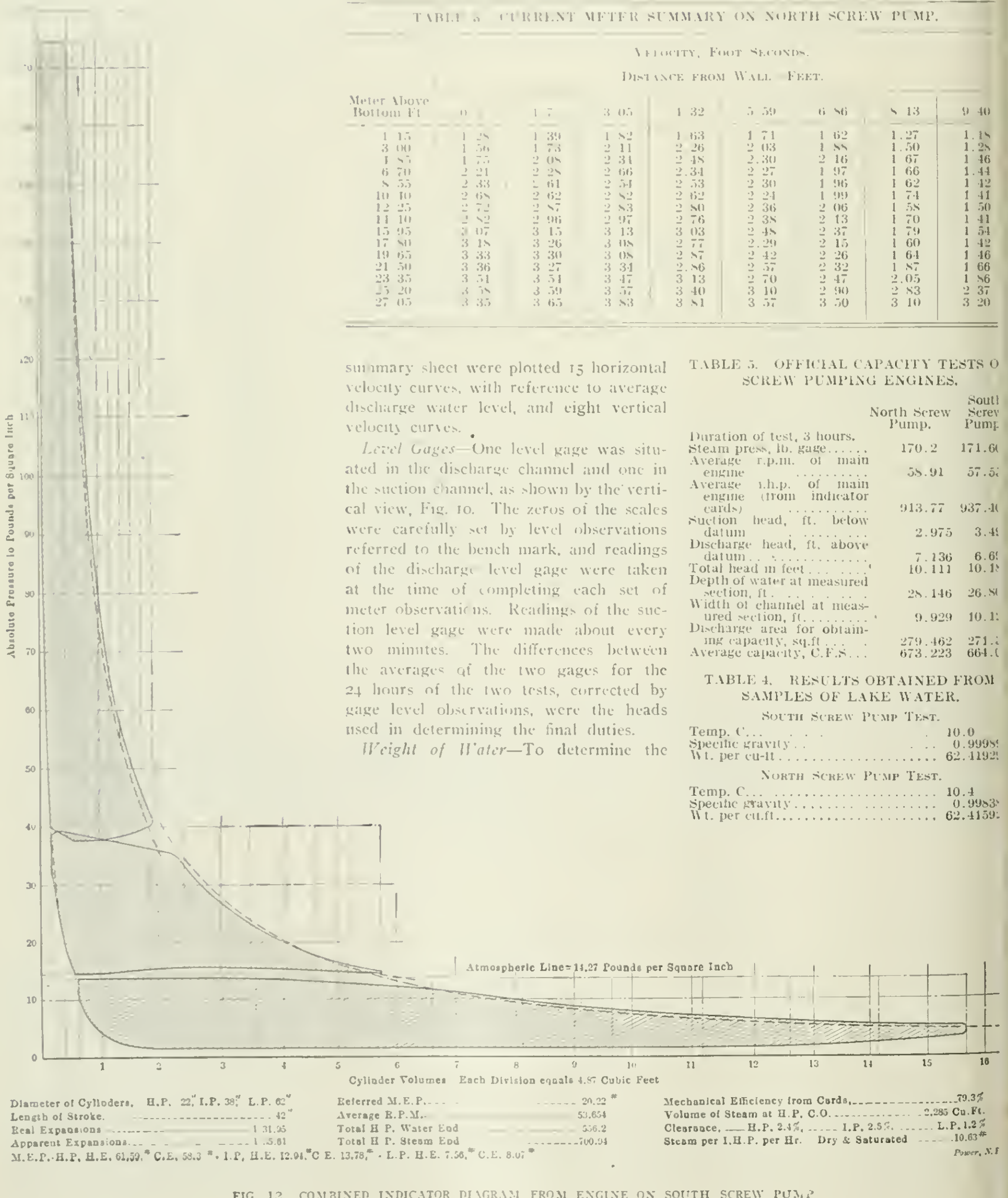


FIG. 12. COMBINED INDICATOR DIAGRAM FROM ENGINE ON SOUTH SCREW PUMP

These boilers were connected with the engines under test by a separate steam line having but one connection with the rest of the main steam piping in the engine room. The gate valve, separating the two sections, was found to be tight. However, in order to effectually guard against any leakage at this point, the steam pressure of the remaining boilers was kept so that the force exerted on each side of the gate valve was practically equal. The remaining procedure under this heading was practically the same as in the test previously described.

A throttling calorimeter was placed between the steam separator and high pressure steam cylinder of each engine. Readings of temperature and manometer (measured in inches of mercury) were taken every 15 minutes. About four hours after the concluding of the test of each engine, or a sufficient time to slowly cool the fires, a boiler leakage test was started and continued for periods of about 12 hours.

TABLE 6 OFFICIAL DUTY TESTS OF SCREW PUMPING ENGINES.

| | South Screw Pump. | North Screw Pump. |
|---|---|---|
| Duration of test in hours | 24 | 24 |
| Barometer, inches mercury | 29.06 | 29.471 |
| Barometer, pounds per square inch | 14.27 | 14.47 |
| Pressure, steam per sq.in. at engine throttle, absolute | 184.43 | 185.56 |
| Pressure steam per sq.in. at engine throttle, gage | 170.16 | 171 09 |
| Pressure, steam per sq.in. at 1st receiver, gage | 21.09 | 22 59 |
| Pressure, steam per sq.in. at 2d receiver, gage | 0.24 | 1 22 |
| Pressure, steam per sq.in. at 1st reheating coil, gage | 34.53 | 38 02 |
| Pressure, steam per sq.in. at 2d reheating coil, gage | 1.206 | 0 70 |
| Pressure, inches mercury calorimeter manometer | 6.46 | 6.18 |
| Vacuum, inches of mercury, exhaust pipe at condenser | 26.60 | 26.49 |
| Water level suction, ft. below datum | 0.713 | 1.439 |
| Water level discharge, ft. above datum | 6.352 | 5 635 |
| Water head, total in ft | 7.065 | 7.074 |
| Temperature, deg. F., at engine throttle | 371.97 | 375.18 |
| Temperature, deg. F., at exhaust at condenser | 109.3 | 115.15 |
| Temperature, deg. F., at hotwell | 59 55 | 63.76 |
| Temperature, deg. F., in calorimeter | 289.52 | 286.81 |
| Temperature, deg. F., circulating water | 49 56 | 50.2 |
| Temperature, deg. F., water pumped | 50.0 | 50.7 |
| Temperature, deg. F., engine room at barometer | 78 7 | 81.37 |
| Temperature, deg. F., air bleeder, L.P. jacket, in | 208 32 | 210.24 |
| Temperature, deg. F., air bleeder, L P. jacket, out | 178 46 | 142.7 |
| Water fed to boiler, total pounds | 194,866 0 | 189,680.5 |
| Water leakage from boilers, total pounds | 4,365 0 | 5,145.1 |
| Water returned from traps, total pounds | 7,272.0 | 7,158.0 |
| Water chargeable to calorimeter, total pounds | 1,384.5 | 1,393.0 |
| Steam used by engine, total pounds | 181,844.5 | 175,684.4 |
| Steam quality, per cent | 98.35 | 98.177 |
| R.p.m. main engine, average | 53.654 | 52.361 |
| R.p.m., circulating engine, average | 319 02 | 346.38 |
| Piston speed, ft. per min., average | 375.38 | 366.53 |
| Discharge channel, average width at meters, ft | 10.125 | 9.929 |
| Discharge channel, average depth at meters, ft | 26.463 | 26.645 |
| Discharge channel, average cross-section area at meters, sq.ft | 267.938 | 264.558 |
| Discharge channel, average velocity at meters, ft. per sec | 2.589 | 2.623 |
| Capacity, water pumped, av. cu.ft. per sec | 693.691 | 693.935 |
| Weight of one cu.ft. of water lifted, lb | 62.419 | 62.416 |
| Foot-pounds, av. per sec. (average cu.ft. per sec. to av. head) | 305,910.957 | 306,393.665 |
| Water H.P., av | 556.2 | 557.08 |
| Steam I H P. main engine, average from cards | 690 72 | 641.54 |
| Steam I H.P circulating engine, average from cards | 10.22 | 12.03 |
| Steam I.H.P. total | 700.94 | 653.57 |
| Mechanical efficiency combined, per cent | 79.3 | 85.2 |
| Saturated steam per I.H.P. per hour | 10.81 | 11.20 |
| Official duty per 1000 pounds steam | 145,317,847.7 | 150,681,634.46 |
| Duty guaranteed | 95,000,000.00 | 95,000,000.00 |

Although not required by the conditions of guarantee, indicator cards were taken once an hour of each steam cylinder of the main engines and circulating pump engines. In Figs. 12 and 13 are shown combined cards of the south and north screw pumping engines respectively. These cards were made up from averages of indicator cards taken during each test. The same indicators and springs were used in the trials of both engines.

The remaining factors in the test merely followed good engineering practice and need not be elaborated upon here. In conclusion it may be stated that the tests of each of the centrifugal and screw pumping engines installed in this station showed a duty largely in excess of that guaranteed, earning for the builders a very considerable bonus. The official trials were conducted by a board of experts, upon which Henry A. Allen represented the Sanitary District, L. E. Strothman served for Allis-Chalmers Company, the builders, and Robert Hunt & Co., through William J. Jennings, acted as the third member.

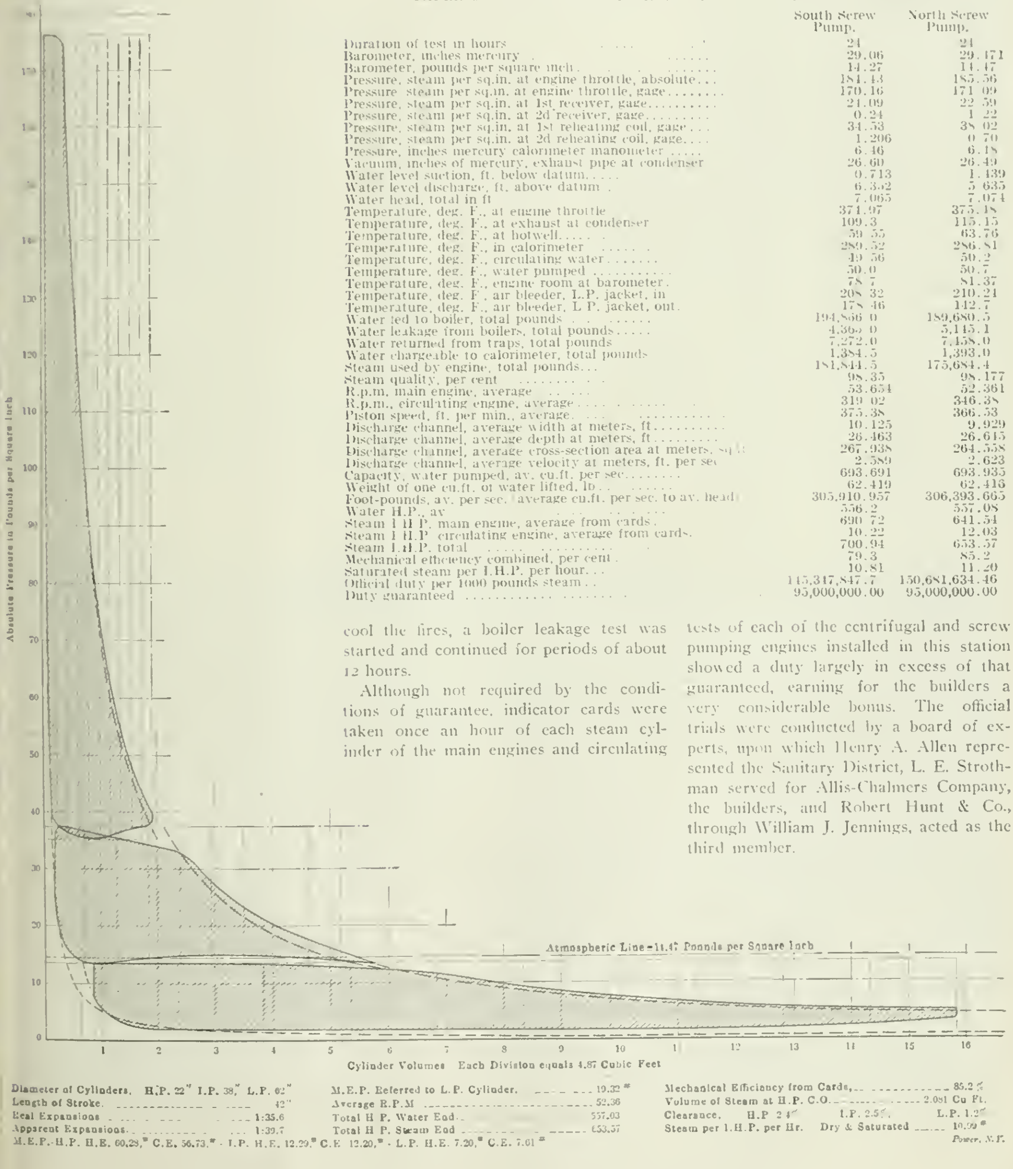


FIG. 13. COMBINED INDICATOR DIAGRAM FROM ENGINE ON NORTH SCREW PUMP

# Coal for Hand Fired Steam Plants*

By D. T. Randall

Steam is being generated in all parts of the country with the coals which are mined nearby or which are available at a reasonable freight rate. Some are burning coals which others would consider impossible fuel for their plants. It is generally known that there is a difference in the character and heating value of the coals mined in the United States, and yet very few people realize how great these variations are. Much coal is left in the mines of West Virginia and Pennsylvania as being of such low grade that it will not pay to market it. This so-called low-grade coal is, however, but little less valuable than the regular output of the mines and is in many cases much better than the best coal mined in the States farther west. Preference is naturally given to those coals which have a small percentage of ash and do not clinker badly, and to the larger sizes such as lump or egg.

The Technologic Branch of the United States Geological Survey has been conducting tests on all the fuels of the country and many valuable facts have been established regarding their character and the best methods of utilizing them. To show the differences in coal mines in the United States, the accompanying Table 1 has been prepared from results taken from Professional Paper No. 48 of the United States Geological Survey.

Experience in burning coals from all sections of the country in a hand-fired furnace indicates that for such an equipment (see United States Geological Survey Bulletin) the size of the coal is not of as much importance as is usually thought to be the case, but the smaller sizes require more draft and are slightly less efficient.

Nor does the ash affect the results as much as might be expected. Small variations in the percentage of ash seem to have but little effect except insofar as the heating value of the coal is varied.

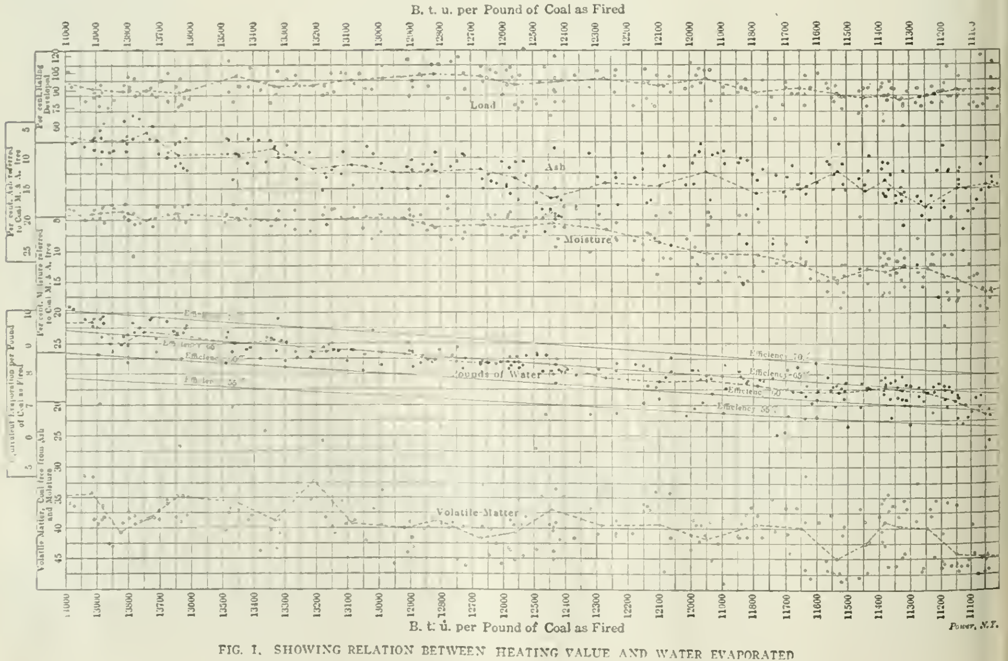
Owing to the fact that the moisture, ash and volatile matter usually increas together in the poorer coals, it is difficult to separate the effects of any on of them from the others. Table 2 seem to indicate, however, that the larger percentages of volatile matter make the coa more difficult to burn completely. Th moisture and ash also have an influenc on the results.

These tests on house boilers show tha for wide ranges of volatile matter ther is a considerable difference in the results These are significant as they were obtaine on a type of furnace which is most unfavorable to perfect combustion, an therefore make the effect of the composition of the coal more marked.

For a range of volatile matter betwee 18 and 40 per cent., the efficiency varie about 12 per cent. in favor of the low

TABLE 1. COALS TESTED ON A HAND-FIRED GRATE UNDER A 210-HORSEPOWE HEINE BOILER.

| | Analysis of Coals as Fired. | | | | | Coal Moisture and Ash Free. | | |
|---|---|---|---|---|---|---|---|---|
| | Fixed Carbon | Volatile. | Moisture. | Ash. | B.t.u. | Fixed Carbon. | Volatile. | B.t.u. |
| West Virginia —6 | 70.03 | 22.38 | 2.14 | 5.45 | 14,639 | 75.78 | 24.22 | 15,84 |
| Pennsylvania —4 | 60.82 | 28.70 | 2.90 | 7.58 | 13,982 | 67.94 | 32.06 | 15,61 |
| Arkansas —1 | 66.36 | 18.61 | 1.99 | 13.04 | 13,302 | 78.10 | 21.90 | 15,65 |
| Kansas —3 | 50.99 | 33.52 | 2.03 | 13.46 | 12,746 | 60.40 | 39.60 | 15,08 |
| Kentucky —3 | 44.84 | 37.32 | 7.92 | 9.92 | 12,003 | 54.58 | 45.42 | 14,60 |
| Alabama —2 | 48.65 | 32.98 | 4.83 | 13.54 | 11,948 | 59.60 | 40.40 | 14,63 |
| Illinois —1 | 38.21 | 36.91 | 9.69 | 15.19 | 10,706 | 50.86 | 49.14 | 14,25 |
| New Mexico —2 | 36.11 | 37.30 | 9.92 | 16.67 | 10,330 | 49.19 | 50.81 | 14,07 |
| Missouri —2 | 37.33 | 32.88 | 13.09 | 16.70 | 9,995 | 53.17 | 46.83 | 14,23 |
| Wyoming —1 | 31.61 | 40.56 | 21.81 | 6.02 | 9,630 | 43.80 | 56.20 | 13,34 |
| North Dakota —1 | 25.40 | 28.31 | 35.84 | 10.63 | 6,674 | 47.45 | 52.55 | 12,46 |



Power, N.Y.

FIG. 1. SHOWING RELATION BETWEEN HEATING VALUE AND WATER EVAPORATED

volatile coals. (See Bulletin 360, United States Geological Survey.)

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*Paper read before the American Waterworks Association convention, at Milwaukee, June 8 to 12, 1909.

TABLE 2. THE RELATION OF VOLATILE MATTER IN COAL TO EFFICIENCY OF HOUSE BOILERS.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Number of Tests Averaged | Volatile Matter in the Combustible. (Per Cent.) | Efficiency. (Per Cent.) | Per Cent. Rated Capacity Developed. | Black Smoke. (Per Cent.) | Ash in Dry Coal. (Per Cent.) | Sulphur in Dry Coal. (Per Cent.) | Clinker. (Per Cent.) | Per Cent. $CO_2$ in Dry Flue Gases. | Per Cent. CO in Dry Flue Gases. |
| 4 | 18.30 | 60.56 | 63.7 | 18.2 | 8.00 | 1.33 | 0.0 | 8.7 | 0.44 |
| 12 | 22.71 | 56.33 | 61.1 | 18.0 | 8.94 | 1.74 | 0.0 | 7.3 | 0.50 |
| 7 | 34.70 | 54.11 | 52.8 | 22.1 | 11.27 | 1.23 | 2.9 | 7.4 | 0.55 |
| 11 | 38.79 | 47.19 | 57.1 | 30.8 | 15.02 | 2.64 | 12.0 | 8.7 | 0.62 |
| 16 | 44.46 | 47.19 | 61.3 | 32.9 | 14.57 | 4.35 | 30.4 | 9.1 | 0.74 |

On tests with a Heine boiler, hand-fired, this variation is only about 6 per cent., owing to the better methods of firing and to a better type of furnace. It is probable that a furnace may be designed to burn high volatile coals with practically the same efficiency as is obtained with the low volatile coals.

To show the relative amounts of coals and their constituents that must be fed into a furnace to furnish it with one million B.t.u., the accompanying chart, Fig. 2, and Table 3 have been prepared.

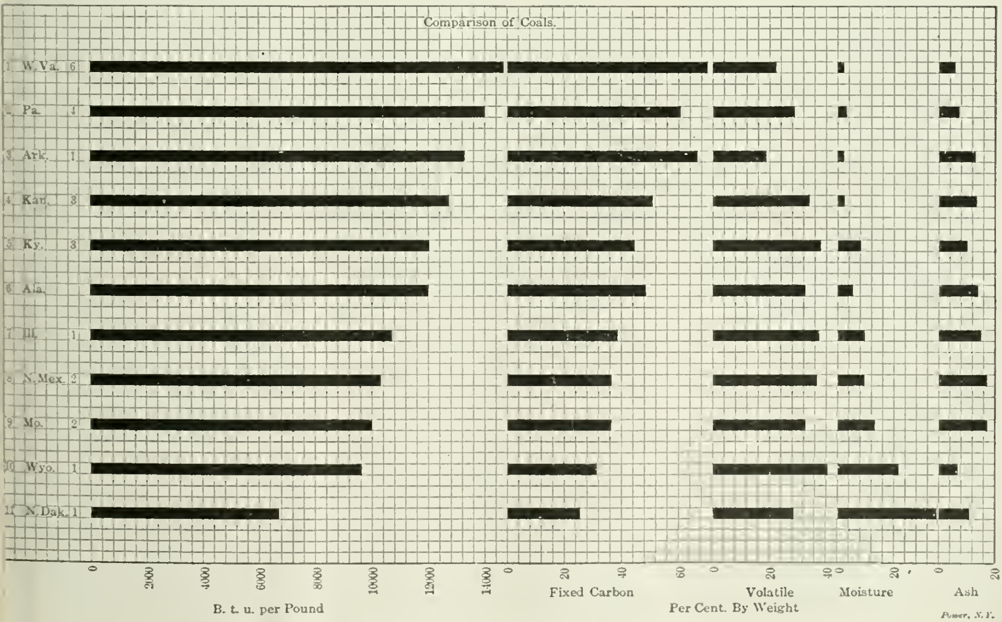
This is a more convenient basis of comparison than the analysis as usually given. However, this does not give an entirely correct comparison, for the reason that not all of the heat as reported in the B.t.u. values is available to the boiler. The percentage of available heat varies with moisture and other constituents of the coals. These values if calculated would compare with the so-called low values used for gases and in some cases for liquid fuels. As there is at present no accepted standard for determining the corrections to the heating values of coals for boiler use, Table 3 has been submitted without an attempt to correct values.

TABLE 3. COMPARISON OF COALS IN TABLE 1 ON BASIS OF AMOUNTS REQUIRED TO SUPPLY ONE MILLION B.T.U. TO FURNACE.

| | Pounds Coal Per 1 Million B.t.u. | Pounds Fixed Carbon Per 1 Million B.t.u. | Pounds Volatile Matter Per 1 Million B.t.u. | Pounds Moisture Per 1 Million B.t.u. | Pounds Ash Per 1 Million B.t.u. |
|---|---|---|---|---|---|
| 1. West Virginia 6.. | 68.31 | 47.84 | 15.29 | 1.46 | 3.72 |
| 2. Pennsylvania 4.. | 71.52 | 43.50 | 20.53 | 2.07 | 5.42 |
| 3. Arkansas 1.. | 75.17 | 49.88 | 13.99 | 1.49 | 9.80 |
| 4. Kansas 3.. | 78.45 | 40.00 | 26.30 | 1.59 | 10.56 |
| 3. Kentucky 3.. | 83.31 | 37.36 | 31.09 | 6.60 | 8.26 |
| 6. Alabama 2.. | 83.69 | 40.71 | 27.60 | 4.04 | 11.33 |
| 7. Illinois 1.. | 93.41 | 35.69 | 34.47 | 9.05 | 14.19 |
| 8. New Mexico 2.. | 96.80 | 34.95 | 36.10 | 9.60 | 16.14 |
| 9. Missouri 2.. | 100.06 | 37.35 | 32.90 | 13.09 | 16.71 |
| 10. Wyoming 1.. | 103.84 | 32.82 | 42.11 | 22.65 | 6.25 |
| 11. North Dakota .. | 149.83 | 38.05 | 42.14 | 53.70 | 15.93 |

The accompanying diagram, Fig. 1, was prepared to show the relation between the heating value of the coals and water evaporated in the boiler per pound of coal fuel for about 400 tests.

It will be noted that in general the evaporation has been nearly in proportion to the heating values of the coals. In some cases the coals of higher heating value did not give as high results as others of lower heating value. This may be due to either of two causes. The composition or size of the coal may be such as to make it difficult to burn it all completely, or the method of firing and the air supply may have been at fault. The results shown in the diagram are not corrected for influence of size of the coal, loss of carbon in the ashpit, loss of heat to evaporate moisture in the coal, and



Power, N.Y.

FIG. 2. SHOWING RELATIVE AMOUNTS OF COAL, ETC., TO BE FED INTO A FURNACE TO FURNISH ONE MILLION B. T. U.

loss due to the use of excessive amounts of air in burning the coal. Many of the variations in results are due to one or more of these causes.

This shows that for an average the results depend principally on the heating value of the coal when the coal is burned in a properly constructed furnace. Of course, the moisture, the ash and the sulphur content influence the efficiency. Ash and in larger amounts, and especially if it tends to clinker, reduces the capacity at which an equipment may be operated.

It must be understood, too, that not all of the heating value of the coals as determined by the calorimeter can be made available to the boiler. The moisture in coal requires considerable heat to evaporate in the furnace. This varies from about ½ per cent. of the fuel value in good eastern coal to about 1¼ per cent. for Illinois coal and to about 5 to 8 per cent. for the lignites.

The most simple furnace and the one least suited to burn bituminous coal is the hand fired grate with a small combustion space bounded principally by iron surfaces. This furnace is found in house boilers and locomotive types. The best furnace for most coals is one which is so designed that the coal is fed regularly in small quantities, air is admitted to the gases which are slowly driven from the coal and combustion takes place in a large combustion chamber which allows the gases to burn before they reach the cold surfaces of the boiler tubes.

Time is required for the gases and air to burn and any means that will cause them to mix quickly will reduce the size of combustion chamber required to secure economy and smokeless combustion. A perfect furnace would burn all coals with equal efficiency. The ordinary hand-fired furnace found in most plants is far from being a perfect furnace.

One should choose a coal suited to a furnace and boiler equipment, or else change the furnace to meet the requirements for a cheaper coal. A strong draft is an important condition to be secured in a boiler plant. A tall stack is a good investment. Stacks should seldom be less than 120 feet high. In many cases they should be higher. A fan may be used with a shorter stack with good results. In many cases coals have been pronounced as unsatisfactory because the draft was too low.

In considering coal for boiler plants it is necessary to know the coals which are available and their relative values. Some otherwise good coals may be unsuited because of trouble from clinker. Not always, but generally, the cheapest coal to buy is the lower-priced one, provided conditions in the plant will permit its use.

In order to compare the cost of coals offered to the Government it has been calculated on the basis of the cost of one million heat units delivered. This varies from 7 to 10 cents in different parts of the country. If the purchaser desires assurance that the same coal which he selects shall be delivered throughout the contract period he naturally desires to make use of specifications covering the essential characteristics of the coal. The United States Government, many State and city governments and numerous commercial firms are now using such specifications with success. The specifications cover such items as price, method and time of delivery, and also establish a standard for the heating value of the coal and the ash content. In some cases the permissible amount of volatile matter is stated in the purchase of coal in order that the purchaser may get what he pays for and pay for what he gets.†

The experiments of the Technologic Branch show that for almost any character of coal furnaces may be adapted or new ones designed which will burn the coal with reasonable efficiency, and that almost no fuel need be rejected as worthless. Even coals of small sizes and high in ash may be so prepared that when properly sized they will give results that are but little below those for the larger-sized and better coals.

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# Valuation of Water Power and Estimation of Steam Diversion Damages*

The author of this paper treated the case exhaustively. At the beginning he annunciated the fundamental legal principle that a riparian owner is entitled to have a stream flow at his premises substantially undiminished in volume or fall, unimpaired in quality and with nearly its natural regimen or order of rise and fall. Also, if a diversion from the stream is made the measure of damages is not the value of the part taken *per se*, but is the difference between the market value of the whole property and the value of what remains after the taking.

Of the effect of dividing water power he said: "The value of a water power per horsepower usually increases as the size of the power increases. If the power is divided, the sum of the values of the two parts taken separately will usually be less than the value of the entire power as a unit."

From the foregoing it is evident that the difference in value of a power before and after a part is taken may be greater than the value of the part taken itself for water-power purposes. The value of the remainder for power purposes may be in some cases substantially destroyed by the taking away of a part. In speaking of the market value of a water power, he said: "The claimant for diversion damages will demand the fair market value for the best use to which the property can ordinarily be put whether heretofore used in that or in some other manner."

In the discussion of damages, the relation of water power to a business and its value, he said: "When an owner is dispossessed by eminent domain he cannot be considered as willing to sell, and if unwilling to sell, he may be discommoded by being forced to do so. Justice apparently demands that the welfare and fortune of the claimant shall be left unimpaired. Unless provision is made t indemnify the claimant for inconvenienc and loss of profit, he will, it is evident be inclined, in order to secure what h believes to be justice to himself, to charg to the water-power account all of th incidental damages which he has suffered and in valuing a water power used in a established business care should be take to credit to the water power only suc part of the aggregate profit as it actually produces." Errors are sometimes mad in water-power valuation where it is assumed that the power is transmitted an sold at retail in the form of electri current.

As to prospective or potential an speculative use, he said: "Water powe may be compared to eggs, potatoes, o other perishable commodities, which i not used are wasted. Their value depends upon supply and demand, and upo the cost of transportation from the sourc of production to the center of consumption; or, in other words, upon marke facilities." The present work of an undeveloped power depends upon severa factors and cases were cited where it wa necessary to determine the value of developed water power, which in the cours of time will become valueless for thei present use owing to the exhaustion of raw material used in the industry operated by the water power.

Auxiliary power, such as steam, ga and electric-combined water powers, wa also discussed, as well as the difficultie which an engineer meets in the valuation of water powers, and the estimatio of the damages caused by diversion.

After discussing the problem in all it phases, the author concluded by saying "The indemnity for taking a water powe as a whole or in part is measured b the difference in market value before an after the taking. Justice apparentl demands that the amount of indemnit should be such that it will leave the owne substantially as well off as before th taking. The considerations which ma properly enter in determining the amou of indemnity must be selected for eac case according to the conditions."

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†See *Bulletin* No. 339, United States Geological Survey.

*Abstract of a paper by Robert E. Horton, presented at the American Water Works Association Convention, Milwaukee, Wis., June 8 to 12, 1909.

# Standard Practice in Pipe Threads

## Great Britain's Whitworth Thread Versus the American Briggs Thread. The 55-Degree Straight Thread and the 60-Degree Tapered Thread

### BY J. F. SPRINGER

In carriage axles there are two broad pes—the straight arm and the tapered m. In the one case, the journal is a rfect cylinder and, of course, the hole rough the hub is the same. In order secure a close but easy fit between two, very accurate workmanship is cessary, and this, of course, results in xpense. With the tapered journal and hole of corresponding form, however, y desired adjustment of the fit between two may readily be secured by means t the retaining nut. Accordingly, tapered s are cheaper than straight ones.

Just as the tapered axle solved the prob- f a close fit at moderate cost, so in am tting tapered joints have fur- shed an economical solution of tight nnections. There are in the United tates today probably no manufacturers steam and hydraulic fittings who make eir product up with straight threads.

The expressions "tapered threads" and traight threads" are apt to be mislead- g. In fact, it is not the threads them- ves that are tapered or straight. What referred to is the manner in which they re coiled. If the ridge of metal forming thread on a pipe is so arranged that coil decreases in diameter—thus form- g a spiral—then the thread is said to tapered. The edge of such a coil ald lie on a conical surface. But if diameter of the coil remains the same thus forming a helix—then the thread straight.

The great advantage of the tapered ead is that it makes a thoroughly tight t possible without extraordinary ex- It might be thought that by mak- g the thread on the pipe a little short nished a straight-threaded connec- n could be made that would be roughly tight. Leaving out of account question whether it would be pos- commercially so to thread pipes as fulfil these conditions, there is a very rious objection to this procedure. If re is actual cutting between the two, ery considerable amount of friction ill arise. This will result in heat. As fitting is usually heavier than the pipe, e heat will penetrate it more slowly: nsequently, the expansion of the pipe ill be greater than that of the fitting. When a joint made under such condi- ons cools off, it cannot be expected to e tight—the pipe shrinks farther.

The joints must be made without heat, hether the threads are straight or tapered. This requirement imposes, then, a great burden on those who may advocate the straight thread. It may safely be said that in the United States there is practically no advocacy of this thread. The tapered thread permits a perfect joint by the simple procedure of taking a turn or two, more or less, as the particular circumstances require.

#### BRITISH PRACTICE

In England the standard pipe thread is that introduced years ago by Whitworth. This thread is notable as being of peculiar form without any good reason for the peculiarity. In Fig. 1 is represented in an exaggerated size a longitudinal section of the Whitworth thread which, it seems, is still adhered to. First of all, a series of isosceles triangles are constructed, each having its vertical angle equal to 55 degrees. This would give a sharp form of thread. As this is undesirable, the groove between threads and the edges of the threads are rounded off. In this way one-sixth the altitude of the triangles is twice removed from the section. That is to say, the lines *D E* and *F G* are drawn cutting off one-sixth of the altitude, above and below, leaving the entire depth of the thread two-thirds that of the triangles. This rounding is performed in such way that the circles are tangent to *D E* and *F G* as well as to the sides of the triangles.

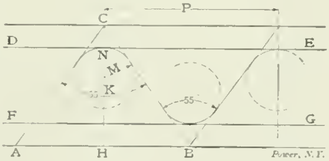


FIG. 1. WHITWORTH THREAD USED IN GREAT BRITAIN

The angle 55 degrees for the vertical angle of the triangles may seem a curious selection. The explanation has been suggested that Whitworth desired to make competition difficult, and so, instead of choosing 60 degrees, he selected 55. This is not very complimentary to him or to his competitors either. It is undeniable that 60 degrees is practically a very easy angle to get. At the same time, 55 degrees should hardly be thought sufficiently difficult to deter very much competition. It has also been suggested that perhaps the reason was the circumstance that by choosing 55 degrees a triangle is determined such that the resulting thread (apart from rounding) would have a depth very nearly equal to the pitch. Then *C H*, the depth, is equal to 0.96049 times the pitch. But this does not seem reasonable, seeing that 0.96049 is really almost 0.04 less than unity. If it seemed desirable to have depth and pitch precisely equal, it could readily be done by laying them off thus, or by selecting the angle 53 degrees 8 seconds instead of 55 degrees. But once started, this peculiar thread, for which there seems to be no explanation, has persisted and probably will persist, until international trade compels a more rational choice.

#### **From a British Viewpoint**

By W. H. Booth

In ordinary steam or water pipe, the threads are supposed to be straight, but in practice there is occasionally a slight taper on the pipe. The British thread is finer than the American and never contains fewer than 11 threads per inch. From observation of both American and British pipe it would appear that the latter makes better steam-tight joints. Less metal is cut away by the fine thread than by the coarse thread, and the pipes can be thinner. Nominally pipe threads are supposed to touch top and bottom and so to make a joint. In practice there is a little play, but not more than is filled by the usual smear of red lead and oil.

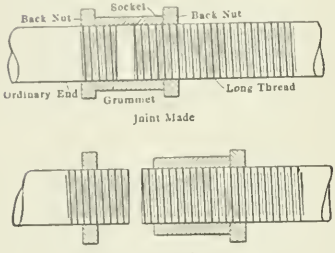
In the ordinary method of die screwing, the advancing edge of the dies, which are bell-mouthed so as to clear off the pipe surface in advance of the threading portion, serves to cut an imperfect thread on the tapering cleared surface, so that when the socket is screwed home a joint is finished upon this taper length. Thus, if a socket does not actually tighten on its straight thread, it will finally tighten on the taper. The straight thread has the advantage over the taper thread that there are all the threads well engaged and, as well, a final taper tightness, whereas with the tapered thread there can only be a fit of any sort at one thread, and that at the very outside of the joint. Frequently in practice a straight thread tightens as it advances in the socket and a joint is made before the bit of tapered-off thread is reached by the socket. This tightening can only happen where the threads touch at the top or bottom.

It should also be added that the customary pictorial presentation of the pressure joint with tapering sockets does not occur in practice. The socket is tapped from each end with a taper top, and the pipes come to a tight joint before they meet in the socket. The probable jumble of thread at the mid-length of the socket does not therefore affect matters, but it is pretty sure that in commercial work the two taps do not start in at the ends of the socket so as to give exactly coincident threads at the middle. The middle might, of course, be cleared out by an aftercut so as to remove these jumbled threads, but no special good would be effected thereby.

The ordinary straight British thread will resemble the thread of Fig. 4, with the exceptions that the four imperfect threads have perfect tops when the dies are new, and the other threads are all perfect and their points touch the parallel top line. The writer has never tried by actual measurement how closely pipe threads approach to theoretical dimensions, but it will be found in practice that if the pipe surface is perfect, it is not usual to have trouble in making tight joints with straight threads. There have been cases where a pipe has been imperfect owing to a flat place along its surface, so that all the threads at that flat surface were imperfect and there was a segmental-shaped gap for leakage. But such a fault is due to lack of proper inspection. In theory, if threads do not fit top and bottom, there is a long helical leak possible, but it must be a very slack thread which could produce such a space as would not be filled by the smear paint. The bit of taper thread helps all this, and practice proves that joints are easily made tight, though theoretically the taper thread seems better calculated to be tight, even though it be so at but one thread.

In Great Britain almost all well casing is made with straight-threaded ends and sockets. The sockets are of special form, thin and with their ends tapered down almost to an edge. The ends of the pipe are "cressed" or swaged-in ⅛ inch, so that the exterior diameter of the thin socket is not so very much greater than the body of the pipe. The pipe ends are threaded exactly half the length of the socket, and when the joint is made no thread appears beyond the ends of the socket. The last three or four threads farthest from the pipe end run out gradually to *nil*, as also do the end threads of the socket, because this is belled out. The socket is a nice fit on the pipe, and the pipe ends are faced off truly square by the longitudinal axis of the pipe. Thus, the pipes butt together in the socket and bear heavy driving. No artesian engineer trusts taper-threaded pipe for casing, and flush-jointed pipes are little used. By flush-jointed is meant pipes which are half cut away for the screwed length, alternately inside and outside, so that the pipes when put together are flush or smooth and parallel inside and out. It rarely happens that the internal and external butting ends have equal stress, and this joint is unfit for drive pipe.

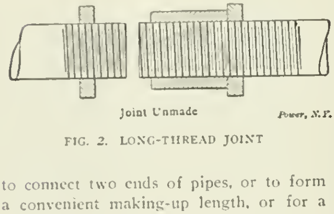
### A Joint Commonly Used in Great Britain



Power, N.Y.

FIG. 2. LONG-THREAD JOINT

A joint commonly used in Great Britain to connect two ends of pipes, or to form a convenient making-up length, or for a place where a length of pipe may be disconnected, is shown in Fig. 2. It is known as the long-thread joint, and in the illustration two positions of the socket are shown—one with the joint made and the other with it unmade. The socket is straight-threaded, as is also the long-threaded portion to the right. The socket and back nut on the right may be run back to the position shown in the lower part of the figure. The pipe to the left is supposed to have a tapered thread, at least for a portion of the distance from the end. When the two ends of pipe have been brought into position, the socket is advanced over the end of the left-hand pipe, and screwed up until it reaches a tight position. The nuts are, of course, screwed close to the socket.



Power, N.Y.

FIG. 3. THE BRIGGS STANDARD AMERICAN THREAD

This joint has been criticized in America, and to employ a straight-threaded socket and a taper-threaded pipe would appear to the writer very crude. If a pipe must be tapered let it have a taper-threaded socket. Then the fit would be ex cellent. But the common fit is merely o one thread and is a matter of force. I is difficult to see why there should be an criticism of the long thread and back nut Where a joint is wanted in the middl of a length of pipe. The long thread mus in the very nature of things be a straigh thread. The socket must be easy and fre upon the long thread or it will wast time in the making and unmaking of joint. The joint cannot be made tight o itself. It is only to be made by means o the back nut which draws the threads o the pipe tightly back on the thread of th socket. Red lead does the rest, but th socket is often so easy that a grumme of wire or yarn is needed to prevent weep.

A special joint is made for so-calle "pressure" pipe, in which the pipes ar taper-threaded as also is the socket; th pipes do not meet in the socket, and th socket is threaded right through excep for a short distance at each end, which i plain and straight and fits close on th pipe. The thread on the pipe also stop within the socket. When put togethe the joint shows no thread and the ap pearance is very neat when the work i good.

On the general question of pipe thread the writer has always insisted on the ne cessity of uniformity of diameter. Whit worth fixed standard diameters, and ye there are makers whose pipes will nc fit other makers' pipe. There is a grea difference in the quality of finish on ar tesian pipes, and some makers cannc make first-rate artesian pipe. In th writer's experience, artesian pipe, b James Russell & Sons, has never bee found faulty. Other makes at less pric have been found to cost twice as muc owing to overtightness and even noninte changeableness.

It is a curious fact that when withdraw ing tightly-driven casing, especially of th larger sizes, pipes will sometimes dra out of their sockets with no apparent in jury to the threads. In this respect th 55-degree angle is less liable to draw tha the 60-degree angle owing to its less de parture of 2½ degrees from the perpen dicular face.

While the lack of international inte changeableness is very annoying, it not so much so as the variation in Englis practice. When up in the bush, an enginee may find himself confronted with tw lots of 4-inch pipe by makers who do n both work to Whitworth standard; wher a pipe line has to be continued from on size to another, the pipes do not fit an the point of change of gage has to be dea with according to circumstances. Half bag of portland cement may be usefull commandeered, or a block of wood ma be bored through to form a coupling; b all respect vanishes for the firms who ar out of standard.

## American Practice

By J. F. Springer

For a very considerable number of years it has been the practice in the United States to employ tapered threads both on the pipe and in the fitting. A tapered thread with one, combined with a straight thread with the other, would enable a fairly tight joint to be made, but only involving a thread or two. Such joints fail, but a tapered thread with both makes it possible to secure not only a tight joint, but to make this joint effective over a considerable number of threads. It would appear to be the essence of good practice where threaded joints are employed at all.

It is important to see, with respect to the American practice with tapered threads, that the joint is not at all a matter of a thread or two. When the wall of the tapered hole in a carriage hub is brought into contact with the tapered arm of the axle, the contact is not a matter of a narrow circular ring or band. If the tapers of the hole and of the arm are made with reasonable accuracy and the degree of taper is the same in both, then contact extends over the whole of the corresponding areas. It is just as perfect throughout as with an accurately made straight hole and straight arm.

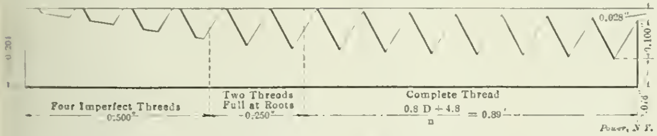


FIG. 4. THE BRIGGS THREAD ON PIPE OF 2⅞-INCHES OUTSIDE DIAMETER

There is, indeed, one great advantage with the tapered hole and arm. To get absolute contact throughout, all that is necessary is to make the two conical surfaces perfect in form. No particular attention is paid to dimensions. With the straight hole and arm the cylindrical surfaces must be perfect to secure perfect contact throughout. And further—here is where the difference lies in economy—the hole and arm must match in diameter as well.

Now when we consider the tapered-thread joint and the straight-thread joint, matters are precisely similar. If the tapers of the male and female threads are the same in degree, there is engagement of the two threads throughout. To secure as extensive a joint with straight threads, not only must both pipe and socket be threaded perfectly cylindrical, but both cylinders must have precisely equal diameters. This equality of diameters is the thing which is expensive to get. Without it, even though the cylinders are perfect in form, a fine joint cannot be obtained. It is right here where American practice is undoubtedly superior. The American manufacturer makes the socket, or fitting, with the hole precisely the same in form as the external surface of the pipe. Any slight difference in diameter is removed by screwing up to the point of equality. When that point of equality is reached for one part of the threads in contact, it is reached for all parts. And so the contact is made close throughout—just as close at one point as at another.

To state the matter in other words: With a straight joint, to get perfect contact throughout, it is necessary not only that the threads be perfect in so far as cylindrical form is concerned, but also that the diameters be precisely alike. With American practice, the form of the two threads is made precisely the same and that is the end of the matter. Equality in diameters is secured by adjustment. And adjustment is cheap. With straight threads, the necessity of making the diameters of the male and female threads the same is expensive.

The taper-threaded connection originated, as Robert Briggs believed, with Joseph Nason. This was probably about sixty years ago, and this method has continued ever since, until today it is recognized American practice. Whether the system actually originated with Mr. Nason, it can scarcely be denied that he was responsible for its general introduction. Mr. Nason adopted this method of making joints, despite the fact that Perkins of England, whose pupil he had been, used an entirely different procedure. The Perkins joint required the two pipe ends to be oppositely threaded—one with a right-hand thread and the other with a left-hand one. One pipe end was faced off plain; the other was provided with a V-shaped ridge. When these ends with their right- and left-hand threads were introduced into a socket correspondingly threaded, and the socket was screwed in the proper direction, the ends of the pipes were forced into contact, the V-shaped ridge even penetrating the metal of the other face. The action is similar to that of the turnbuckle. This style of joint was used with success upon 9 miles of 3-inch pipe line for the transportation of petroleum from Baku to the Caspian sea in the Russian oil fields. But the transportation of heavy crude oil is quite a different proposition from that of the transference of steam under pressure. Unless the threaded portion of the joint is made very accurate, the sealing is accomplished mainly at but one point. Even if some soft metal gasket be provided here, this objection of limited sealing surface applies. Possibly some such reason as this impelled Mr. Nason to depart from the example of his teacher. There is, of course, some objection to having the two ends of a single length of pipe faced differently, but this is a very moderate objection. At any rate, Mr. Nason adopted the taper-threaded joint, and this style of connection has maintained its lead in spite of sixty years of advance in mechanical methods and in spite of the enormously increased steam pressures of recent years.

Robert Briggs occupied much the same relation to Mr. Nason that the latter had to Mr. Perkins. To Briggs and Nason, as well as to Walworth, Gregg, Morse, Greenwood, Tasker and Mapes, we owe the general introduction of steam heating in the United States. The perfection of today is largely due to these men.

This problem of the pipe joint was one of the first to be solved, and it was to this phase of the subject that Mr. Briggs devoted a great deal of attention. He found that not only in the care of steam pipes used for heating purposes, but likewise in that of pipes in general a great deal of variation in practice had grown up, and it was largely through his efforts that uniformity has resulted. At one time a fitting purchased from one manufacturer could not be relied upon as being of precisely the same dimensions as a pipe of corresponding size bought of another maker. Perhaps the number of threads per inch and the degree of taper might be the same. If, however, the vertical angle of the threads was different or the depth of the grooves between threads was not the same, one might expect trouble in using the two together, either in difficulty of making the joint or in unsatisfactory service afterward. About 1862, when superintendent of the Pascal Iron Works, Mr. Briggs prepared the celebrated standard dimensions.

### How The Briggs "Standard" Was Derived

In the first place, the taper adopted was 1 in 32 as respects the axis, or (what is the same thing) 1 in 16 total. This degree of total taper amounts to ¾ inch for a length of one foot. The triangle adopted to determine the form of the thread was the equilateral triangle. The vertical angle is thus 60 degrees. The threads and grooves were rounded, each being allowed 0.03812 of the altitude of the triangle. In Fig. 3, the triangle *A B C* represents the outline of a thread.

In putting on the tapered threads, there will be a first portion in which every thread is perfect both at top and bottom. However, in cutting the threads farther back, a point will be reached where the taper will bring the summits of all subsequent threads up beyond the metal. Consequently, from this point on, all threads are imperfect at the top. In accordance with the Briggs system, the two threads following the absolutely perfect ones will be perfect at the bottom. To sum up, there will be a series of absolutely perfect threads, perfect top and bottom; then two perfect at bottom but not at top; then three imperfect both at top and bottom. The number of absolutely perfect threads varies with the size of the pipe, but the number of the remaining less imperfect ones is fixed for the various sizes. The distance threaded with absolutely perfect threads is determined by the formula,

$$L = (4.8 + 0.8 D) p$$

where

$L$ = Length of pipe threaded with the absolutely perfect threads.

$D$ = Outside diameter of the pipe.

$p$ = Pitch of the thread

Thus, for pipe whose outside diameter is 2⅞ inches and which has eight threads per inch, the length of perfect thread is (remembering that the pitch is equal to unity divided by the number of threads per inch)

$$L = (4.8 + 0.8 \times 2.875) \times 0.125 = 0.8875.$$

That is, such a pipe will have absolutely perfect threads for 0.8875 inch. Then there will be two full threads (each 0.125 inch), perfect at bottom but blunt at top. Finally, there will be a distance of four threads ($4 \times 0.125 = 0.5$ inch), where the threads are very imperfect.

It is a matter of considerable importance to know just what amount of metal is left at the bottom of the first groove. The formula for this, as given by Mr. Briggs, is

$$T = 0.0175 D + 0.025.$$

Applying this to the case already considered, gives

$$T = 0.0175 \times 2.875 + 0.025 = 0.0753.$$

That is to say, in the case of a 2⅞-inch (nominally 2½-inch) pipe, there would be 0.0753 inch of metal supporting the commencement of the groove. In order to determine the internal diameter, it would be necessary to subtract twice this amount from the diameter from bottom to bottom of the groove. That is, the internal diameter is

$$2.620 - 0.151 = 2.469.$$

The simplicity of the 60-degree thread is noteworthy. Likewise, it being noticed that a sharp thread would give a depth, or height, of 0.866 times the pitch, the amount of rounding is taken at just that percentage that will give the total depth as 0.8 times the pitch. This is a simple relation between pitch and depth.

The question of uniformity of pipe-thread dimensions having been brought before the American Society of Mechanical Engineers by George M. Bond, at its Boston meeting in 1885, the interest aroused led to the appointment of a committee to look into the subject. Mr. Briggs had then been dead for some years. However, he had written a very complete paper for the Institution of Civil Engineers (British) on "American Practice in Warming Buildings by Steam." This contained an elaborate exposition of his standard and was available for the committee. The committee in reporting adopted his system. They had the co-operation of the manufacturers of pipe and fittings. This concerted action of both engineers and manufacturers, in about 1886, established the Briggs system upon a thoroughly solid foundation, so far as the United States was concerned.

The accompanying table exhibits particulars for tubing ranging from nominal inside diameter of ⅛ inch to 10 inches. If a workman suspects a pipe end to be imperfectly threaded, a good test is to see whether there are the proper number of absolutely perfect threads. By using the last column of the table, paying attention only to the nearest whole number, he can see whether there is agreement. Thus, a pipe, nominally 2½ inches inside diameter should have seven absolutely perfect threads, perfect both at top and bottom. If there is a less number, the pipe has probably been insufficiently chased. If there is a greater number, the chasing has probably been too deep, with the result that at the end of the pipe there is less metal supporting the threads than the standard calls for. This may or may not be important.

BRIGGS STANDARD DIMENSIONS OF WROUGHT-IRON WELDED TUBES.

TAPER 1 IN 32 TO AXIS

| Diameter | | | | | Thickness of Metal. | No. of Threads per Inch. | Length of Perfect Threads. | No. of Perfect Threads. |
|---|---|---|---|---|---|---|---|---|
| Nominal Inside. | Actual Inside. | Actual Outside. | Bottom of Thread. | Top of Thread. | | | | |
| ⅛ | 0 270 | 0 405 | 0 334 | 0 393 | 0 068 | 27 | 0 19 | 5 13 |
| ¼ | 0 364 | 0 540 | 0 433 | 0 522 | 0 088 | 18 | 0 29 | 5 22 |
| ⅜ | 0 494 | 0.675 | 0 568 | 0 658 | 0 091 | 18 | 0 30 | 5 40 |
| ½ | 0 623 | 0 840 | 0 701 | 0 845 | 0 109 | 14 | 0 39 | 5 46 |
| ¾ | 0 824 | 1 050 | 0 911 | 1 025 | 0 113 | 14 | 0 40 | 5 60 |
| 1 | 1 048 | 1 315 | 1 144 | 1 283 | 0 131 | 11½ | 0 51 | 5 87 |
| 1¼ | 1.380 | 1 660 | 1 488 | 1 627 | 0 140 | 11½ | 0 54 | 6 21 |
| 1½ | 1 610 | 1 900 | 1 727 | 1 866 | 0 145 | 11½ | 0 55 | 6 33 |
| 2 | 2 067 | 2 375 | 2 223 | 2 339 | 0 154 | 11½ | 0 58 | 6 67 |
| 2½ | 2 468 | 2 875 | 2 620 | 2 820 | 0 204 | 8 | 0 89 | 7 12 |
| 3 | 3 067 | 3 500 | 3 241 | 3 441 | 0 217 | 8 | 0 95 | 7 60 |
| 3½ | 3 548 | 4 000 | 3 738 | 3 938 | 0 226 | 8 | 1 00 | 8 00 |
| 4 | 4 026 | 4 500 | 4 234 | 4 434 | 0 237 | 8 | 1 05 | 8 40 |
| 4½ | 4 508 | 5 000 | 4 731 | 4 931 | 0 246 | 8 | 1 10 | 8 80 |
| 5 | 5 045 | 5 563 | 5 290 | 5 490 | 0 259 | 8 | 1 16 | 9 28 |
| 6 | 6 065 | 6 625 | 6 346 | 6 546 | 0 280 | 8 | 1 26 | 10 08 |
| 7 | 7 023 | 7 625 | 7 340 | 7 540 | 0 301 | 8 | 1.36 | 10 88 |
| 8 | 8 982 | 8 625 | 8 334 | 8 534 | 0 322 | 8 | 1 46 | 11 68 |
| 9 | 9 000 | 9 688 | 9 327 | 9 527 | 0 344 | 8 | 1 57 | 12 56 |
| 10 | 10 019 | 10 750 | 10 445 | 10 645 | 0 366 | 8 | 1 68 | 13 44 |

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## Gas Engines for Use with Producer Gas*

By H. F. Smith

The question of the correct construction of engines for operation on producer gas is one on which the most advanced engineers in this line of work disagree to a considerable extent, and on which there cannot be said to be any definite or standard practice. However, the main features necessary to secure satisfactory commercial results on producer gas have been sufficiently well established to serve as a very substantial foundation for anyone contemplating entering this line of work. It has been the writer's privilege to test out, either directly or indirectly, nearly thirty different makes of gas engines, both large and small, in connection with producers of standard design, and the results of these tests seem to indicate clearly in what direction success is assured and in what direction difficulties are to be expected.

### Compression

About the first question that ordinarily arises is that of the proper compression to use for producer gas. My experience has indicated that of all the several requirements this is perhaps of the least importance. For several years I have operated on producer gas in electric-lighting service an engine having a maximum initial compression of 55 pounds per square inch. This engine governs by throttling, and on conditions of light load the maximum compression probably falls as low as 30 pounds. Nevertheless, the operation of the plant at all times has been prefectly smooth and reliable, and the firing of the charges at these extremely low compressions perfectly regular. On the other hand, I have seen engines operating with 160 to 180 pounds compression that were extremely unsatisfactory and not even tolerably efficient. Increasing the compression increases the initial pressure and temperatures, and therefore increases the efficiency of the cycle and the power that can be obtained from a cylinder of given dimensions. It does not appear, however, that compression with producer gas is of any greater importance than with gasolene. A gasolene engine operating with an initial compression of 80 pounds will give a higher efficiency than an engine operating with initial compression of 30 pounds, and this is also true of engines for producer gas; but with producer gas it is practical, on ac-ount of the characteristics of the fuel, carry the compression to points that uld not be tolerated for gasolene or r city gas. While it is quite possible carry the compression on producer gas 200 pounds per square inch, or even igher, experience has shown that under rdinary conditions the heat losses in- roduced by abnormally high compres- n, together with the increased friction nd strain on the various parts, soon wipes ut the increase in the efficiency of the ycle For this reason the compression mmonly used is about 160 to 170 pounds, solute

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*Abstract of a paper recently read before the National Gas and Gasolene Engine Trades Association.

### Size and Location of Valves

The location and size of the valves are vastly greater importance than the com- ression. The velocity of gas travel rough the ports, for both inlet and ex- ist gases, should not much exceed 80 t per second, and a lower speed will e much more satisfactory results. As- ng the customary piston speed of 0 feet per minute, we might arbitrarily tablish the clear internal diameters of inlet and exhaust valves at approxi- tely 0.45 of the cylinder-bore diam- r. This may appear abnormally large, d many successful producer-gas en- es are fitted with smaller valves, but ves very much smaller, either inlet or haust, will undoubtedly be a more or s serious handicap to the successful eration of the engine. The cages and ssageways leading to the valve proper uld also be of ample dimensions. No rm can possibly result from making m too big, but very much harm may t from making them too small.

The location of the valves necessarily ries with the type of engine. With rizontal engines, the almost universal stom is to locate the exhaust valve and et valve both on the vertical axis of e cylinder, the exhaust valve being be- w and the inlet valve above. With rtical engines there is little question that from a theoretical standpoint least, both valves should be located to n vertically downward in the cylinder l, in order that there shall not be any l pockets or any other notable irregu- rity of the contour in the combustion mber.

### Combustion Chamber Wall

he internal finish of the combustion ce is also a matter of considerable im- rtance, particularly where high com- ssions are to be used, and engines for e on producer gas must not have any ll openings out of the combustion amber that are not closed flush with e internal surface of the inner wall. lief cocks and air starter connections, well as taps for indicator connections, ming cocks, etc., must all be fitted with ugs or valves closing down flush with e internal surface of the combustion ace. Failure to give careful attention to this feature will invariably result in premature ignition and back-firing.

### Ignition

Ignition devices suitable for use on gasolene or city gas are frequently entirely unsuited to producer gas. Electric ignition should of course be utilized exclusively, and I am very much inclined to favor a thoroughly substantial form of make-and break igniter, either mechanically or electrically operated. Electrically operated igniters of this kind, however, should be supplied from a source giving not less than 40 volts and capable of supplying from 2 to 5 amperes. For mechanically operated make-and-break igniters a smaller current will suffice. Ordinarily, a storage battery of 10 to 12 volts and a fairly low internal resistance will give satisfactory results. Dry batteries and primary batteries of any ordinary type are not well adapted to this service; storage batteries for ignition purposes and small dynamos for charging them have been worked out to a degree of perfection that makes the use of any other form of current supply a needless experiment.

### Governing

Producer gas lends itself to several different methods of governing, and is perhaps the most tractable of all fuels in this particular. It is quite possible to make use of the ordinary hit-and-miss method of governing for producer gas, but this is usually not very satisfactory either as to regulation or as to its effect on the operation of the producer equipment. It is best to use some form of throttling control by which an impulse is secured at regular intervals. The most common method is that of straight throttling, with constant quality of mixture. Only one precaution needs to be observed in applying this method of control to producer gas, namely, that the mechanism whereby the throttling is brought about should be of the simplest and most direct possible construction. By all means the best method of throttling regulation, for producer gas, is that of varying the lift of the inlet valve. This system is ideal in that it does not introduce in the gas passages a single additional working part, the throttling being effected by the inlet valve itself. There are a number of thoroughly practical mechanical methods for applying this system of control, and it has been a matter of constant wonder to me that such a beautifully simple and effective method of governing has been apparently neglected so long. Regulation by throttling the entire mixture at the point of admission to the intake manifold on multiple-cylinder engines has been satisfactorily worked out in a number of commercial designs, and will give satisfactory results when care is taken to provide simple and easy means for dismantling the governor valve so that it can be readily cleaned.

Governing by varying the quality of the explosive mixture, using constant compression, can also be applied satisfactorily with producer gas, largely because of the extremely wide variations of mixture that are permissible with this fuel; the range over which producer gas mixtures are explosive is considerably wider than for any other fuel used in internal combustion engines, so that this fuel lends itself particularly well to this method of governing.

### Mixture Control

The proper control of the proportion of air to gas, where the method of governing by constant quality of mixture is employed, is of great importance. It is particularly important in multiple-cylinder engines that the quality of the mixture in the several cylinders be controlled at one point, and that by the single movement of one lever or valve. Furthermore, it is very important that this lever or valve should have attached to it an indicating device, showing at a glance the amount of air opening existing at each position. When an engine is to operate on gas from a suction producer, there is a tendency on the part of the makers to neglect the necessary provision for adjusting the air intake so as to cause the correct amount of suction on the gas line for the operation of the producer. I might add for those who are not personally familiar with the work, that where engines operate on suction-producers, it is customary to run the engines with the gas valves wide open, and control the mixture by closing down to a greater or less extent on the air intakes. A very satisfactory plan to control the mixture for an engine provided with an intake manifold consists of inserting in both the gas and the air passages ordinary plug cocks graduated to show the amount of opening.

The most practical sort of mixing device consists of an ordinary pipe tee, the branch of which is connected to the intake of the engine, one end connected to the gas main and the other end of the air-intake pipe, both gas main and air-intake pipe being fitted with graduated plugged cocks, as just suggested.

### Piping

To engineers accustomed to working with natural gas or city gas, the size of gas main specified for producer work frequently seems unnecessarily large. It must be borne in mind, however, that the volume of gas to be handled is very much greater, and the question of pipe friction, and particularly the resistance to the gas flow introduced by short bends, must be carefully considered. It is, therefore, always best to carry the pipe line from the producer to a point very close to the engine the full size of the outlet connection provided on the producer equipment, regardless of what the dimension of the gas intake of the engine may be.

# Recent Developments in the Utilization of Low Grade Fuels in Gas Producers

By Dr. F. E. Junge

A gas-power plant of 450 horsepower normal capacity, using raw peat with 30 per cent. water (1 cu.m. = 220 kg.), has recently been built by the Gorlitzer Maschinenbauanstalt for an industrial concern in Ekaterinburg, Russia. The plant has now been in operation for several months and the good results attained justify a description of its constructive details. The essential parts are the generator *G*, the air preheater *H*, two-way valve *K*, dust catcher *C* wet scrubber *S*, moisture separator *W*, dry cleaner or purifier *P* The piping and most of the other parts are practically the same as in every other suction plant but the generator is somewhat different, as can be seen from Figs. 1 and 2. The gas is drawn, either by the aspirating action of the engine piston or by a fan, through an entrance pipe located in the middle of the generator chamber; this pipe serves as a preheater for the air that is used in the process of gasification. The producer is of the down-draft type, fuel being charged in the ordinary way from above. The double cover shown in the drawing has been disposed of in practice, because a single bell was found sufficient, there being no gas losses. The fuel resting on top is slowly transformed to coke on its way downward, so that only incandescent coke and ash are found around the central chamber below, where the gas escapes. The tarry vapors distilled above mix with the air and are combined with the latter into fixed gases of high-heat value while flowing through the incandescent zone. There is no grate; the bottom is water-sealed.

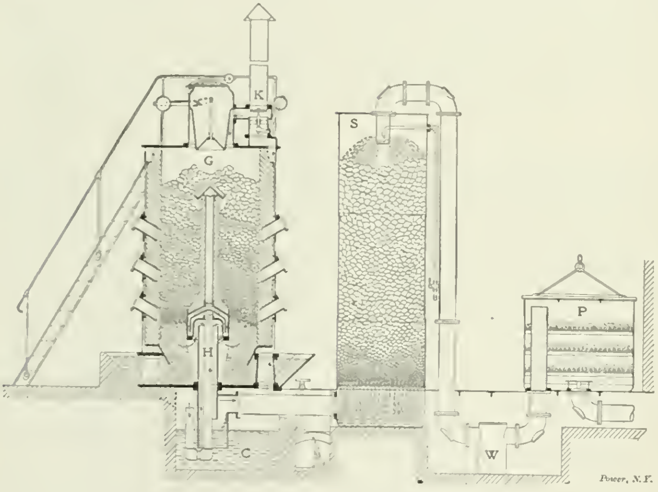


FIG. 1. SECTION OF GÖRLITZ PRODUCER FOR RAW PEAT

Obviously, the advantage of this producer consists in the conservation of the heat which is liberated during the process of preliminary gasification. If, with fuels containing much water, such as peat, the air were introduced into the fire without being preheated. It would absorb heat in the furnace itself. But heat is needed both for evaporating the water in the fuel and for heating the fuel itself up to the point of distillation. If cold air is admitted, the temperature in the hot zone is reduced so low that the fire is extinguished, at least when raw peat is used. Therefore, all the air which is used in the process is taken from the lower channel, which contains the gas-conducting pipe and at the same time serves as a collector for the water overflowing from the scrubber. Part of the air ascends through a central pipe in the middle of the gas-outlet pipe, passes the preheater and goes up through the center of the fuel bed to the fuel at the top. The other part ascends the outer walls of the producer, within the walls of the sheet-iron jacket, absorbs the radiant heat of the producer walls and is also admitted above the fuel bed. A large part of the sensible heat of the gas is therefore utilized in the process. The disagreeable vapors arising from the scrubber water are taken up by the air current and destroyed in the fire. The withdrawing of the ashes, poking and every other operation is the same as in the ordinary suction producers for high-grade coals.

In Ekaterinburg one of these producers with a shell diameter of 1.5 meters (59 inches) generates the gas for a 450-horsepower Görlitz gas engine which drives a flour mill from Sunday evening until the following Sunday morning of each week The only load is 450 horsepower, the nigh load 400 to 500. The fuel cost per ef fective horsepower-hour in this particula locality when using peat amounts to 0.1 cent if the waste heat is not utilized, an to 0.072 cent if it is utilized. With woo the cost is 0.22 and 0.16 cent, respectively In Germany peat of the quality here use costs approximately 16 cents per cubi meter. The engine is cleaned once ever two months. Anybody who knows Russian conditions will appreciate what i means that a gas-power plant using ra peat can run such a length of time without giving trouble.

Another type of producer which ha been in practical use for several yea and has shown good results with lo grade fuels is the Pintsch producer f gasifying "Kohlenlösche;" that is, the fu which settles in the smoke box of loc motives, a mixture of coke dust and as having no tarry constituents. It had bee tried under boilers, but with little succes In the locality (district of Königsberg where the first Pintsch producer was i stalled, the available fuel had a heat val of 6050 to 6230 heat units per kilogra It contains from 19.2 to 23.1 per cent. ash and 5 to 30 per cent. of water. T heat value of the gas produced vari from 987 to 1050 heat units per cub meter.

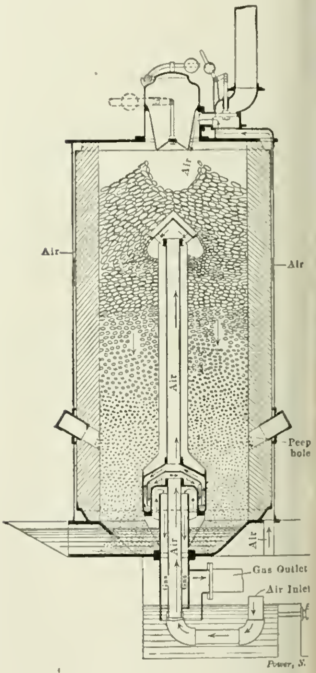


FIG. 2. GÖRLITZ GENERATOR

The construction of the producer, as own in Figs. 3 and 4, is very simple. el is charged from above in the or- ary way and a mixture of air and m is drawn in through openings *A* om below. A stepped grate is provided. e gas is discharged in the center of furnace below the fire bridge *B*, which rves as an evaporator for the water. flows from the outlet pipe through the eheater *H*, gravel-filled wet scrubber *S* d sawdust cleaner *D* in the ordinary y. With the construction shown in drawing trouble was experienced in removal of the slag, which could be ne only in the intervals between opera- n, and the result was that the active ne in the producer was reduced and the s impoverished by too much carbon xide. So a water-sealed bottom was pted instead of a closed bottom. The moval of slag can now be accomplished thout shutting down, excessive accumu- n of large lumps of ashes above the te is prevented and continuity of work secured.

The power plant of the railroad shops Königsberg contains three producers d three double-acting four-stroke-cycle s engines of 180 horsepower each, run- ng at 150 revolutions per minute. The gines are coupled to direct-current namos of 110 volts. The plant at In- rburg contains two producers and two rizontal single-acting power-stroke en- s of 90 horsepower each, running at revolutions per minute and driving direct-current dynamos by belts. In h plants the gas engines are started running the dynamos as motors with rrent supplied by a battery. All of engines take gas from a common duct nnected with the producers.

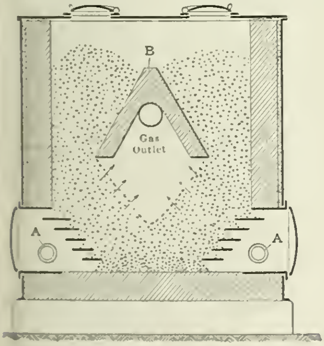
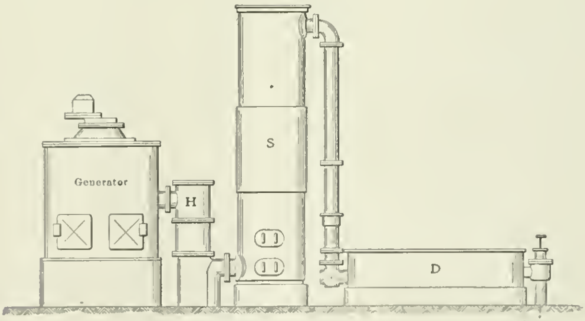


FIG. 3. PINTSCH GENERATOR FOR COKE DUST



Power, N.Y.

FIG. 4. COMPLETE PINTSCH PRODUCER

The results at Königsberg and Inster- rg being encouraging, a number of other ctric central stations of the Prussian lway have been equipped with gas pro- cers and engines. In the Allenstein ant, which is equipped with two units 160 horsepower each, the fuel consump- n on test was found to be 1.24 kilograms[†] per kilowatt-hour, or 0.75 kilogram per horsepower-hour. Figuring the price of "Kohlenlosche" at 18 marks for 10,000 kilograms, which is the average price during the last few years, the fuel cost comes out as 0.14 pfennig (0.03 cent) per horsepower-hour. Inasmuch as a large portion of this fuel could not be used or sold previously and had therefore figured on the balance sheet of the railroads as "waste," which had to be disposed of at some expense, its utilization in gas producers is a decided advantage. All of the available locomotive fuel residue of that district (7,500,000 kilograms) is now used for the generation of electric energy. It would seem possible, without change of apparatus, to effect similar economies in the operation of American railroads, as the composition of the fuel in question is in many parts of the country practically the same as it is in Germany.

# The Legal Aspect of Smoke Abatement [*]

By D. R. Cobb

Smoke alone is not a nuisance at common law, although under circumstances sufficiently aggravated it might become such, but to recover damages it is necessary to prove tangible and appreciable injury to the plaintiff. The police power steps in where the common law of nuisance would be of little or no avail. While at common law each individual case must stand or fall upon its own merits, the police power is exercised in the direction of establishing general and arbitrary definitions, standards and limitations for the observance of all.

It is therefore necessary clearly to distinguish between the right inherent in every community to abate a public nuisance—it being necessary to prove that the particular act complained of is such—and the right which the municipality has by statute to deal with an act either by the legislature direct or under delegated authority by its own ordinance, defined to be a nuisance.

Of course it must often happen that the same act is not only a public nuisance at common law, but a nuisance by express definition and prohibition by the municipality. For all practical purposes, it is only necessary to consider the subject of smoke abatement from the latter standpoint. The difficulty of proving the emission of smoke from a stack or chimney to be a public nuisance renders a resort to the common-law remedy quite generally disappointing.

The police power of the State being vested in the legislature, that body may by direct act declare what shall constitute a nuisance, or, as is usually the case, delegate its power in this respect to the municipality. If not given in express terms, it may usually be implied from the general grant of powers to the municipality.

A municipality then may receive from the legislature the power to declare that a nuisance which is not such *per se* and is not so recognized by the common law, and in prosecuting under the terms of its ordinance, the defendant cannot be heard to say that the act complained of was not in fact a nuisance.

The right to pass ordinances defining and punishing nuisances, must be exercised by the municipality direct, and may not be conferred on any other board, department or officer. Aside from the State and Federal constitutions, the only restrictions on the power of the municipality are that its ordinance must be a reasonable exercise of the power conferred upon it by the legislature and must not be oppressive in its operation. Upon this ground that the measure complained of was unreasonable and oppressive, the principal fight against ordinances declaring dense smoke a nuisance has been made, and while there may be some

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[†] A kilogram = 2.2 pounds.

[*] Abstract of a paper read before the International Association for the Prevention of Smoke, June 24-26, 1909.

[illegible] exceptions among the authorities, and some courts have been reluctant in yielding to the doctrine that all dense smoke is *per se* a nuisance, the battle may now be said to have been won by the opponents of the smoke nuisance, and the time is at hand when manufacturers must adopt smokeless fuel, smoke-consuming devices or close their shops.

This is not, however, an unmitigated hardship. There seems to be no difficulty that American inventive genius cannot surmount. The improvements in the construction of boilers and their accessories, including devices for the consumption of smoke, will, as I verily believe, enable any manufacturer to comply with the most rigorous ordinance, with a result not only gratifying to the public but most satisfactory to himself and in no way detrimental to his purse.

A reference to a few of the leading decisions will indicate the present state of the law on the subject of smoke abatement.

In Moses versus the United States Congress had enacted,

"That the owner, agent, lessee or occupant of any building of any description from the smokestack or chimney of which there shall issue or be emitted thick or dense black or gray smoke or cinders, within the District of Columbia, on or after the day above named, shall be deemed and held guilty of committing a public nuisance, and of violating the provisions of this act."

The plaintiff in-error had been convicted of a violation of this ordinance. Upon the trial he offered to show that he had attached to his furnace the best known smoke consuming appliance; that neither it nor any other then known would prevent the emission of smoke. The evidence was rejected by the trial court. The court of appeals sustained the ruling and the conviction, saying:

"It is a matter of common knowledge not to be ignored by the courts that the emission of a volume of dense black smoke from a single smokestack or chimney of a large furnace, may under some circumstances work physical discomfort to the general public coming within its circle of distribution upon public thoroughfares, and may possibly work injury to public interests in other respects. A statute declaring the emission of thick or dense black smoke a nuisance *per se* and punishing the act as an offense, is within the police power, and therefore does not deprive persons of property without due process of law. * * * Evidence that no smoke-consuming device known will prevent the emission of all black smoke from furnaces burning soft coal, is immaterial upon a prosecution under the statute."

In an early Missouri case, the supreme court refused to uphold an ordinance prohibiting dense smoke, on the ground that it was passed without proper legislative authority, in the course of its opinion saying:

"Now this ordinance would punish every housekeeper who kindled a fire to cook his or her morning meal, or to warm the house. Every replenishing of the furnace, whether in the heart of the business centers or upon the remote western boundary of the city, would alike subject the owner to punishment. No exception whatever would be made as to time or quantity. When it is considered that St. Louis has attained its growth in wealth and population in a large degree from the fact of its proximity to the great mines of bituminous coal which lie at its very door, and that this fuel has enabled it to become a great manufacturing city, and that this soft coal is peculiarly liable to produce this objectionable dense smoke, it seems to us that this ordinance which makes no reasonable allowance for the regulation of this smoke, but essays in advance of any known device for preventing it to punish all who produce it to any degree whatever, is wholly unreasonable."

But in a later case, the Missouri supreme court upheld an act of the legislature making a public nuisance "the emission or discharge into the open air of dense smoke within the corporate limits of any corporate city of this State which now has or may hereafter have a population of one hundred thousand inhabitants," and thus placed itself in accord with the best judicial thought on the subject.

Harmon versus City of Chicago, decided by the Illinois supreme court in 1884, has been a leading case on smoke abatement. It upheld an ordinance forbidding the emission of dense smoke and sustained its validity as applied to boats engaged at the time in interstate commerce.

The decisions of the State of New York have likewise upheld reasonable ordinances of the same character.

In case of the infraction of an ordinance, the remedy may be fourfold:

1—A criminal prosecution.

2—A suit in equity for an injunction.

3—An order directing abatement made after notice and hearing.

4—Summary abatement based on common knowledge of the council or other proper authority without a hearing.

The adoption of any one of these proceedings has been held to be a waiver of the others. Of these remedies, the criminal prosecution is probably the most useful in the ordinary case. The remedy by abatement can be resorted to in case of emergency, but summary abatement involving the destruction of valuable property should not be attempted before a hearing is had except in extreme cases.

In considering statutes and ordinances aimed against the smoke nuisance, it is to be borne in mind that when the legislature acts directly or authorizes the municipality to act in a definite way and the municipality passes an ordinance within the scope of the legislative act, th courts will not question closely the reasonableness of the law. An ordinanc passed by the municipality under genera or implied authority is therefore mor open to attack in the courts.

Ordinances simply forbidding dens black smoke as such, seem to be mor successful and workable than ordinance undertaking to define what dense smok is or just how dense smoke must be i order to fall within the municipal prohibition.

An ordinance declaring black, gray o other offensive character of smoke a nuisance and providing a penalty therefo with a provision for summary abatemer for use in cases of emergency will probably prove satisfactory and readily enforceable in most localities. If, using th best means at hand, there must of necessity be certain periods when blac smoke will be emitted from stacks an chimneys, it may be wise for a municipality to make some reasonable allowanc for such occasions, particularly when acting under a general or implied delegation of authority.

In abating the smoke nuisance, th rights of important commercial bodi must be balanced against those of th community at large, and the change to smokeless city made with as little disturbance and hardship as possible. Th success of any scheme for smoke prevention must therefore depend largel upon the intelligence and discretion of th officers intrusted with the duty of carrying it out.

Summarizing the conclusions to l drawn from this discussion, we have tl following:

1—The right to abate a public nuisanc exists at common law, but the fact actual nuisance must be proven in eac case.

2—The legislature in the exercise the police power may declare that to be nuisance which is not at common law *per se* a nuisance.

3—That which the legislature may in this regard it may delegate to municipality.

4—An ordinance aimed to prevent tl smoke nuisance and not unreasonable oppressive in character will be sustaine

5—An ordinance prohibiting in gener terms the emission of dense, black, gr or other offensive character of smok from stacks and chimneys, is not unreasonable or oppressive.

6—The ordinance should prohibit und penalty the commission of the forbidd offense and provide means for summar abatement in cases of emergency.

Volatile matter in various coals has considerable range in heat-unit value, depending upon the carbon and hydrog contents.

# The Selection of an Oil for Lubrication

## Some Notes on the Use of Oil Testers, Emulsifiable Oil as a Lubricant, The Evaporation of Oils and Analysis of the Residue Deposited

HENRY M. WELLS AND WM. SCOTT-TAGGART

Practically all the useful information friction and the influence of tempera- re, pressure and speed on its coeffi- nts has been obtained by means of cially designed apparatus. Now it is y important that it should be clearly lerstood such apparatus is primarily tended for friction testing and that it no means follows that the same in- ument is useful as an oil tester. At st sight this statement appears para- xical, but by an "oil tester" is meant instrument or machine by means of hich the friction-reducing properties of rious oils can be compared and the re- lts used as a basis to decide the com- rative suitability of the oils for some ven purpose.

### Friction-testing Apparatus vs. Oil Tester

A number of so-called oil testers are on e market and very interesting machines y are, but a little consideration will w them all to be, practically, some m of friction-testing machine. A real tester should be a machine that repro- es as nearly as possible the actual con- ions under which an oil will run. For stance, Beauchamp Towers' testing ap- ratus for locomotive axles was in reality actual axle; and O. Lasche's tests re made on a dynamo bearing. The ap- ratus in each case could be used for neral friction tests and also as oil ters for testing the most suitable oils axles and for dynamo bearings re- ctively; moreover they could be used testing the most suitable method of lying the lubricant for each type of ring Neither, however, could be used testing oils for light shafts, heavy gine-bearing oil, textile spindle oil or nder oil. These oils could have been on the apparatus and certain re- obtained, but it would have been festly absurd to have judged their lty by these results. In spite of this arently clear difference between a fric- testing apparatus and an oil tester, nmechanical minds are found using ap- ratus for testing oils that does not re- oduce conditions at all approaching se under which the oils will have to rk.

To give one illustration of many that ve come under the writers' notice: A ge steel firm on the Continent was ac- stomed to test all its oils on an oil ter. The instrument consisted essentially of a vertical spindle about 1 inch in diameter which could be driven at various speeds. A full range of pressures could be applied and also any temperature required could be obtained. Being electrically driven there was an easy method of indicating the power required to drive the spindle under various conditions. Several oils were tested, among which were rape oil and a compounded mineral oil suitable for heavy rolling-mill engines. The oil tester gave results that showed in favor of the mineral oil by about 3 per cent. This was very unsatisfactory when compared with the very decidedly superior results found when testing on the rolling-mill engine itself. The writers therefore made up an oil composed of 90 per cent. of kerosene oil and 10 per cent. of the mineral oil. This was tested on the oil tester and its results gave friction-reducing properties equal to one-quarter those of the two previous tests. If the oil tester was to be the deciding factor as to the best oil, it was clear that the paraffin mixture was the best oil for a large rolling-mill engine, a conclusion that Euclid would describe as being absurd. The reader will readily see what had been done. It was simply a case of finding the most suitable oil for the oil tester, and the oil tester being a machine itself one could easily judge as to the kind of oil that would be most suitable for its own working conditions. This is the case in all oil testers where there are two 2-inch shafts used to test oils that are to be used on from fine vertical high-speed spindles to the largest steam engine shafting.

If careful tests are made it will be found that one oil out of many will give the best results on any given oil tester, but looking at the totally incompetent character of the instrument and its absurd limitations for the purpose in view, it would be manifestly foolish to decide that the oil showing the best results would be the best except on a machine similar to the tester. In the opinion of the writers most oil testers are useless for comparing the lubricating qualities of various oils unless they reproduce fairly accurate conditions, but they are useful in investigating friction phenomena and much valuable information may be learned from them.

The only real test for an oil for any given purpose is the actual one on the machine or engine itself and checked by means of a dynamometer, indicator or, if electric driving, by an ammeter.

### Emulsification of Oil

Many lubricating oils at present must work in the presence of moisture or water in large quantities. The water may be due to leakage or may be a necessary condition and introduced purposely. The oil used in the crank chambers of engines employing forced feed lubrication, invariably becomes mixed with water that has leaked past the glands. Turbines in the same way allow water to escape. In gas engines, some water, either through leakage from joints, splashing or other causes, finds its way into the oil; in all steam engines the cylinder oil performs its lubricating functions in the presence of water, while in engines oiled by splash lubrication water is part of the system, the oil floating on its surface.

This condition presents a problem in lubrication that has not been studied, and present methods of dealing with it are based on the "hit-or-miss" principle. For instance an oil traveler brings a sample of oil to an engineer and makes wonderful claims for it. He demonstrates by means of a bottle and a mixture of the oil and water and a few minutes shaking that the clear water settles out immediately. An order is given and within 48 hours that oil has to be taken out of the crank chamber. The test of shaking oil and water in a bottle is ridiculous. Another method adopted to trap the unwary is to send a sample of oil that has been mixed with an alkaline solution, the two substances shown in the same bottle and no signs of emulsion. This, of course, means nothing, for it is known only too well that one oil works well with one sample of water and yet breaks down utterly with another water that is less alkaline but differs from it in other respects. As a matter of fact the problem of emulsification is one that requires investigation; very little is known on the subject, but it is receiving attention from several scientists, and the firm of Henry M. Wells is going into the matter very carefully, so we trust some results of the investigation will be ready to be given later.

The practical point to be observed at present is, that the best oil for lubrication may be chosen and yet it fails because it emulsifies. In testing lubricants therefore, the question as to its emulsifying properties must be fully taken into [illegible] Under a short-period test a certain oil will prove superior to another, but after a further period this superiority disappears through emulsification being set up and destroying its lubricating value, so the apparently inferior oil, from a pure friction reducing point of view, assumes the position as the best oil because it does not emulsify. Many engineers have been heard to remark that the water that finds admission to the oil is almost pure distilled water. It is certainly much purer than the water in the boiler, but even condensed superheated steam is not pure and it necessitates finding an oil to suit it. There is a peculiar delicacy in the chemical reactions that evidently take place, for tests of oil made with double-distilled water obtained from sources wide apart show no emulsion with one water and a strong emulsion with others. If one has been successful in finding a suitable oil that will not emulsify with the water in a certain power plant, it is by no means a proof that the same oil will suit the water in another power plant. The assumption is one that is frequently made to the sad undoing of the old traveler and often serious trouble to the engineer.

With cylinder oils the problem of emulsification is an extremely important one. It is frequently if not entirely overlooked that the presence of moisture on the cylinder walls is almost the chief factor in the choice of the lubricant. The movement of the piston over the film of oil has a tendency thoroughly to mix oil and water, if the oil has emulsifying qualities. When such is the case, the cylinder is not being lubricated by the lubricant applied through the lubricator, but by another substance made within the cylinder itself. No matter how thoroughly a cylinder oil is tested for gravity, viscosity, flash point, etc., the chances are enormously in favor of it becoming a different substance in the cylinder when it is doing its work. A cylinder oil reaching the high-water mark of the various tests mentioned here may prove a most uneconomical oil simply because it is easily emulsified. Where water is dear or scarce, it is necessary to reuse the condensed steam. An emulsifiable oil renders the reuse of the water a difficult if not impossible matter, and in any case an expensive oil eliminating or purifying plant must be used to free the oil from the water. In marine work such an oil would be impossible, at any rate for long, even for swabbing.

It is thus seen that from this point of view alone miscibility of oil requires serious consideration. Further, when an oil is in the form of an emulsion on the cylinder walls, it is easily removed or washed away and therefore large quantities of oil are required to replace it, and it must be remembered that even then good lubrication is not being obtained because it is an emulsion that is lubricating the engine and not the pure oil, which may be an extremely good lubricant by itself.

Another very interesting fact may be explained in this connection. It has long been known by those deeply interested in lubrication that surface tension is a primary factor in the maintenance of a film of oil. Only a very thin film of oil can exist between two pressure surfaces, and a good oil will remain intact as a film for some time without reinforcement of further supplies of oil. Now if the surface tension of an oil is lowered by some cause it is clear that the oil film will be weakened and break down quickly unless frequent additions of oil are supplied. This test of surface tension is not at all a bad one for cylinder oils. Our investigations prove conclusively, that an emulsified oil has a considerably lower surface tension than the oil from which it is formed. The strength of the film is therefore very unstable. A further peculiarity and yet one of vast importance to lubrication lies in the fact that any oil that possesses emulsifying properties has a much lower surface tension than an oil that will not emulsify. In other words, a test for surface tension is a good indication of the property of emulsification possessed by the oil and, moreover, a delicate test for the degree of such properties.

It has been already remarked that tests on oil testers are of short duration and a reasonable time element is absent. Even the atmospheric conditions of the actual workrooms are absent. Moisture plays an important part in most cases of lubrication merely by its presence in the atmosphere in the form of condensation on metallic surfaces. Textile mills, of course, are strongly charged with moisture either naturally or artificially. Wet doubling and flax spinning present the moisture problem in an acute form, so that this question of moisture and oil is a fairly general one and must modify considerably all ideas on lubrication. The oxidation of an oil emulsion is extremely rapid in cases where the oil comes in contact with air. This brings about a rapid deterioration of its lubricating qualities, and where compounded oils are used containing unsuitable animal and vegetable oils, acids develop and cause serious damage to metal. But many mineral oils oxidize quickly by mere exposure to air. Such oils are very poor lubricants. A casual visitor going through a textile mill or engineering workshop and seeing machinery covered with a thin coat of varnish, will recognize at once that a knowledge of lubrication is not one of the strong features of the engineer or manager. Such a state of things invariably indicates the use of a very inferior oil.

### Heavy Oils and Large Bearings

When treating the question of viscosity it was concluded that thin oils are generally the best under normal conditions. Logically this conclusion, as a straigh issue, would eliminate the consideration heavy and light oils as to which is th better for heavy engine bearings. On is strongly inclined to think that a bi steam-engine bearing, for instance, mu require a thicker oil than a much smalle bearing, but if methods of lubrication ar somewhat similar and surface speeds the shafts do not differ very much, th same oil will do for both. The pressur on the shaft per unit of area will n differ much if properly designed, and thi pressure is the chief factor. Mere siz of shaft does not count for much nor doe the size of the engine. The real facts t be taken into account are the surfac speed, pressure and the area over whic the pressure acts. If these are onl roughly known there is some real guide t choosing a suitable oil. It is owing t misconception, arising out of mere size, b oil men and even engineers that cause this paragraph to be written, and it i safe to say that more lubrication trouble are caused through too thick oils bein used than when too thin oils are used.

### Evaporation of Oils

Mineral oils evaporate very slowly, bu some relatively quicker than others. Th varnish-like substance mentioned in previous note is partly due to evaporatio and partly to oxidization. When varnis or gum forms from either cause or thei combination, the oil is at fault. The sam causes are at work on all oils, but result are different simply because the oils hav varying properties. Some oils lose ver little by evaporation, but that smal amount leaves the residue thick and gummy while, on the other hand, some oil will evaporate to dryness and leave practically no residue behind, the oil remaining limpid throughout the process. Thi is a very good test, not for choosing goo oils, but to eliminate bad oils. It is great advantage to an engineer if he ca at least cut out bad oils from his plant.

In the case of cylinder oils, the hig temperatures at first sight, compel one t recognize that evaporation may be o some consequence to the problem of lubrication. A little consideration, howeve will show that there is no definite basi for arriving at such a conclusion. Th high temperatures are associated wit high pressures, so that this fact alone wil retard considerably any evaporation. Th surrounding steam will further retard an tendency for the oil to evaporate. The tw factors together will therefore tend to reduce evaporation of the cylinder oil considerably under working conditions. I spite of this reasoning, engineers wil say that dried-up oil is frequently foun in steam pipes, valves, clearance spaces glands and piston rings of steam engines so oil must have evaporated and left thi residue. There is no denying this, bu it is chiefly due to oil, on hot metal surfaces, evaporating when the engine ha opped, pressure removed and moisture most absent. A poor oil will undoubted- leave a residue if pockets, ledges, etc., -event the oil flowing away. The de- osits often found in steam engines, and hich are usually spoken of as burnt oil, e quite different and will be mentioned little later.

The point to be specially noted in re- rd to the evaporation of an oil, is not e amount evaporated, but the char- ter of the residue after evaporation has d full play. The table, taken from the sults of experiment on over 500 differ- t oils from practically all the oil re- ieries in the world as well as the com- inded and mixed oils sold on the mar- t, will convey some idea of the variation und in cylinder oils:

EVAPORATION OF CYLINDER OILS.

| Loss in Weight at 750° F. in 30 Minutes, Per Cent. | Loss in Weight at 360° F. in 80 Hours, Per Cent. | Loss in Weight at 360° F. in 140 Hours, Per Cent. | Character of Residue After 140 Hours. |
|---|---|---|---|
| 45 4 | 6.0 | 7.3 | Tough and leathery. |
| 39 7 | 44 0 | 44 4 | Cokey. |
| 42.75 | 6 0 | 17.0 | Solid. |
| 36.5 | 2.6 | 2.9 | Flows easily. |
| 55.0 | 12.2 | 12 8 | Limpid oil. |
| 68 5 | none | 2.6 | Limpid oil. |
| 50 3 | 1 6 | 2.4 | Soft tarry mass. |
| 20 0 | 1.0 | 1.6 | Semisolid. |
| 25.6 | 6.6 | 8.6 | Limpid oil. |
| 20.0 | 26.4 | 26.4 | Hard and leathery. |
| 30.9 | 6.4 | 11.2 | Semilimpid oil. |
| 34 6 | none | none | Sticky oil. |
| 82 0 | 23 0 | 26.5 | Tough elastic. |
| 80.5 | 0.4 | 3.0 | Limpid oil. |
| 48.5 | 1.0 | 2.5 | Tough and rubbery. |
| 81.5 | 14.0 | 14.2 | Tough and rubbery. |
| 48 1 | 6 0 | 10.0 | Limpid oil. |

t is somewhat difficult to describe the eict appearance of the residues from t se tests; they require to be felt as to tir oiliness or otherwise. Those with a oily residue are superior to those with- o it, and this irrespective of the amount e porated. A sticky residue like No. 12, is ar inferior to No. 5, which has a limpid o residue, and yet no measurable quan- ti of No. 12 evaporated during the 140 h rs. The tests were made under atmos- p ric pressure and practically no move- nt of air. Since they were made we h designed apparatus wherein a cham- b containing the samples is under the i pressure of steam and the steam can b superheated to any degree required and alwed to flow through the apparatus, th reproducing almost actual conditions. T results prove that the best lubricants a those that leave behind an oily residue.

f course if oils are submitted to very hi temperatures for even a short time th will burn up. Most of the oils given in he list at 750 degrees Fahrenheit for h an hour, were almost burnt up, and m y of those in our long list lost all th were capable of, short of vaporizing th residue, before the end of the half h's test.

In a steam engine, temperatures never reach a figure that will burn cylinder oil. Distillation, of course, takes place when temperatures reach the boiling point of the oil, but this point is so high for cylinder oils that it is practically never reached by superheated steam in the steam engine. Evaporation which may be rapid undoubtedly carries off some of the lighter fractions of the oil. The lighter fractions driven off are of no lubricating value whatever and are usually either colorless or of a very faint yellow tint. What part they play in the properties of the oil is unknown, but they are under investigation; at present their absence from the oil appears an advantage if not carried too far. Most of the oils, if freed from even a small percentage of such fractions, undergo considerable change and many rapidly solidify.

### Deposits

Residues left by oils after evaporation, in the case of cylinder oils, are frequently spoken of as deposits of burnt oil and even described as carbon. The subject has been investigated, chiefly in the engineering and chemical laboratories of the Liverpool University. The research there was not very productive of quantities of deposits of the character usually found in steam engines, this being mainly due to using very high superheat from a flash boiler. The deposits found were tarry residues after fractional distillation of the oils had driven off the lighter fractions. In no case did decomposition of the oil or cracking take place under 750 degrees Fahrenheit, so none of the deposits contained decomposed oil or burnt oil, and there was no carbon, as such, in them. They consisted of a thick pitchy material with a hard gritty substance intermixed. The oils, it may be added, were pure hydrocarbon oils, specimen analyses of which are as follows:

| | No. 1. | No. 2. |
|---|---|---|
| Carbon, per cent. | 86.06 | 86.58 |
| Hydrogen, per cent. | 13.90 | 13.44 |

Since no chemical reaction or decomposition had taken place the deposits were evidently composed of something foreign to the oil. An analysis proved this to be the case, the result showing:

A pitchy substance of inorganic matter, per cent. .......................... 13.5

Iron peroxide ($Fe_3O_4$), per cent. 86.5.

The deposit was treated with ethereal and carbon bisulphide to free it from oil. The iron peroxide was in the form of small scales and only after considerable trouble taken to account for the presence of iron was it at last traced to the boiler tubes, and ultimately by examining such tubes was the matter placed beyond doubt. Particles of scale from the tubes had become detached and followed the steam, forming nuclei around which oil gathered. The oil dried up by evaporation and distillation and the combined pitchy residue of the oil and the grit from the boiler formed the deposit.

Analyses of deposits taken from steam engines, when carefully made, invariably show the presence of iron. Engineers speak of such iron as being the result of using a poor lubricant and causing wear to take place, hence the iron. Unfortunately for this view, many deposits are taken from parts of the engine where no results of wear could reach them, and from parts before the oil has arrived at the working surfaces. Of course abraded iron (if wear took place) would be found if deposits were taken from, say, the low-pressure cylinder, but deposits are not usually found there. Many deposits and usually those that accumulate in large quantities do not contain iron. Their chief constituents are forms of magnesium, calcium, sodium, etc., all of which are in the boiler water. They have come over with the steam, and have been trapped by the oils which formed nuclei for an accumulation of deposit.

Oil that is readily distilled, with a large percentage of a pitchy or other base, will quickly form deposits if boiler water primes. These deposits are so situated sometimes as to be easily carried bodily forward into the valve chest or the cylinder, and, of course, not being lubricants may cause wear and give trouble in other directions. It must be remembered, however, that if the steam had been clean it is probable that no deposits whatever would have been formed. It is something for the engineer to know that the formation of deposits invariably means faulty steam raising, and if remedied, deposits may cease unless the oil is positively bad.

## The Case of the Turbine Steamer "Creole"

### Statement by the Fore River Shipbuilding Company

The Fore River Shipbuilding Company, contracted with the Southern Pacific Company, for the building of the steamer "Creole" strictly on the owners' plans and specifications for the hull and agreed to install twin-screw Curtis marine turbines and Babcock & Wilcox water-tube boilers. The shipbuilding company guaranteed that the vessel, under such arrangements as should be agreed upon between the parties to be proper, should show a speed of 16 knots on the round trip between New York and New Orleans in ordinary weather at 10,000 tons displacement and with a coal consumption not exceeding 7 tons per hour. The contract also provided that if the turbines and boilers did not prove entirely satisfactory to the Southern Pacific Company, and that company should decide to install reciprocating engines and Scotch boilers, the shipbuilding company would, if requested within six months after delivery of the ship, stiffen up the hull as might be necessary for this change.

Before the delivery of the "Creole," in December, 1907, the builders installed a fourth set of screw propellers and made several trials of the vessel both light and loaded. The load-draft trial run for a period of twenty-four hours in heavy weather showed that the vessel was able to meet the contract conditions, the speed and coal consumption having been measured and certified to by independent outside experts. On the measured mile at Provincetown, the vessel showed 17.23 knots light as a mean of high rates, and 16.57 knots loaded. A speed through the water of about 16.25 knots is sufficient to show 16 knots average round trip from New York to New Orleans. After this time the vessel made fourteen round trips to New Orleans, but failed on any trip to show the contract speed. The management of the Southern Pacific Company, always refusing to provide a fireroom force satisfactory to the shipbuilding company, or of numbers and efficiency adequate for the type of boilers, met with continual and increasing difficulties in the operation of the water-tube boilers. These boilers on the builders' trials were shown to have fulfilled the efficiency guaranteed and were built by manufacturers whose experience in land and marine boilers is unexcelled.

Although difficulties were encountered in obtaining efficient screw propellers for the "Creole," the builders continued to give this matter attention and had secured satisfactory screws. The turbines were shown on trial and in service to have obtained the designed efficiency and economy and to be successful in mechanical operation, notwithstanding the severe treatment which they received from excessive boiler priming brought about by inexperience and carelessness in the fireroom.

Notwithstanding the fact that the shipbuilding company installed assisted fireroom draft on the "Creole," and carefully overhauled all auxiliaries on the vessel, subjected to unusual deterioration from the use of salt and muddy water in the boilers, and excessive priming from careless water tending, the boiler difficulties continued to increase until the vessel was laid up by the Southern Pacific Company with the boilers in such condition that it was not safe to continue operation without careful overhauling.

The Southern Pacific Company, has demanded that the shipbuilding company should remove the Curtis turbines and Babcock & Wilcox water tube boilers from the "Creole," and install at their own expense reciprocating engines and Scotch boilers. The shipbuilding company declined to do this on the ground that the turbines, boilers and engine room auxiliaries are exactly as was contracted for and are capable under proper and intelligent operation of fulfilling the contract conditions. Considering the conditions of operation by the Southern Pacific Company, and particularly the scale of compensation of mechanical staff adopted by the company, it is probable that the operation of water-tube boilers is not satisfactory, although they were recommended by and acceptable to the company's management at the time the contract was made.

If the builders had sacrificed the greater turbine efficiency due to the higher pressure and drier steam of the water-tube boilers, and had installed Scotch boilers originally, they are confident that the turbine equipment would have given satisfaction, being convinced that the difficulties experienced were due to the conditions of operation of the water tube boilers, the turbines having withstood punishment which no reciprocating engine could have survived.

## The New "Clermont" Launched

On Saturday, July 10, a replica of Robert Fulton's steamboat, "Clermont," the first ever put into practical service, was launched with appropriate ceremonies, under the auspices of the Hudson-Fulton Celebration Commission, at the Mariner's Harbor yards of the Staten Island Shipbuilding Company.

Gen. Stewart L. Woodford, presid of the Hudson-Fulton commission, pr sided and delivered an address. M Alice Carey Sutcliffe, great great gra daughter of Robert Fulton, was spons for the craft and broke over its bow glass vase filled with water from the w from which Fulton drank more than hundred years ago. As the vessel gli into the water a dozen carrier pige were automatically released from a bas and a salute of sixteen guns, one for e State in the Union at the time of building of the first "Clermont," was fi by the United States Cadetship "Was Members of the First and Second B talions of the Naval Militia of New Y acted as sentries and guards of honor.

The bronze bell which was used on original "Clermont" to summon p sengers who were late, and also ser the purpose of signaling, instead of us a steam whistle, was suspended from launching platform and was used to sig the opening of the exercises.

The replica of the "Clermont" shown Fig. 2, while still on the ways, is an ex reproduction of the original vessel has been built from the specifications u which Fulton obtained his second pat It is 150 feet long, 18 feet wide an feet deep and draws 2 feet of water. sides are almost straight up and do and both ends are wedge shaped, as sho in the illustration. It will be equip with a replica of the engine used in original "Clermont" and during the H son celebration this fall will travel un its own steam up the Hudson river Albany. Fig. 1 shows the hull of "Clermont" just after launching.

As a coincident, the Holland-Ameri line steamship "Soestdyk" left Rott dam the same day carrying on board exact reproduction of the "Half Mo in which Capt. Hendrick Hudson f sailed up the Hudson river.

The "Half Moon" is built of heavy timber with a high poop and long nar nose. She is of about 80 tons displa ment, 63 feet in length and 18 feet d draws 7½ feet of water and will ca a crew of twenty men.

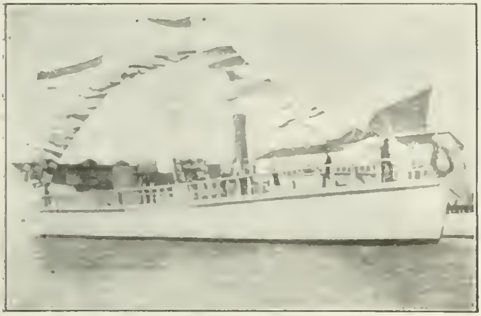


FIG. 1. THE "CLERMONT" AFTER LAUNCHING

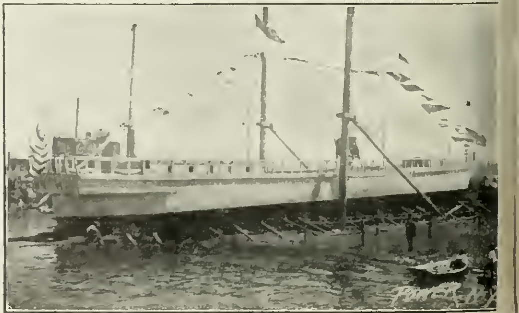


FIG. 2. THE "CLERMONT" ON THE WAYS

# Practical Letters from Practical Men

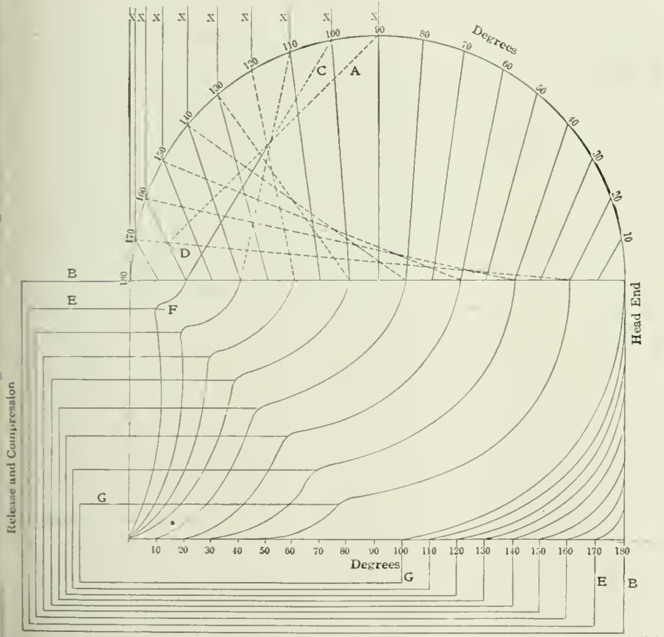
Don't Bother About the Style, but Write Just What You Think,
Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

## A Valve Lap Chart

This accompanying chart is plotted out o show the effect of adding lap to a slide alve, and the corresponding position f the eccentric, together with its effect n the exhaust opening and the time at vhich compression begins. It is not laimed that the expansion lines fol-ow the law of the theoretical curve.

Assume a slide valve having neither



*Power, N.Y.*

VALVE-LAP CHART

utside nor inside lap. The eccentric in is case will be set 90 degrees ahead of e crank, and cutoff will not take place ntil the end of the stroke is reached. t the same time the exhaust port at one nd of the cylinder is opened and that n the opposite end closed. A card ken under such conditions would be milar to a pump card, where there is o release, compression, nor cutoff, ex-pt at the end of the stroke.

On the 90 degree point on the chart, hich represents the heavy side of the eccentric position for a no-lap valve, follow the dotted line *A* downward to the 180 degree point or the end of the stroke, which is the cutoff, release and compression point. Then follow the line *B* at the left downward to the end of the diagram, or 180 degrees from the other end, showing that there is no compression for such a valve set 90 degrees ahead of the crank.

Suppose a little outside lap is added; just enough to cut off the steam earlier and give a little expansion and compression and an earlier release. This condition will require the eccentric to be advanced to 100 degrees ahead of the crank, otherwise the port would not open while the engine is on the center. Follow the dotted line *C* to where it joins the full line *D*, running to the 160 degree point, which shows earlier cutoff, due to adding lap. Continue to follow the expansion line down to the release point *F*, which comes directly under the 170-degree full-line point; also follow the line *E* which extends from the release point and shows that compression starts 170 degrees from the other end.

If an extreme amount of lap is added and it is desired to cut off the steam twenty degrees from the head end, follow dotted lines, as stated before beginning at the 20 degree cutoff, and find that the eccentric must be advanced 170 degrees ahead of the crank, which puts it almost on its dead center where it has hardly any chance to advance the valve for port opening; consequently, the port is open only a trifling amount, and for an extremely short period. Now follow the expansion line down to the release as before, and the line marked *A* will show that the compression will start at 100 degrees from the other end. Also note that the release comes directly under the 100 degree full-line point.

It will be found in this chart that at whatever degree the exhaust opens on one side the exhaust closes for compression on the opposite side at the same point and degree, which is the case with valves having no inside lap.

This chart will make clear the reason why slide valves usually cut off at about ¾ stroke; because if cutoff occurs earlier, other bad conditions come up, such as too early exhaust opening, slow port opening and excessive compression, whereas if cutoff is later there are less expansion and compression to fill the clearance space. The early release can be remedied by adding inside lap and a greater benefit from expansion would be realized, but by this one would get an earlier exhaust closure, and a consequent excessive compression which would go at times above boiler pressure, lift the valve from the seat and cause a thump, a very common thing in some shaft-governor engines working with light load and short valve travel. It will be noticed that the full lines in the semicircle represent the cutoff in degrees, and the dotted lines from the same point of cutoff go to the eccentric position, showing the relation in degrees of point of cutoff to the position of the eccentric.

The lines *B*, *E*, etc., come from release or exhaust opening, and go to exhaust closure for each corresponding cutoff. The full lines *x* and their decreasing distance apart in going from 90 degrees to 180 degrees represent how sparingly lap is to be added as the eccentric approaches its dead center of the 180 degree mark, because with a given eccentric throw or where the throw of the eccentric is made twice the lap plus twice the port opening, any addition of lap must be accompanied with an increased eccentric throw by substituting a new eccentric or a rocker arm between the valve and eccentric, if full port opening is desired.

A. C. Waldron.

Lynn, Mass.

## Expert Advice

In the June 22 number, Henry D. Jackson has an article entitled, "Expert Advice." I believe in advice and expertness, but the question is who is the expert? If Mr. Jackson will look in a dictionary he will find that the definition of expert is: skilful, adroit, having a facility of operation from practice. If Mr. Jackson will also look at the issue of April 20, he will see that before a man is given a license in New York City he is examined as to the plant he is to operate. If he is to take charge of a plant having an ice machine, he is examined as to his knowledge of ice machines; if there are dynamos, he is examined regarding what he knows about them, and so on.

According to this, then, each plant is in charge of a man having a facility of operation from practice; in other words, he is an expert.

A person must be superhuman who can find more leaks in a plant in one day than the man who is there 365 days each year.

"Coöperation" is very good for the expert, but I think the best coöperation would be between the owner and engineer. Of course there is a feeling between the expert and the engineer, and that is natural and just, because the engineer does not think it fair for the expert to be given facilities for investigation that were withheld from him.

I was assistant in a plant, and an expert had what he called a "fuel economizer." The expert ran a test of 12 hours with the economizer. The next day I took the boiler for 12 hours and did the same work with conditions as nearly the same as possible, on one-third less coal. In another place an expert came in and pumped all the information he could out of the chief (I was assistant engineer), with the net result that the plant was put in the care of an engineering-supervision company and the chief and three firemen were looking for jobs. I was the only one left out of the entire crew. If the chief had shown the expert a little "petty jealousy" he would have kept his job.

I am certainly surprised that an engineer must call in an expert to show him the finer points of engineering in Massachusetts. I do not know the license law of that State, but probably it is needed. As the engineers' license law of New York City now stands, it won't pay to hire the so-called expert here.

H. E. Samuels.

Brooklyn, N. Y.

## Vibration and Tension

In a recent number, the question was asked as to the relation between the vibration and tension of elevator ropes.

This can be expressed by the following formula:

$$n = \frac{170}{l}\sqrt{\frac{P}{m}}$$

in which

$n$ = Number of vibrations per minute,
$l$ = Length of rope in feet,
$P$ = Load or stretching force,
$m$ = Weight of rope in pounds per foot of length.

From the above formula it is seen that:

1. The tension being constant, the number of vibrations varies inversely as the length: also inversely as the diameter. A rope twice as long or of twice the diameter would give half the number of vibrations.

2. In any given rope the number of vibrations varies as the square root o the load on the rope; and inversely as th square root of the mass. That is; I the length is kept constant and the tensio doubled; or twice as heavy rope used we would get four times the number o vibrations.

Example: Suppose a $\frac{9}{16}$-inch rope 5 feet long gives vibrations at the rat of 180 per minute. Taking the weight o rope as one-half pound per foot of length we have

$$180 = \frac{170}{50}\sqrt{\frac{P}{0.5}},$$

from which $P$, the load on the rope, equa approximately 1390 pounds.

With a similar rope of the same size weight and length whose number of vibr tions, $n_1$, is 150 per minute, its load $P_1$ wi equal

$$P \times \left(\frac{n_1}{n}\right)^2,$$

or

$$1390\left(\frac{150}{180}\right)^2$$

which gives approximately 965 pounds.

L. Corwin.

Newburgh, N. Y.

Equivalents of Extra Strong Pipe

| Pipe Size | ¼" | ⅜" | ½" | ¾" | 1" | 1¼" | 1½" | 2" | 2½" | 3" | 3½" | 4" | 4½" | 6" | 6" | Pipe Size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Int. Area | .068 | .139 | .231 | .452 | .71 | 1.271 | 1.753 | 2.935 | 4.209 | 6.569 | 8.856 | 11.45 | 14.18 | 18.193 | 26.97 | Int. Area |
| ¼" | 1 | 2.05 | 3.4 | 6.7 | 10.4 | 18.8 | 25.8 | 43. | 62. | 96.6 | 130. | 168.5 | 208. | 267. | 382. | ¼" |
| ⅜" | | 1 | 1.66 | 3.26 | 5.1 | 9.2 | 12.6 | 21.1 | 30.3 | 47.3 | 63.8 | 82.5 | 102. | 131. | 186. | ⅜" |
| ½" | | | 1 | 1.96 | 3.08 | 5.5 | 7.6 | 12.7 | 18.2 | 28.4 | 38.4 | 47.6 | 61.5 | 78.8 | 112. | ½" |
| ¾" | | | | 1 | 1.57 | 2.82 | 3.9 | 6.6 | 9.3 | 14.5 | 19.6 | 25.3 | 31.3 | 40.2 | 57.4 | ¾" |
| 1" | | | | | 1 | 1.79 | 2.47 | 4.14 | 5.93 | 9.25 | 12.5 | 16.1 | 20. | 25.6 | 36.5 | 1" |
| 1¼" | | | | | | 1 | 1.38 | 2.3 | 3.31 | 5.16 | 6.96 | 8.4 | 11.1 | 14.3 | 20.4 | 1¼" |
| 1½" | | | | | | | 1 | 1.67 | 2.4 | 3.74 | 5.05 | 6.54 | 8.1 | 10.4 | 14.8 | 1½" |
| 2" | | | | | | | | 1 | 1.43 | 2.24 | 3.02 | 3.91 | 4.84 | 6.2 | 8.9 | 2" |
| 2½" | | | | | | | | | 1 | 1.56 | 2.1 | 2.72 | 3.36 | 4.31 | 6.15 | 2½" |
| 3" | | | | | | | | | | 1 | 1.35 | 1.75 | 2.16 | 2.77 | 3.95 | 3" |
| 3½" | | | | | | | | | | | 1 | 1.29 | 1.6 | 2.05 | 2.92 | 3½" |
| 4" | | | | | | | | | | | | 1 | 1.24 | 1.59 | 2.26 | 4" |
| 4½" | | | | | | | | | | | | | 1 | 1.28 | 1.83 | 4½" |
| 5" | | | | | | | | | | | | | | 1 | 1.37 | 5" |
| 6" | | | | | | | | | | | | | | | 1 | 6" |
| | ¼" | ⅜" | ½" | ¾" | 1" | 1¼" | 1½" | 2" | 2½" | 3" | 3½" | 4" | 4½" | 6" | 6" | |

Power, N Y

## Sprung Boiler Braces

In answer to W. E. McClelland's question in the June 22 number, I should say that the through braces if straightened out would spring again more easily and quickly than the first time, as they have been weakened from their first strain.

C. A. Helman.

Holyoke, Mass.

## Tables for Conversion of Pipe Sizes

The accompanying tables are for the conversion of pipe sizes, and were compiled by H. D. Nitchie, an engineer of the Watson-Stillman Company, for use in connection with his own work.

A glance shows how the tables work.

Equivalents of Double Extra Strong Pipe

| Pipe Size | ⅜" | ½" | ¾" | 1" | 1¼" | 1½" | 2" | 2½" | 3" | 3½" | 4" | 4½" | 6" | 6" | Pipe Size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Int. Area | .042 | .047 | .139 | .271 | .615 | .93 | 1.744 | 2.419 | 4.097 | 5.794 | 7.724 | 10. | 12.96 | 18.66 | Int. Area |
| ⅜" | 1 | 1.12 | 3.32 | 6.45 | 14.6 | 22.1 | 41.5 | 57.5 | 95.6 | 137 | 184 | 236 | 303 | 444 | ⅜" |
| ½" | | 1 | 2.96 | 6.77 | 13.1 | 19.7 | 37.2 | 51.5 | 87 | 123 | 164 | 213 | 276 | 398 | ½" |
| ¾" | | | 1 | 1.95 | 4.43 | 6.7 | 12.6 | 17.4 | 29.4 | 41.6 | 55.5 | 72. | 93.5 | 134 | ¾" |
| 1 | | | | 1 | 2.27 | 3.42 | 6.45 | 8.95 | 15.1 | 21.4 | 28.5 | 37. | 47.9 | 69 | 1" |
| 1¼" | | | | | 1 | 1.51 | 2.84 | 3.94 | 6.65 | 9.4 | 12.5 | 16.3 | 21.1 | 30.4 | 1¼" |
| 1½" | | | | | | 1 | 1.88 | 2.6 | 4.4 | 6.21 | 8.3 | 10.8 | 14. | 20 | 1½" |
| 2" | | | | | | | 1 | 1.39 | 2.34 | 3.31 | 4.42 | 5.74 | 7.45 | 10.7 | 2" |
| 2½" | | | | | | | | 1 | 1.69 | 2.39 | 3.19 | 4.1 | 5.33 | 7.72 | 2½" |
| 3" | | | | | | | | | 1 | 1.41 | 1.88 | 2.44 | 3.16 | 4.55 | 3" |
| 3½" | | | | | | | | | | 1 | 1.33 | 1.73 | 2.24 | 3.22 | 3½" |
| 4" | | | | | | | | | | | 1 | 1.3 | 1.68 | 2.42 | 4" |
| 4½" | | | | | | | | | | | | 1 | 1.3 | 1.87 | 4½" |
| 5" | | | | | | | | | | | | | 1 | 1.44 | 5" |
| 6" | | | | | | | | | | | | | | 1 | 6" |
| | ⅜ | ½" | ¾" | 1" | 1¼" | 1½" | 2" | 2½" | 3" | 3½" | 4" | 4½" | 5" | 6" | |

*Power, N.Y.*

or instance, in the table for extra-strong ipe, if there are thirty ¼-inch pipes and he equivalent area of a main to suply these is required, read from the ¼-ich column at the side, across until the umber nearest to 30 is found. In this ase it would be 25.8, or a pipe somehere between 1½ and 2 inches in diamer. A 2-inch pipe would, therefore, be hosen. Using the table the other way if, r instance, a 3-inch pipe is being used nd it is desired to know how many ⅜-inch pipes will have an equal area of cross-section, read down from the 3-inch column to the crosswise ⅜-inch column, and find that it takes 47 pipes of the latter size to make this area.

A. E. Michel.

New York City.

## Storing Compressed Air in a Natural Rock Receiver

In any compressed-air plant a large receiver capacity that can store the air when the consumption is light and restore it when consumption is correspondingly heavy is very desirable. This is especially true of those plants where the compressor is driven by an electric motor. The conditions are, then, a compressor having constant speed and, in mining work, a constantly changing load.

Compressors of modern design for electric drive are equipped with unloading devices which overcome, to a certain extent, the loss of power through air blowing off at the safety valve when a hoist or a number of drills are stopped for a few minutes. But with an unloader cutting out the compressor every few minutes the daily capacity of the plant is very much less than if it were allowed to compress air constantly, and if that air could be stored and given back when all the drills and hoists happened to be at work at the same moment, calling for more air than the compressor could deliver, a great advantage would be gained.

The storage capacity of the ordinary mining installation is very small. Suppose a ten-drill plant has a storage equal to 5000 feet of 6-inch pipe and a receiver 48 inches by 15 feet. This would hold 1188 cubic feet of compressed air, which at eight atmospheres would be equal to 9504 cubic feet of free air. If the compressor were stopped, only about one-third of this air could be used, as when about that amount had been drawn off the pressure would be too low to do effective work. Ten 3¼-inch drills at a 3000-foot altitude would pull down the pressure in this pipe line and receiving tank from 96 to 60 pounds in about four minutes.

At one of the mines in this district they have two electrically driven compressors with a combined capacity of 7500 cubic feet of free air per minute. These machines are equipped with automatic unloading devices which operate whenever the air rises to 100 pounds per square inch.

The idea of sealing up an unused crosscut in the mine and making of it a large underground air receiver was successfully carried out. The crosscut was roughly 9 feet high, 6 feet wide and 400 feet long and was driven through solid rock which showed no cracks nor seams. The bulkhead was built of concrete, 10 feet thick and carefully pointed on the inner side with strong cement. A 6-inch pipe connection and a manhole were built into the bulkhead; the manhole being sealed the same as a manhole in a boiler. When tested, it was found that this natural receiver lost only 10 pounds in 18 hours; one or two very small leaks around the bulkhead no doubt accounted for this loss.

The capacity of this crosscut is not less than 22,000 cubic feet, or is equal to 117 ordinary air receivers 48 inches by 15 feet. In free air compressed to eight atmospheres, it will hold 176,000 cubic feet, or the entire output of the compressors for 23 minutes. Allowing that one-third of this air is available at a working pressure, as cited, ten drills could be operated for 50 or 60 minutes after the compressor was stopped.

The advantage of such a large storage is very noticeable in the engine room. It tends to balance the rapid fluctuations in the load, the compressor and rope drive run more steadily and the unloaders cut out less often. The motors are not subjected to the strains of the load being constantly thrown off and on.

In the mine, a hoisting engine or a group of drills may be thrown on or off without seriously affecting the air pressure. In short, it stores and restores the air, piling up a reserve when a machine is stopped and giving it back when a sudden call is made.

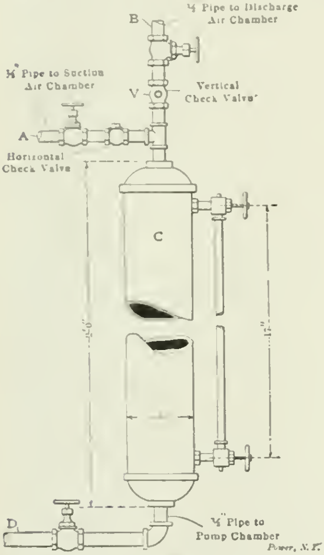
This idea is not new, but the writer does not know of any other place where it has been successful, the difficulty usually encountered being the leakage of air through seams in the rock.

C. SANGSTER.

Rossland, B. C.

## Device for Charging Air Chambers of Pumping Engines

In the operation of pumping engines it is generally necessary to provide means of supplying air under pressure to the air chambers, particularly those on the discharge pipes, as through leaks in the piping or by absorption or entrainment in the rapidly moving water the air gets away and must be replaced if the pump is to work smoothly.



DEVICE FOR CHARGING AIR CHAMBER

It is generally customary to provide an air compressor of some kind; many plants use the direct-acting air-brake type, which is very compact and convenient. When the water is taken from a well or pond, by a pump located considerably above the surface of the water, advantage may be taken of the fact that the pressure in the pump chamber of a reciprocating pump is alternately above and below the atmospheric line to employ what is sometimes called a snifting valve, in which on the suction stroke the air is drawn into a cylinder connected by a pipe with the pump chamber, and on the discharge stroke is forced through a pipe into the air chamber, check valves on the air-suction and discharge pipes preventing the entrapped air from getting back through the suction pipe on the discharge stroke, or returning from the air chamber on the suction stroke.

In a small pumping station the water comes to the pump from a supply main serving at a pressure of about 25 pounds and is discharged by the pump against a pressure of about 145 pounds per square inch, in order to supply an elevated part of the town.

On account of the high pressure in the discharge pipe it was found very difficult to supply air to the discharge air chamber with the single-stage air compressor in use at this plant, as the slightest wearing away of the piston or valves rendered the compressor useless. As the cost of a new two-stage compressor or of adding an extra cylinder to the old machine was considerable, a special form of snifting valve was devised which takes its air supply from a large air tank in the basement, connected to the suction main and used as a shock absorber.

As the air pressure in this tank is only 25 pounds, the single-stage compressor will put air into it with ease. An air pipe runs from the top of this tank to the suction check valve on the snifting device attached to the water end of the pump. At an elevation of about 14 feet above the water level in the suction tank the pressure due to a column of water of this hight is thus available to force the air into the snifter. The sketch shows the construction of the device, which is operated as follows:

Air from the suction tank enters at *A*, on the suction stroke, displaying the water in the cylinder *C* and forcing it into the pump chamber through the pipe *D*. On the discharge stroke, water, under 145 pounds pressure from the pump chamber, rushes into the cylinder and forces the air through the vertical check valve at *V* into the discharge air chamber.

The snifter was made at trifling expense out of an old cast-iron water column taken from an abandoned boiler. It has worked in a perfectly satisfactory manner for about a year with a considerable saving in expense and annoyance.

Experiments have been made which show that with a properly proportioned inspirator, using the high-pressure water, it is possible to draw air into the suction tank, thus dispensing entirely with the steam-operated air compressor, but as the experimental inspirator was too small to use in practice the compressor is still in service.

A. O. DOANE.

Boston, Mass.

## Plugging the Blowoff

In William Kavanagh's article in the June 15 number, on boiler management, he states that a plug should be put in the blow-down connection, but does not state why it is put there or when to take it out. If the blowoff is plugged and the boiler washed, where is the water going to? It will certainly run out of the lower manhole or handhole and make a dirty mess.

I suppose Mr. Kavanagh's idea is to prevent scale from lodging in the blowoff pipe and valve. When I wash out a boiler, I always leave the blowoff open, and when through washing I remove the bonnet of the blowoff valve and remove any scale that has lodged there.

I do not think that his method of removing scale would be very efficient where the feed water contains much calcium sulphate, although it might remove the soft scale due to carbonates.

LOUIS B. CARL.

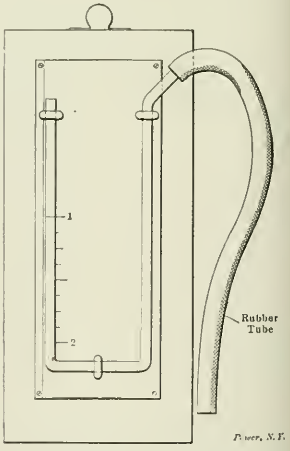
Marshfield, Wis.

## Homemade Draft Gage

Following is how a very simple little draft gage for the boiler flue can be made:

Get a piece of ⅞-inch pine board, 6 inches wide and 1 foot long, planed on one side. Take another piece of wood about ½ inch thick by 4 inches wide and 8 inches long, glue a piece of writing paper to one side and screw this to the other board.

Secure a glass tube ¼ inch inside diameter by 13 or 14 inches long, and bend as shown in the sketch, having the legs of the U-bend about 2 inches apart. On one end of the tube make a bend of about 45 degrees, on which place a rubber tube about 2 feet long.



HOMEMADE DRAFT GAGE

The bending can be done by means of a blowtorch or gas jet, using care in turning the glass properly as it heats. When it comes to a dull red it will bend easily.

The glass tube can be secured to the thin piece of wood by using brass or ti bands. Next make the marks for the scale, 1/16 or 1/8 inch apart, on the writ ing paper, as shown. The tube is then filled with water up to the top mark, when it will be ready for service.

When readings are to be taken, place the instrument near the stack or flue, using a $^1\!/_4$- or $^3\!/_8$-inch pipe leading to the inside of the flue.

WILLIAM E. MILLER.

Jackson, Tenn.

## Peculiarities in Operation of Rotary Converters

We are operating three 300-kilowatt Westinghouse rotary converters, direct-connected to the alternating-current generator busbars in the power house, through suitable reactances, as shown in the accompanying diagram. This system of connection gives rise to several peculiar operating conditions not commonly met with in rotary-converter installations. For example, if Nos. 1 and 2 machines are running, and the circuit-breaker on No. 1 opens, the machine will not drop its load, as might be expected, but will continue to carry about two-thirds of its former load, and by increasing the field excitation it can be made to divide the load equally with the other machine, although its breaker is still open.

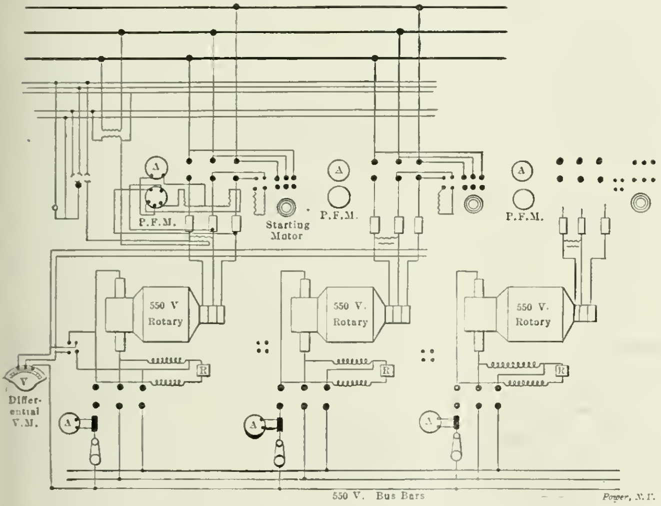


DIAGRAM OF ROTARY-CONVERTER CONNECTIONS

These machines have their breakers in the negative lead and equalize on the positive side. With the breaker and negative switch of No. 1 machine open, there is twice the current flowing in the negative lead of No. 2 as in its positive lead, but the alternating-current ammeters of the two machines show equal readings. This indicates that all the current delivered by the two machines is returning through the negative lead of No. 2 and this must be so, for it is the only closed path to the machines from the negative side of the load. The same conditions occur if all three machines are running and one of their breakers opens, only there are two negative returns instead of one, as before.

If, instead of strengthening the field of No. 1, we weaken it, the machine will drop its load and the positive switch can be pulled without an arc, but if the field is weakened below the point where the machine dropped its load, the rotary converter will run inverted, delivering alternating current to the generator busbars. It will do this if both positive and negative switches are open, taking direct current from the other machine through its equalizer.

These conditions are due to the fact that there is a complete local circuit formed by the rotary converters and the alternating-current and direct-current busbars. Any other difference in condition of operation of the two machines, a slight difference in the relative positions of the direct-current brushes of the machines, for example, will cause large cross currents to flow in this local circuit, making it necessary for successful operation that the relative positions of the direct-current brushes of the several machines be exactly alike. However, by exercising due care in maintaining like conditions of operation for all the machines, their performance has been entirely satisfactory.

Conditions similar to the foregoing are seldom, if ever, met with in substations remote from the power house, because step-down transformers are used with each machine, or a transformer with a set of secondaries for each machine, thus insulating the alternating-current circuits of each machine from its neighbor. This prevents the formation of any local circuits in the substation.

SAMUEL H. HARVEY.

Hamilton, Ohio.

## Iron and Steel Pipe

Older engineers believe that the pipe of today is not as good as that of twenty years ago. One advocate of steel pipe states that 85 per cent. of the pipe used today is steel.

Is this the reason we are renewing our piping oftener than of old? It is a question which should interest every engineer. Are we paying an extra price for wrought-iron pipe to no purpose, or are we increasing our maintenance costs by installing steel pipe?

The writer made extensive alterations in a large heating plant in which the return mains installed twenty years ago were found to be entirely free from pitting and this pipe was reinstalled in preference to the new pipe of the quality we are now getting. A perfect thread could be cut on it with ease and a chemical test of a sample showed it to be wrought iron. Pipe taken from work of recent years on the same system was unfit for further use. We have numerous samples of steel pipe which has been in service but a few years and is badly pitted, while in some of our installations twenty-five years old the original pipe is still in service.

The statement has been made that we cannot tell iron pipe from steel pipe without first cutting and threading it. This is quite natural since the difference is due to the chemical composition and cannot be told by inspection. A careful watch over the work done on a pipe machine for an extended period has demonstrated that while we could cut a perfect thread on wrought iron with no trouble, steel pipe threaded with the same dies and handled by the same man invariably gave a poorer thread and often could only be cut by frequent reversing and starting the machine. Occasionally the steel pipe would work well, but just as often it would be found impossible to thread it at all.

An argument used by advocates of steel pipe is that it is almost universally used and it must be satisfactory or its use would not be so extensive. It is probably a fact that a majority of pipe users do not known that there is a difference in the material from which pipe is made and suppose that when they order "wrought iron" that is what they receive. A recent request to a number of supply houses for prices on wrought-iron pipe brought quotations on "wrought pipe," "wrought steel," "iron pipe," etc., and when pressed for a definite statement as to the nature of the material most of them acknowledged that they were quoting on steel; one firm stating that they did not know where wrought-iron pipe could be obtained. The conclusions drawn are that an order for wrought-iron pipe, unless suitable specification was made, would be filled with steel pipe, which would account for its widespread use, and that there is a tendency to conceal the identity of the steel pipe under misleading names.

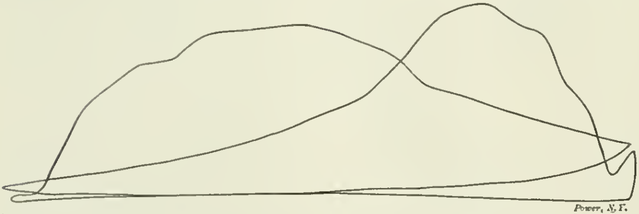
Laboratory tests, even when every effort is made to conform to practical conditions, are not conclusive and any engineer can make more reliable tests on the piping of his own plant, with very little trouble. When making repairs or alterations, tag the pipe installed and record the name of the firm supplying it, the name of the maker, if obtainable, the date installed, the manner in which it threaded, etc. Obtain the history of the piping of your plant and note the condition of any pipe which is removed, examining it for general corrosion and pitting.

Lewis C. Reynolds.

Willard, N. Y.

## Valves Require Setting

The accompanying diagrams are submitted for the purpose of criticism by readers. They are from an 11x18-inch Buckeye engine running at 180 revolutions per minute; spring, 40. What should be done to the engine to produce good diagrams?



CARD TAKEN FROM 11X18-INCH BUCKEYE, 40-POUND SPRING

Hugh Conway.

Anniston, Ala.

## Vibration and Tension

For the benefit of Mr. Hastings the following laws of strings are submitted:

Law of lengths—The tension and diameter being constant, the number of vibrations vary inversely as the length.

Law of diameters—The tension and the length being constant, the number of vibrations vary inversely as the diameter.

Law of densities—The length, tension and diameter being constant, the number of vibrations vary inversely as the square root of the density.

Law of tensions—The length and the diameter being constant, the number of vibrations vary as the square root of the tension.

The latter stated in a formula is,

$$\frac{N}{n} = \frac{\sqrt{T}}{\sqrt{t}}.$$

Squaring both sides of the equation we have,

$$\frac{N^2}{n^2} = \frac{T}{t}$$

If a string is plucked or struck at the center it vibrates as a whole. If plucked at a point one-third of its length it will vibrate in three sections, etc. This form of vibration causes what are known as overtones in music. Suppose the car is at the bottom of the shaft and one cable makes 15 vibrations while the other makes 16, when plucked at midpoint, then

$$\frac{T}{t} = \frac{N^2}{n^2} = \frac{225}{256} = 88 \text{ per cent.},$$

or the second cable has only 88 per cent. as much tension or load as the first.

## Kerosene Oil in Boilers

In recent issues there have been published a number of references to the use of kerosene oil as a scale remover in steam boilers. Some of the correspondents think its use is desirable, while others appear to doubt if much benefit is derived from its use.

One of the reasons advanced for being skeptical, regarding the ability of kerosene to remove scale from the shell and tubes of a boiler, is, that the vaporizing point of kerosene is below the boiling point of water, therefore, the kerosene can not exist in the boiler in the liquid state, but only as vapor in the steam space. As in all disputes of a similar nature, "the proof of the pudding is in the eating" and kerosene oil will remove scale, which can be readily proved by any skeptic with a trial. It is effective whether fed in drop by drop, or put in the boiler when washing out.

The fact that kerosene does remove scale from the water surfaces of a boiler is conclusive proof that it exists in the boiler in a liquid state for an appreciable length of time. That this fact does not conflict with the accepted figures regarding its point of vaporization, can best be grasped by using the illustration familiar to every engineer, and used by F. R. Low in explaining the possibility of water being present in steam pipes carrying superheated steam where the temperature is considerably above the point of vaporization of the water contained in the pipes.

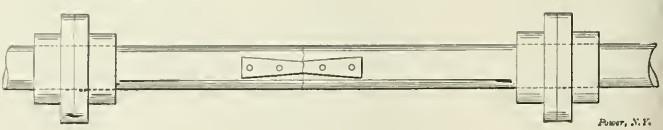
The illustration is, that a cake of ice might be placed in a room where the temperature was 90 degrees Fahrenheit, and notwithstanding the fact that this temperature would be 58 degrees above the freezing point of water, the ice would remain as ice in this temperature for a very considerable length of time. Similarly kerosene oil placed in a boiler, where the temperature is above that at which it vaporizes, would not cease to be a liquid instantly, but would require some appreciable length of time to accomplish the change from the liquid to the gaseous state. It is also not reasonable to assume that, because the specific gravity of the oil is less than that of the water, the kerosene would necessarily remain on the surface of the water, for the currents produced by the liberation of steam in a boiler under operation are very strong and they carry downward material of less specific gravity, as well as elevating material of greater specific gravity, than the water in the boiler, therefore the oil is probably brought in more or less intimate contact with all of the water surfaces during the operation of the boiler.

J. E. Terman.

New Haven, Conn.

## A Line Shaft Repair

A main shaft broke between two couplings, as per the accompanying sketch, and was repaired in the following manner:



A LINE SHAFT REPAIR

It was a 6-inch shaft and it was necessary to make a quick repair. First I secured a bar of steel and made two keys ⅞ inch wide in the center and 1 1/16 inches both ends and ¾ inch thick.

The keyway was drilled out with a portable electric drill, then chipped out with hammer and chisel and the keys made a good fit, of which there were two diametrically opposite each other. Four ½-inch holes were drilled and tapped in one and set screws screwed home tight, thus making a good job, and, although we got a new piece of shaft in case anything should happen, we have not seen the slightest signs of their pulling away from each other, as owing to the key being taper toward the center it tightens up should there be any end pull.

J. H. Houldsworth.

Toronto, Ont.

## Trouble with an Exciter Set

In a large railway plant the current is supplied by alternators at 400 volts and stepped up to 15,000 volts for transmission to the various substations.

Excitation current is supplied by a direct-current generator driven by an induction motor supplied with current from the alternators which it excites.

When a short-circuit occurs on the transmission line the exciter set dies, almost instantly putting the whole system out of business, which necessitates the starting of a steam-driven exciter to get the system in operation again.

Why does the exciter set fail?

C. L. Greer.

Handley, Tex.

## A Freak Motor Action

A large company of the Middle West has about one hundred 110- and 220-volt direct-current motors in operation. Frequently one of these does something which is not according to Hoyle, and for which it is hard to account. A 15-horsepower, 220-volt, compound-wound motor drove several lathes and drill presses from a line shaft. It was run as a shunt motor, as the man who installed it said that it sparked excessively when the compounding was used either accumulatively or differentially. As the motor worked well as a shunt machine the electrician who succeeded the installer of the motor made no effort to use the compound winding, letting "well enough alone."

However, the commutator insulation broke down and as a result two coils were burned out. It was, of course, necessary to take the motor out of service to rebuild the commutator and put in two new coils. The motor had 47 slots in the re and 93 bars in the commutator. Some time was spent in trying to solve the probl m before the ends of the missing coils were found. Will some one please tell why an odd number of bars is used?

After the repairs were made the motor was put into the belt of a prony brake and overloaded. It was run with the mpound assisting the shunt winding nd did finely, dropping considerably in peed from no load to full load.

The motor was put back in service after is thorough test and ran well for some ne, perhaps a month. It seemed certain at there had been some mistake about e compounding, for it was left cut in d there was no sparking at practically ull load.

After about a month of fine service the reman of the machine shop complained hat the speed of that motor varied so nuch as to prevent accurate work on the athes. Investigation showed that the peed was running from a maximum to a minimum about six times per minute. With each variation the ammeter swung from 20 to 100 amperes, reading at 100 amperes when the motor speed was the lowest. The normal rating was 56 amperes and 550 revolutions per minute, but at each variation the speed was so reduced that for an instant the armature seemed to stop and to be driven by the momentum of the line shaft, for the loose side of the drive belt could be seen to tighten as the needle of the ammeter swung to 100 amperes. Then as speed increased again there was excessive sparking and the ammeter read down to 20 amperes when maximum speed was attained.

This change of speed and sparking occurred with such regularity that it seemed that some shaft or clutch must be sticking. But careful search proved this to be impossible. Then a trip to the power house was made, which showed considerable variation in the reading of one voltmeter, corresponding with the variation of the ammeter on the motor. The brushes and contacts were examined and found in good condition. It was decided to run the machine as a shunt motor and so the compounding was cut out. The motor then started its load easily and the ammeter showed 40 or 50 amperes, varying just as the load varied. It has been running as a shunt machine for some time and no further trouble has been had with the same load conditions.

Current was furnished by three 110-volt accumulatively compounded dynamos. Two of these were running in parallel with the compounding short-circuited, since no equalizer is used. These were on the negative side of the 220-volt circuit while the one was running accumulatively compounded on the positive side of the 220-volt circuit. This was the one which showed the variation in voltage. These machines are driven by gasolene-kerosene traction engines which are being tested, and so there are many engines in the power house during the week. They are equipped with centrifugal governors.

It is possible that this motor racing was caused by the engine which had been put on the belt a few hours before the motor gave trouble. It seems that the generator on the positive side might be under- and the motor over-compounded. It is probable that the motor, dynamo and engine combination was such as to allow this trouble to occur. Because the motor sparked so badly there was not time to experiment, and so it is an open question as to what caused the trouble.

We had no time to find whether the engine had been sent in with a defective governor and caused the motor to race, or if the motor and dynamo combination caused the engine to race slightly. At any rate both engine and motor ran well as soon as the compounding was cut out.

C. W. Hull.

Charles City, Iowa.

## Ammonia from Lime and Soot

I recently had to renew a patch of cement, and wanted to make the new cement the same color as the old. Having no lampblack, I mixed in soot taken from the boiler tubes, and could immediately smell ammonia.

This struck me as peculiar and I started to look for the cause. I then found that portland cement and soot mixed give out the same odor, and now I get it from a weak solution of limewater and soot. I have been fooling with this stuff for some time and used it for disinfecting and the solid part for polishing. Another thing, the odor seems to be almost everlasting, as I have put on a half a pail of water a dozen or more times and still get the ammonia smell. Why is this so?

Harold James.

New York City.

## Water Power

In the June 15 number there is an article on water power by W. E. Crane, in which he makes a statement, with reference to my article on the same subject in the issue of April 13, which does not seem to me strictly justified. He says: "Henry D. Jackson takes up the subject of water power, and suggests the careful looking up of the Government records for a long time. This must mean the record of rainfall."

It is to this last statement that I take exception. In saying Government records, I mean all the Government records which may be of importance to discover what may be the flow of the stream. The Government not only gives the stream flow by gaging on a large number of streams for the country, but also gives tables of rainfall, runoff, etc., which may be used to determine the flow of a stream, if one knows or can determine the natural watershed of the stream. In the article he speaks of, I was dealing with stream flow, which would have no connection whatever with the Government records of rainfall or runoff.

As Mr. Crane says, it is of the utmost importance to know the character of the country through which the stream passes, and to take into consideration the destruction of the forests in figuring on the probable condition of the plant in later years; but the Government records are very complete along the lines of rainfall and runoff, so that there should be very little trouble in making a complete and accurate survey from any water-power development from the Government records if they are carefully worked out. It is not to be taken that this is a job that is easily or quickly made. It will require a great deal of careful plotting, careful study and considerable knowledge of conditions to work out a reliable water-power development from any of the records that at present vary, but a man who knows his business along these lines, and is conservative can usually obtain results which are on the safe side.

Henry D. Jackson.

Boston, Mass.

## Trouble with an Engine Governor

A short time ago I was asked by an engineering friend to work at his governor which was causing him anxiety and giving very unsatisfactory service.

The engine was of the Greene type, the governor operating on the tappets directly, forcing the lower tappets down, thus reducing the catch on the tappets on the steam valve rock shaft and by so doing regulating the point of cutoff. The rod from the governor was constructed of ⅝-inch steel and extended down to within a foot of the pressure bar which operated the movement of the tappets. This rod was then forged square, and passed down through a sleeve which was made correspondingly square to steady the rod.

When I arrived I found the engine to be running irregularly. I lifted the governor rod and discovered that it moved by jerks and was not at all sensitive. We took off the removable plate screwed to the front of the square sleeve and found it to be full of filings or chips. Then the engineer suddenly recollected that he had filed off a set screw on the valve gear the night before. This accounted for the filings and as the sleeve had a recess at the top to faciliate oiling, there was a nice little pocket to catch the filings, putting the working of the governor to the bad. A thorough washing out with kerosene and a good oiling cured the trouble.

Charles H. Taylor.

Bridgeport, Conn.

## Dashpots

One of the most important conditions necessary to obtain a well working dashpot is that the valve motion and valves be carefully adjusted and working freely. There is positively no use bothering with the dashpot as long as the valve motion is out of adjustment. If the valve motion and valves are right and the governor adjusted correctly and the trouble is in the dashpot, the following ought to help cure the trouble:

When a dashpot plunger rises, it creates a partial vacuum in the dashpot. As the vacuum space of the dashpot is air-tight, no air can enter to fill the space from which the plunger has been withdrawn. The higher the plunger is raised the lower this pressure will be and if air leaks into this space the vacuum will be destroyed and there will be no tendency for the dashpot plunger to fall, other than that caused by its own weight, which will not be sufficient to overcome the friction of the valve and its connections to the dashpot. In addition to this friction the plunger, in falling, must force out of the vacuum space the air that leaked in as the plunger was being raised. It will thus be seen that while the vacuum space of the dashpot must be air tight, provision must be made to expel easily any air that may leak in.

A Corliss engine dashpot will work perfectly regardless of the point of cutoff, the amount of compression or the boiler pressure. High boiler pressure is hard on a dashpot and I would not advise higher pressure than 125 pounds, gage.

A single-eccentric Corliss engine will run with the point of cutoff at zero, or the valve may only be opened the amount of lead and still the dashpot will seat.

H. W. Benton.

Cleveland, O.

## Repairing a Centrifugal Pump

At the United States navy yard at Bremerton, Wash., there are two 50,000-gallon 42-inch centrifugal pumps, used for pumping out the drydock when ships are repaired. A very quick and practical method of repairing cast-iron castings was used there to repair the casing of one of the pumps. Two 12-inch radial cracks developed in the 42-inch outer cast-iron casing. It was necessary to have a repair made at once to keep the pumps in use and without the expense of removal and a new casing.

The cracks were chipped out with cold chisels until they were about 2 inches wide and as long as the cracks extended. A cast-iron mold was fitted over the outside of the pump casing and a companion mold placed on the inside to prevent the metal from running through. The pump casing was heated by means of torches, until the metal around the crack was hot. Melted cast iron of a softer grade than the pump casing was then poured into the crack and the whole allowed to cool. The molten metal fused itself into the sides of the crack and made a perfect joint.

The molds were removed and the patch on the inside of the pump casing chipped off even with the casing so as not to interfere with the flow of water through it. As the patch was supposed to be weaker than the solid metal, it was smoothed off on the outside and a ridge about 1 inch high was left. After being painted it was hardly noticeable and has shown no signs of leaking or breaking. The pump is used on extremely heavy duty, being run up to 180 revolutions per minute, which gives a considerable outward centrifugal pressure.

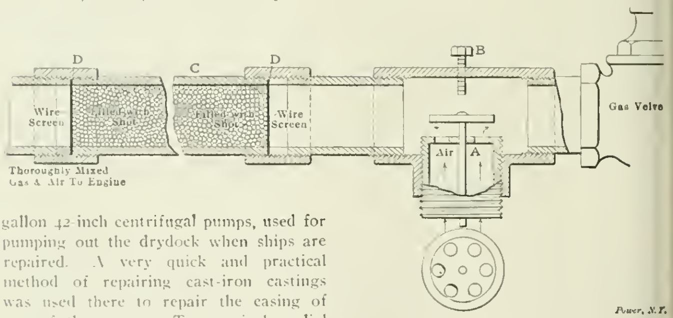
Louis P. Zimmerman.

Seattle, Wash.

## Air and Gas Mixer for Gas Engine

A small gas engine was intended originally to be run with artificial gas. The present owner wanted to run it with natural gas. After a thorough overhauling, it failed to give the power it should. Several different sizes of hot tubes and then an electric ignition were tried, but the results in power were still far from those desired.

As the engine seemed all right, it was decided that a good mixture of natural gas and air had not been obtained with the artificial gas mixer, as, owing to the construction of the mixing mechanism, a large enough proportion of air could no be obtained. Not desiring to buy a mixe until he was certain that this was th trouble, the machinist, who was changin the engine, decided to make one.



AIR AND GAS MIXER FOR GAS ENGINES

He took an ordinary tee, filled a nippl with babbitt metal and turned the uppe end off square; bored holes through thi lengthwise, made a valve stem, an screwed the whole into the lower par of the tee as at *A*. A hole was drille through in the top of the tee and a scre *B* placed in it for the purpose of regulating the amount of entering air. Then piece of large gas pipe *C* was obtaine and a wire screen *D D* placed in betwee the two ends of the pipe when screwe into a collar. The pipe *C* was filled wit large-sized shot through which the ga and air passed to the engine, thoroughl mixing.

The engine then apparently ran all righ but its power was subsequently increase an appreciable extent by reducing th compression space from 4 inches in dept to 1 inch, by bolting in a cast-iron fillin

Royal Wolfe.

Lancaster, O.

## A Rotary Converter Trouble

I have under my care two rotary conerters that have been causing considerble trouble lately. The machines are 50 kilowatts capacity each and are run t 900 revolutions per minute, on a threehase 60-cycle and 350-volt system. They .eliver direct current at 550 volts for treet-railway work.

In an hour after having been given a ood cleaning they begin to burn at four ifferent places on the commutator. These aces are exactly one-quarter of the ircumference apart and cover about four egments. From these four spots the irning follows around the commutator itil the sparking is so bad that it is necssary to shut down the machine and ean it. After cleaning, upon first startig up the sparking all takes place under ie positive brushes, while the negative rushes run without a sign of a spark. )f course after the commutator is burnt ome, the negative brushes spark, but not ntil then.

I have tested for short-circuits, grounds nd loose connections, but cannot find anying out of place. The machines heat onsiderably.

What do the other readers think about ?

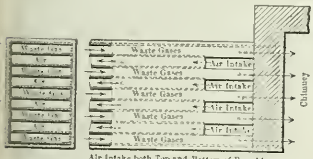
J. J. McIntosh.

Phoenix, Ariz.

## Boiler Room Economy

Now that we have steam engines and rbines down so fine, we are deep in coal talysis, smokeless combustion, CO and $O_2$ percentage, etc. It would seem, hower, that one thing was being overlooked. 'e are trying to cut down the air suppy to as near the theoretical amount as ssible, but it would appear that we do t care in what condition this air reaches e fire.

In many boiler rooms the chimney is nnected with the boilers by a long sheet-iron breeching. Suppose this breeching was made twice the size with separate compartments, part of these arranged for the waste gases and the rest for air, something as shown in Fig. 1, the whole well insulated, and the tops formed of a number of removable, asbestos-covered lids for sweeping out the flues.



Air Intake both Top and Bottom of Breeching.

*Power, N.Y.*

FIG. 1

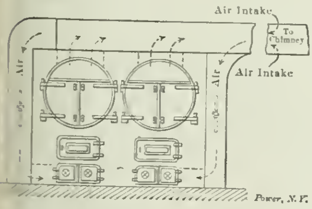


FIG. 2

At the boiler end, the air passages could be arranged to run down both sides of the setting and enter the furnace through the side walls of the ashpit, the doors to be kept closed. The probable results of such an arrangement would be that instead of having cold air rushing into the furnace, reducing the temperature of the fire and the efficiency of the plant, there would be a fairly well ventilated room to work in, and a saving in the coal bills.

R. Cederblom.

Gary, Ind.

## Slide Valve Duplicate

In order fully to understand the action of a slide valve, the following plan may be adopted:

Center the engine in the usual way, by division marks on the crosshead, guides, and crank disk, or flywheel. Then take off the steam-chest bonnet and remove the valve. Place the valve on its back on the work bench, and place a piece of smooth pine board over the valve face.

Lay off the lap, both inside and outside, so as to obtain an exact duplicate of the valve, and make sure that the measurement takes in the part of the valve that the valve stem fastens to. This, in some engines, is a lug on the back of the valve, while in others it is a pair of lugs that engage another lug on the valve stem itself.

With a fine saw cut out the edge of the board, hollow out for the exhaust cavity, and make the duplicate, so that when it is put up against the locknuts, or lug on the stem, it will occupy the same place as the valve itself. Then turn the engine slowly in the direction it is to run and the events of the valve can be accurately noticed.

First see that the eccentric is in its proper place and that the valve travel is equal. All this may be done with the duplicate; and a better idea can be obtained of just what a valve is doing in this way than by any other method.

Holding the wooden duplicate to the lug on the stem as the engine is turned over gives one an accurate idea of the various events of the stroke, and they may be accurately marked.

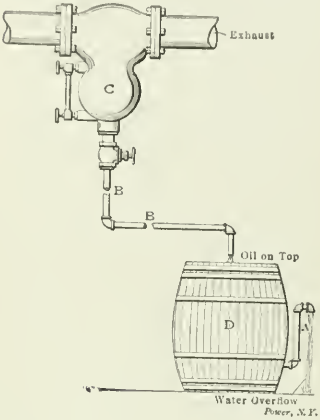
To those who have experienced trouble with valves of the type used by the Russell engine, I would especially urge giving this method a fair trial, as to one not used to these valves they are quite a puzzle.

James W. Little.

Fruitland, Wash.

## Separating Oil and Water

The sketch shows how we separate oil from the water coming from the oil separator on the exhaust line. The water and oil from oil separator *C* are carried through the pipe *B* and discharged into the barrel *D*. The overflow pipe *A* takes the water out and leaves the oil on top, where it is skimmed off and used on the elevators.



SEPARATING OIL AND WATER

T. A. Knowlton.

Conway, N. H.

## Cause of Engine Wreck

Twice a cross-compound Corliss engine was wrecked in a large flour mill under very peculiar conditions. After the first wreck the writer was sent to investigate the cause. I found the grooved wheel for rope transmission in pieces, the crank disk split from the hub out about 7 inches, the key partly sheared off, the connecting rod bent and the piston started on the rod, breaking the riveted end of the piston rod off in the form of a complete ring.

After questioning the engineer very closely upon the circumstances leading to the wreck, I found this condition: The engineer, a capable man, warmed up his engine and opened all the drips and blowoffs from the receiver, trap and below the exhaust pipe, almost directly under the vertical riser to the barometric condenser. Then opening up the throttle valve he started up very slowly. When at about half speed, 45 revolutions per minute, with no load on, he started to close the drips, and just as he reëntered the engine room the wreck occurred, with the condenser holding 24 inches of vacuum. Only one blow was heard. The engineer happened to be close to the throttle valve, which he shut and made a bolt for the door, a perfectly proper thing to do. He waited until all was quiet and then went back to see what was wrong with the engine.

The engineer attributed the wreck to the barometric condenser because water was in the exhaust pipe and the low-pressure cylinder, at a low temperature. The fact was that the water came from the receiver below the cylinder, and I so stated at the time of my visit, and also predicted that this would occur again if they started up again under the same conditions, and suggested that the receiver be placed above the cylinders instead of below them, so there could be no possible accumulation of water.

I questioned the engineer very closely as to the trap working at all times, and he assured me that there was absolutely nothing wrong with it, but was informed this was one of the reliable type, as it always worked. The receiver was about 36 inches in diameter by about 10 feet long, with a baffle through the center, the steam inlet being 7 inches and the outlet to the low-pressure cylinder being 14 inches. The 1½-inch drip to the trap was right under the 14-inch outlet.

I left the plant, firmly convinced that another wreck would take place, but my investigations did not go as far as I should have liked, owing to their being shut down. Now, then, what happened about three or four weeks ago? We were informed by the engine people that their engine was wrecked again and they wished me to visit the plant and report to them the cause of the second wreck. I found the mill running with the high-pressure side only, exhausting through the low pressure side to the atmosphere, with the relief valve of the condenser removed.

Upon questioning the engineer as to the cause of the second wreck he again stated that he was positive it was caused by back flow from the condenser. The writer said that it was a physical impossibility to get water back from the condenser, especially while the condenser was maintaining a 16-inch vacuum. I tested the trap under the receiver and found that it leaked badly. We took off the relief valve on the condenser, opened the water nozzle wide and started the circulating pump up at full speed and utterly failed to get any water back in the exhaust pipe, satisfying ourselves that no water could possibly come from that source. By putting the relief valve back in place and starting the circulating pump, it showed conclusively that when starting the engine up with no load on a vacuum was obtained in the receiver. At this time the trap failed to operate and a rush of air under the 16-inch vacuum back through the trap carried the water from the receiver into the low pressure cylinder, causing the wreck. The discharge from the trap was 1¼ inches, open to the atmosphere. Taking the trap apart we found that the discharge opening was about 1 inch in diameter with a ball-float valve, which opened wide under a vacuum and allowed air to rush in. This trap was set without much fall, and with the discharge about level with the bottom of the receiver.

Had there been a swinging check valve on the discharge from the trap the accident would never have taken place, or if they had had an automatic pump and receiver with a check valve this would have saved their engine.

B. W. Thurtell.

Chicago, Ill.

## Knock in High Pressure Cylinder

A 14 and 22 by 36-inch Corliss compound engine, eight months after being rebored, showed signs of knocking in the high-pressure cylinder. At first it was a hard matter to account for this knocking without removing the cylinder head; the noise was almost as great at full load as it was with light or no load.

After removing the cylinder head the trouble was determined immediately by bringing the piston to the head end. It was found that the piston ring did not pass over to the counterbore. The same trouble was experienced at the crank end of the cylinder. As the wear on the cylinder increased, shoulders started to form and offer a noncushioning resistance for the rings at both ends, which caused two hard, distinct knocks for each revolution.

The shoulders were cut down and the ends of the cylinder beveled with an emery wheel coupled to a flexible shaft. This shaft was connected to the motor shaft with a universal joint. The motor was a portable type, 1-horsepower 115-volt, with intermediate fields, and a maximum speed of 3600 revolutions per minute. The entire cutting was done in three hours, while the old method would have required at least a day.

M. C. Saeger.

New York City.

## Gage Cocks

It is usually conceded that the water column of a boiler is of such vital importance that it and its connections are entitled to the most careful consideration, and no pains should be spared to make them as efficient as possible. For this reason it is acknowledged that the glass alone should not be relied upon, but as an additional precaution gage cocks are provided. The idea is that should the glass or its connections become choked, the use of these cocks will disclose this fact, and also provide a means of ascertaining the water level until the glass can be put into operating order again.

While the importance of the gage cock is universally conceded, I have observed in my experience as an inspector that they are seldom used. In fact, in a great many instances they are not kept in operating order. This is due to two causes, one being that the cocks usually provided are of such inferior nature that it would require a large percentage of the engineer's time to keep them in working order; the other, that there exists a wel founded lack of confidence in them because, as commonly installed, gage cock are little better than useless.

The only reason for placing them o the water column seems to be that that i where they have been placed for years and it has never been clear to me wh they are not connected directly to th boiler shell or head, where they belong In this arrangement the gage cocks an glass would be entirely independent o one another, which is as it should b With the cocks on the water column, i the lower connection becomes choke near the boiler, as is apt to occur, th cocks would be of no more value than th glass. Because unless the lower cock wa held open long enough to blow down th water in the column to a considerable extent, so that its failure to rise agai would be noticed, the existence of an trouble would not be suspected, althoug the water might be becoming dangerously low.

Of course this condition would be revealed by blowing down the water co umn by means of the blow-down valv provided for that purpose, when the fai ure of the water to rise would call attention to it. It is seldom, however, th the column is blown down more than tw or three times a day, and in the meantim considerable damage might be don Furthermore, after this condition was di covered the gage cocks on the water c umn would be of no use. As a matt of fact, the only value of a set of coc placed on the column is to indica whether the small opening between t glass and the column is clear, and th may be ascertained with equal ease a certainty by blowing down the colum

There is no reason why a ¾- or 1-in pipe cannot be tapped into the boiler sh or head for each cock, even in flush-fro settings, which would be the most troubl some to equip. In this case the pip could be tapped into the head at t proper point and carried across to a poi just to one side of the flue-door hin then through the front. Crosses and t should be used for the turns, plugging t open sides, so that the plugs can be moved and the pipes cleaned. Anoth and perhaps better plan would be to ca the pipes to the side of the flue-cap do by means of 45-degree elbows. The p ticular plan adopted would, of course, pend upon the arrangement of the boi in question and the engineer's individ preference.

M. Kennett

Webster Groves, Mo.

## Michigan State Convention of the N. A. S. E.

This convention, which was held at Bay City, July 15, 16 and 17, was the eighth annual meeting of the Michigan organization and was one of the most successful meetings as well. The citizens of Bay City took great interest in the entertainment of the visitors and did all in their power to make their stay pleasant. The convention was called to order by Everett C Wood, who called upon Rev. Charles Marvin, of the West Side Presbyterian church, for the invocation. Mayor E. E. Evans then welcomed the association to the city and later both of these gentlemen devoted their personal attention to entertaining the delegates. It is a notable circumstance that at the closing session Mayor Evans and Rev. Mr. Marvin were elected and installed as honorary members of the State N. A. S. E.

A. B. La Franier, State president, responded to the mayor and was followed by Hon. George L. Lusk, postmaster and chief engineer of the Federal building.

F. W. Raven, national secretary, then addressed the convention, after which Aaron T. Miller, State deputy, was called upon for a few remarks. The opening exercises concluded with an address by Edward G. Jacques on "The Engineer and his Relation to his Employer."

At the business sessions means for obtaining a State license law were discussed, based on the experience which the members have had in the past along these lines, and the convention pledged its hearty support of the movement for the coming year. A new license committee was appointed to take the matter in hand. Election of officers resulted as follows: A. C. Benton, Battle Creek, president; H. F. Brandau, Jackson, vice-president; E. C. Smith, Kalamazoo, secretary; W. S. Hayton, Detroit, treasurer; A. D. Sharrer, Flint, conductor; F. H. Tibado, Detroit, doorkeeper. As trustee to fill a vacancy, W. E. Fuller was chosen and John Andrews was selected trustee for three years.

On the opening evening, E. C. Adams gave an interesting exhibition of sleight-of-hand at Ridotto hall; and the following evening all went for a trolley ride to Wenonah beach, where at the Casino a vaudeville program was provided, after which many of the visitors formed a dancing party at the pavilion while others enjoyed the various side shows and other amusements. The meeting closed with a grand excursion on Saginaw bay, on the steamer "State of New York," the evening of Saturday the 17th.

Kalamazoo was selected as the place of next meeting, which will be begun on the third Thursday of July, 1910.

## Obituary

Joseph W. Thompson, inventor of the steam-engine indicator which bears the name "American-Thompson," died Thursday, July 15, at his home in Salem, O. Mr. Thompson was also the inventor of many features of the Buckeye engine, especially the valve mechanism and the automatic governor. He was associated with the Buckeye Engine Company practically all his business life. He was born December 23, 1833.

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The length of time required for the gases to pass from the coal to the heating surface probably averages considerably less than one second, a fact which shows that the gases and air must be intimately mixed when large volumes of gas are distilled, as at times of hand firing, or the gas must be distilled uniformly, as in a mechanical stoker.

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Small sizes of coal burn with less smoke than large sizes, but develop lower capacities.

DELEGATES AND VISITORS AT N. A. S. E. CONVENTION, JULY 15-17, 1909

# POWER
## AND THE ENGINEER

DEVOTED TO THE GENERATION AND
TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

John A. Hill, Pres. and Treas. Robert McKean, Sec'y.

505 Pearl Street, New York.
355 Dearborn Street, Chicago.
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of Power solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they are possessors of letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "Powpubco," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During 1908 we printed and circulated 1,856,000 copies of* Power.

*Our circulation for July, 1909, was weekly and monthly,* 141,000.

August 3.................. 42,000

*This paper reaches 42,000 separate readers each month and 33,000 each week.*

*None sent free regularly, no returns from news companies, no back numbers. Figures are* [illegible] *circulation.*

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## Steam Jets for Boiler Furnaces

It has been frequently claimed that steam blowing into a boiler furnace from a suitable nozzle will increase the combustion efficiency of the fuel on the grate. On the face of it such a claim is erroneous, for to separate a pound of steam into its elements, hydrogen and oxygen, requires the same amount of heat that is given off when a pound of steam is formed by the union of hydrogen and oxygen. Aside from this, it is a difficult matter to burn hydrogen in the average furnace and, even after the steam is decomposed, it is very likely that most of the hydrogen will escape unburned up the stack. In addition, it should not be forgotten that the amount of oxygen required to burn enough hydrogen to form a pound of water vapor is exactly the amount obtained from the dissociation of a pound of such vapor. Consequently, there would be no oxygen available from this source to burn the coal and in the end no advantage gained.

It is then evident that the only purpose for which a steam jet can be advantageously used is to mix the air and gases thoroughly and prevent the hot gases from coming in contact with the heating surface of the boiler before they are ignited. It is usually found applied to furnaces of improper design or in cases where the supply of air is too small. When not automatic in action it very frequently happens that the jets are allowed to remain on too long and, with an adjustment necessary to prevent smoke at times of firing, the tendency is to waste rather than to conserve the energy of the coal. If a certain amount of air is admitted with the steam and the jets properly regulated, it is possible to better combustion and save coal, but all things considered, steam jets are usually expensive and, as suggested by the United States Geological Survey, some form of mechanical stoker properly set under the boiler is the easiest and most satisfactory solution of the problem.

## Why Not Condense?

In many situations where water is available the horsepower of an engine may be increased and the fuel cost per horsepower-hour very materially reduced by the installation of efficient condensing apparatus. Increasing the mean effective pressure in the engine cylinder ten pounds or more at only the expense of operating a comparatively small pumping outfit presents an opportunity for economy that is too obvious to need argument. Condensing the exhaust from simple engines has been given much more attention in foreign countries than here. When Charles T. Porter had his engine on exhibition in England, in 1862, he was frequently asked: "Where is the condenser?" "How is the air pump operated?" etc. On being informed that no condenser was used with the engine, the inquirer lost all interest in the Porter-Allen engine. So marked was the lack of interest in or the disapproval of an engine lacking the essential feature of a condenser that Mr. Porter was constrained to design and build a condenser and attach it to his engine in order to get the attention to which his radical departure from previous practice in engine design and operation entitled him.

In many instances noncondensing engines are installed because of either the high cost or the difficulty attending the getting of condensing water. Where it would be profitable to run condensing if it were not for the cost of condensing water, the installation of a correctly designed cooling tower will permit the use of condensing equipment at no additional expense for water, as the amount of water needed to make up for the evaporation in the cooling tower will not exceed the saving in boiler feed water made by running the engine condensing. There are, of course, many installations where the heat in the exhaust steam is utilized to such advantage that the use of a condenser would be extremely poor practice, but there are numerous other cases where this condition does not exist and where the lack of condensing equipment is wasting money. Of course this is an old story, and it is surprising how many plant owners fail to recognize its point.

## "Do It Now" and also Well

The crisp little injunction to "do it now," which one sees hanging in almost every business place, applies to nothing more forcefully than to making repairs and adjustments in a power plant. If a gland shows suspicious indications of approaching leakiness, don't wait until steam blows through in a continuous jet; repack it at the earliest possible moment. If indicator cards suggest leaky piston rings or valve adjustments that are not quite right, lots of trouble may, and lots of waste will, be prevented by making them good immediately. When a commutator begins to look dingy or a rheostat shows a bad spark upon moving from one point to the next, don't wait until a circle of sparks surrounds the commutator or the rheostat breaks down and disables the generator.

Promptness, however, is not the sole requirement in cases of this kind. Adjustments, repairs, etc., must be attended to not only "now" but thoroughly and carefully. Temporary work and makeshifts are the curse of many a power plant and factory, and slovenly repairs are practically temporary work.

We once knew an engineer who wore out the commutator of a fine generator in seven months by repeated turning off because he was too lazy to discover that the sparking which made frequent turning off necessary was due to driving the machine far above its rated speed, so that at full load the field strength was only about eighty per cent. of what it should have been; frequent brief overloads produced a display similar to a Fourth of July pinwheel. The moral of this little situation is that it is not always enough merely to make a needed repair; the source of the trouble which made it necessary to do the repairing should be dug out and, if possible, removed.

The principal reason that most power-plant apparatus will not show anything like the same efficiency after six months of service that it did before is that it has not been kept up properly. It is, in one sense, a distinct disadvantage that a steam engine will usually keep turning over as long as the steam supply holds out. If it would lie down as soon as the piston or valves or rod packing leaked seriously, there would be fewer uneconomical steam plants.

Whatever you do, do it well; it means less work the year 'round.

## The Combustion Space of a Furnace

As the village street which afterward became the city's thoroughfare followed the trail which a wandering calf made through the woods, so boilermakers have followed the designer who put the furnace grates twenty-four inches below the boiler shell regardless of the future location of the boiler or the nature of the fuel to be used. With anthracite this distance is ample, for the short flame, even with the deepest of fires, seldom if ever reaches the comparatively cold shell of the boiler, to be extinguished and go up the chimney as smoke, with a large percentage of the inflammable gas unburned. But with bituminous coal the case is different. If a knife blade or any small piece of iron or steel is held in the flame of a lamp, smoke will be made around it and will continue as long as the piece is held in the flame, or until it becomes so hot that it can have no chilling effect on the gases that come in contact with it. If chilled below the temperature of ignition a gas flame will go out, of course, and this is just what happens when the flame from soft coal strikes the comparatively cold boiler shell, and the burning gas loaded with carbon dust and hydrocarbon vapor is chilled below the burning temperature and goes out, allowing the smoke to go up the flue instead of being burned.

Various devices for admitting air over the fire just after coaling have been tried with more or less success. They are successful, however, just in proportion as they interpose a nonconducting sheet of air between the flame and the boiler shell, preventing the cooling process from taking place and permitting the uncooled gases to burn. This, of course, reduces to some extent the amount of smoke that would otherwise be made, but it means a loss of all the heat that is used to raise the temperature of the surplus air to that of the gases with which it is mixed in passing through the combustion chamber and the boiler tubes.

If the grates could be placed at such a distance from the shell of the boiler that with the deepest of fires and the longest of flames only the completely burned gases could come in contact with the boiler, smoke would be much reduced, at least, and in many cases prevented entirely. How far to place the grates below the boiler may be a debatable point, but that it should be much more than the usual two feet is evident.

## Buying Coal

There has recently been published by the United States Geological Survey a bulletin in which are given the results of the experience of the Government in the purchase of coal under heat-unit specifications. The contractors gave the price at which coal would be furnished, also its value in B.t.u. and the percentage of ash. The several tenders were reduced to a uniform basis on the cost of one million heat units for each kind of coal, taking into consideration also the ash and heat capacity, and that coal which yielded the one million heat units for the least cost was taken as being tendered by the lowest bidder. Deductions were made from the contract price for any excess of ash or decrease in heating value, and bonuses were paid for decrease of ash and excess of heat units.

It is stated that the Government has as a result made a marked saving in its coal bill and has in many instances received a much better grade of coal than was specified in the contract, while the deductions for inferior grades more than made up for the cost of handling the extra amount of ash and the loss in heating capacity. If a businesslike way of dealing with the coal question has resulted so well for the United States Government there is no reason why it would not work equally to the advantage of the private consumer; but to the average business man coal is simply coal, and his chief anxiety in the matter is to get the amount needed for use in his plant at the lowest possible price per ton, forgetting that he may by this process be paying a great deal more for what heat he gets than he would if he bought a higher-priced coal containing less ash and water and more heat units.

As we have pointed out before, heat is what is wanted and what is paid for in the end, and ash and water are not only useless but detrimental, reducing the efficiency of the fuel and adding to the labor. The ashes have to be shoveled into the furnace with the coal and shoveled out after the combustible is burned; the water has only to be shoveled into the furnace and goes out itself, but after having used up a good percentage of the heat of the coal to convert it into vapor which goes up the chimney, taking most of its heat with it. While the heat-unit basis of purchasing coal entails the expense of making frequent analyses and determinations of heat value, the expense involved is slight compared with the benefits derived from this plan of buying.

## The Sign upon the Wall

The following was posted, typewritten, upon the wall of a plant:

"The success of a plant of this character depends so largely upon the intelligence, skill and fidelity of all the men in our employ that we cannot too urgently and seriously charge each and every man with the responsibility of his position. A little lack of attention to, or want of interest in, any one of the many details left to the care of each man will in the aggregate amount to the loss of many dollars each week. The waste or using of more oil than actually required, or of ammonia, the lack of skill and care to economize coal, attention of tankmen to see that water is not drawn too low in the forecooler, the want of minute care in holding storage temperature to the correct point; all of these items and many more will not only reflect on the character of the business, and standing with the trade, but will, at the end of the season, mean hundreds of dollars difference in the earnings of this company.

"We want to charge each and every man with the responsibility of his position, and the necessity of coöperating with the management, to the making and maintaining of our business at the high point of efficiency and economy of operating that we have always striven for; and by every man feeling a proper interest and responsibility for his work, the aggregate result will be a success by which we will all permanently benefit.

"It is the leaks and wastage, and improper operation, that has turned many a business from success to failure, and with the hearty, sincere coöperation of you all the result will be only success, and in achieving this end permanent employment and an increased value of each will result.

"Success does not depend upon any one man, but on the coöperation and intelligence of us all."

Although hand-fired furnaces can be operated without objectionable smoke, the fireman is so variable a factor that the ultimate solution of the problem depends on the mechanical stoker; in other words, the personal element must be eliminated.

# Heat Loss of the Steam-engine Cylinder

By Cornelius I. Myers

Your editorial on "Heat Loss of the Steam-engine Cylinder" takes the very words from my mouth; and the mention of a pumping-station engineer forms another coincidence.

Last fall I was watching very closely the results of preliminary tests on a 20,000,000-gallon vertical triple-expansion pumping engine, built by the Wisconsin Engine Company for the city of Milwaukee. The engine did not, at first, give the expected duty, and many experimental variations were made in the reheater and jacket connections to discover the reason. The trouble was finally located in the condenser and remedied, but in the meantime we found that as a means of increasing the economy of the engine, the reheaters in the steam receivers were of no service, the duty being practically the same whether or not they were used.

One thing, however, was noticed, and that was the separating effect of the reheating coils on the lubricating oil in the steam. The oil coming in an atomized state from the high-pressure cylinder into the first receiver was separated out and appeared in the discharge from the trap with the condensed steam from this receiver, this feature being an unfavorable one, as the oil was in exactly the state desired for the lubrication of the intermediate and low-pressure cylinders.

The effect of the steam in the jackets of the cylinders was not by any means satisfying, although the data obtained were not complete enough to be of much use. I therefore made arrangements with James Hamilton, engineer-in-charge of the North Point pumping station, to make a series of experiments sometime this summer to determine, if possible, just what effect these steam jackets had on the economy of the engine.

I have made many experiments with engines of various types, but have never yet been able to get the process of "robbing Peter to pay Paul" in a reheating receiver to give any increased efficiency to the engines, nor do I see, despite the testimony and argument of much older engineers, how the exchange of heat from one body of steam to another can increase the total heat of the two, or result in a condition of the latter body wherein it will perform more advantageously in the cylinder of the engine, especially when the latter body is not brought to a superheated state. I am equally at a loss to see why jacketing a steam cylinder with steam-jacket temperature the same as the initial temperature within the cylinder should give any increase of efficiency to that cylinder, when the condensation of the jacket steam is taken into consideration.

Let us take, for example, a cylinder covered in the most thorough manner with the best nonconducting material. The condensation per hour within the cylinder will approximate a constant number of pounds per square foot of radiating surface per degree difference between the average temperature within and without the cylinder walls during the revolutions or cycle of the engine.

Suppose we consider the high-pressure cylinder of the triple-expansion engine, having a radiating surface of 50 square feet, taking saturated steam at 150 pounds pressure, and exhausting into a receiver where the pressure is 30 pounds. The initial temperature is 365 degrees Fahrenheit, and the temperature of the exhaust steam is 274 degrees Fahrenheit, the average temperature throughout the cycle being approximately 292 degrees Fahrenheit. If the temperature of the surrounding air is 80 degrees Fahrenheit, the condensation will be the constant $C$ times $50 \times (292 - 80) = 10{,}600 \times C$.

In jacketing this cylinder we will increase the radiating surface from 10 to 15 per cent., say to 55 square feet, and the average temperature of the radiating surface will be that of steam at the initial pressure in the cylinder or 365 degrees Fahrenheit, and the condensation per hour will be $C \times 55\ (365 - 80) = 15{,}600 \times C$, or 47 *per cent.* more than in the first case. How this second condition benefits the engine I cannot see, for the radiation is greater and the heat given up to the steam in the cylinder takes an equal number of heat units from the steam in the jacket, and the heat transferred to the steam jackets takes place during the exhaust stroke as well as the working stroke. If we also jacket the intermediate and low-pressure cylinders, as has been the general custom, the result in the low-pressure jacket will be to give up practically half of this effect to the steam exhausted into the condenser, not only wasting that amount of heat, but giving the condenser more work to do to maintain the vacuum.

Steam is relatively a good conductor of heat, as was recognized when engine builders separated the exhaust passage from the barrel in the design of the steam-engine cylinder. This is also demonstrated by the fact that in a pumping engine such as I have mentioned sometimes as much as 10 per cent. of the total condensed steam comes from the jackets and reheaters.

"Dead" air is an excellent nonconductor of heat, and a partial or perfect vacuum is still better. Provided there is no current of air or vapor moving through the jacket of the steam cylinder, a vacuum in the jacket space should give very marked results, and I hope within a short time to be able to give figures showing the exact merit of the application of this idea to the Corliss engine.

# Meeting of the Ohio Electric Light Association

The fifteenth annual convention of the Ohio Electric Light Association opened at the Boody house, Toledo, O., July 13, and continued for the following two days, after which headquarters were transferred to "The Breakers," at Cedar Point, O., where the meeting ended on the 16th with a banquet and grand ball at the Coliseum. Mayor Brand Whitlock of Toledo welcomed the convention, which was presided over by Past President W. P. Engle, in the absence of President C. R. McKay, formerly of Toledo, but who had removed from the State. During the sessions, papers were read on many subjects pertaining to the operation of lighting plants, with special reference to the development in economical means of lighting and methods of handling the situation which has been brought about by this development.

Of the papers bearing directly on power-house operation, "Boiler Room Economies," by N. B. Ayers, was of interest as outlining simple common-sense methods of improving the efficiency of the boiler room.

"Engine Room Management," by C. R. Brosius, explained how power-house operations could be systematized to bring up the general efficiency. The question of records was also taken up and illustrated by diagrams and reproductions of actual record sheets in a large power plant and many suggestions for instituting such a system in other plants were given. Other papers read at the convention were as follows:

"Report on the Titanium Carbide Arc Lamp," by C. R. McKay.

"Residence Lighting in Detroit," by F. T. Mather.

"Plans to be Followed in Supplying Lamps to Consumers," by J. C. Rothery.

"The Commercial Organization of Electric Light Companies and their Relation to the Public," by C. C. Custer.

"Factors that Should be Considered in Making Street Lighting Contracts," by Samuel Rust.

The entertainment features of the program were elaborate and included a banquet and theater party at the Casino on Tuesday evening, a trip to Toledo beach Wednesday, followed by a six o'clock frog-leg and chicken dinner, with a grand ball, and vaudeville stunts by the amusement committee.

The most pretentious excursion of all, however, occurred Thursday afternoon, when the entire convention left on special cars for Sandusky and Cedar Point, where, after the festivities, the meeting adjourned to assemble next year at a point selected by the advisory committee.

Officers for the ensuing year are J. C. Rothery, East Liverpool, O., president; E. H. Beil, Youngstown, O., vice-president; and D. L. Gaskill, Greenville, O., secretary-treasurer.

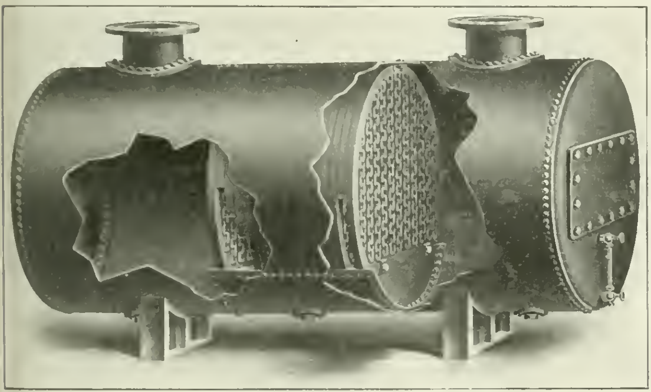
# Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

## "Utility" Oil Separator

The "Utility" oil separator is manufactured by The Standard Steam Specialty Company, 542 and 544 West Broadway, New York City. In operation, the exhaust steam entering the separator is greatly expanded in volume and reduced in velocity and the course of the steam changed in direction before passing hrough the large impinging area of the



THE "UTILITY" OIL SEPARATOR

emovable wrought-iron chain and baffles. hese baffles are arranged so as completely to separate the steam flow and ve a free area of such capacity that no k pressure is created, it is claimed.

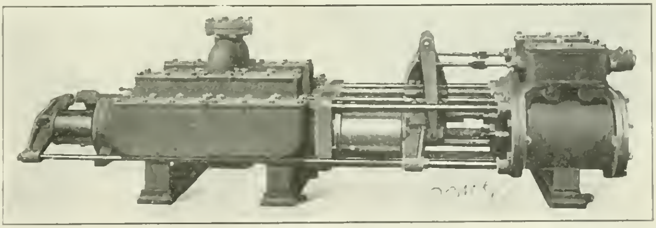
The separated oil is precipitated by ravity, in an opposite direction to the ow of the steam, into the large oily rip chamber, from which, together with e drip of the expansion chambers, it discharged by means of a trap.

It is stated that with this principal of il separation the baffles never require moving for cleaning purposes, and are f such area that the first few take out l of the oil, and the remaining ones do ot show any trace of oil. The maker uarantees that every drop of condensaon beyond the outlet point may be rerned to the boilers absolutely free from il

This oil separator is suitable for use in nnection with vacuum-heating systems r keeping the thermo valves free from l and accumulated grit; also for use under vacuum conditions and between reciprocating engines and low-pressure turbines, and in refrigerating plants.

## An End Packed Pump

The illustration shows a type of pump not only designed for general use with high pressures, but specified for boiler feeding and similar work at pressures of from 125 to 300 pounds per square inch.



END-PACKED PUMP

As all packing glands are external, breakage is at once detected and stopped. Because of the convenience of packing the percentage of "slip" is reduced.

For boiler feeding the proportions between the steam piston and water plunger are about the same as in a packed piston pump, for the same pressure, but the design of the end-packed water end is said to be better able to withstand the expansion and contraction and continual train than the packed piston water box. The valve-chamber covers are arranged for reaching the valves quickly and in a convenient manner. The plungers being held rigidly in line by the side tie rods and supported by long bronze-lined stuffing-box throats, there is said to be no perceptible wear on the packing. Large glands are provided so as to obtain long service with no packing troubles.

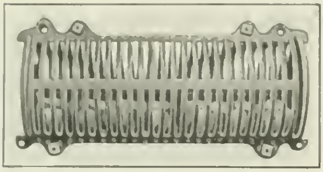
The valve motion is operated by steel levers working in the crosshead slides. The steam-valve rods are provided with nuts for adjustment and accurate setting, and steam cylinders of 12-inch stroke are fitted with suitable cushion ports and regulating valves to give as smooth operation as possible. This pump is made by the Buffalo Steam Pump Company, Buffalo, N. Y.

## Another Metal Boiler Cleaner

If hanging a cast-iron cage full of metal balls in a steam boiler will clean off all the old scale, prevent the formation of new, stop corrosion and pitting, take out the scum and keep the water and the surfaces clean and pure, the discovery of that fact will be a bigger boon to steam engineers than the invention of the compound engine or the development of the superheater.

We do not believe that all the troubles due to impure feed water can be so easily side-tracked. We do not know of any explanation, chemical, electrical or mechanical, why any metal suspended in boiler water should neutralize its chemical characteristics and render it an ideal boiler feed; but so many things work, as Professor Sweet says, that ought not to work, and so many things that ought to work don't work, that one is not warranted in positive predomination where natural laws are not actually contravened.

The Connecticut Metal Boiler Cleaner Company, First National Bank building, New Haven, is making the device shown in the accompanying engraving. It is a cast-iron container for balls of a metal

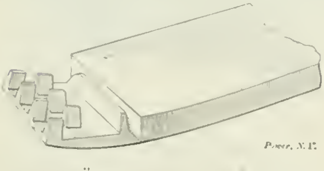


NEW METAL BOILER CLEANER

the composition of which is not revealed. They will put it into your boiler and you can watch it work and pay for it if it does what they claim. There does not seem to be much risk in such a proposition, and if it is found to do more than a slab or two of zinc would suspended in the same way, it may be worth the price. There was a similar device upon the market for a short time eight or ten years ago; a cylinderful of plates of a mysterious alloy through which the hot water was pumped to the boiler. It was backed up by numerous and enthusiastic testimonials and indorsements. If it would have done what was claimed for it, there would not be a boiler running today without one on; but the very memory of the thing was so dead that it needed this recurrence to recall it.

## "Fansher" Belt Fastener

The illustration plainly shows the construction of the "Fansher" belt fastener, made by Fansher Brothers, 18 to 24 Benton street, Dayton, O. It consists of a metal piece of a width corresponding to the belt on which it is to be applied, having peculiarly shaped projecting teeth designed to hold securely the two ends of the belt together. It is readily applied,



"FANSHER" FASTENER ATTACHED TO BELT

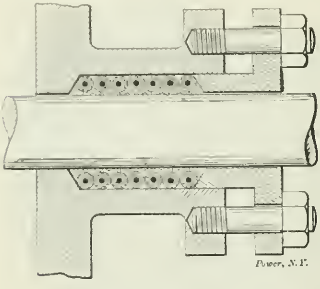
can be easily removed, and in service is said not to tear, stretch or let the ends of the belt sag out of alinement.

The illustration shows the manner of application. Being made of metal the fastener is durable and it is claimed that it tends to prolong the life of the belt.

## "A. M. C." Elastic Metallic Packing

The "A. M. C." elastic metallic packing is suitable for steam, air, ammonia and water. It is manufactured by the Morigreve Engineering Company, 100 William street, New York City. This packing is made up of a series of rings of antifriction metal accurately fitted to rods and backed up with specially prepared fibrous packing which, being resilient, holds the metal to the rod and allows considerable movement on the rod, should it be out of alinement. The fibrous packing not being exposed to wear will last indefinitely, it is claimed, retaining its compressibility, and will keep the metal rings steam-tight to the rod. The packing as applied to a piston rod is shown in the illustration.

It is claimed that for pump use this packing will work at 180 pounds pressure and a variation in temperature of from 70 degrees to 140 degrees; also, it cannot burn out, is not affected by change of temperature and will not leak, even on starting a cold engine. Further than this, it is claimed to be perfectly elastic and equal in this respect to fibrous packing. It is made of the best antifriction metal.

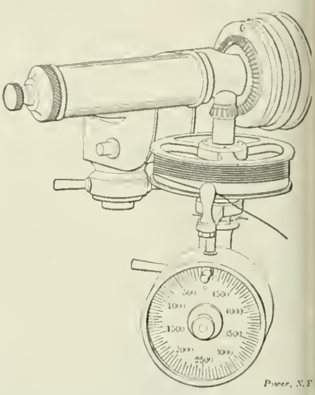


"A. M. C." PACKING IN STUFFING BOX

## Crosby Reducing Wheel with Recording Counter

A reducing wheel with a recording counter for determining the number of revolutions of an engine per minute has recently been got out by the Crosby Steam Gage and Valve Company, 97 Oliver street, Boston, Mass. The illustration shows the device with the recording indicator attached. The latter is actuated by the moving parts of the reducing wheel, and records on a chart every revolution of the engine; so that during the taking of the diagram by the indicator attached to the reducing wheel the revolutions of the engine are recorded simultaneously.

Its capacity to record 5000 revolutions per minute permits its being used during a considerable period for indicating work and the average number per minute s determined is more accurate for such pur pose than if the revolutions were merel counted intermittently by the ordinar speed instrument. Another feature is th fact that the record charts can be pre

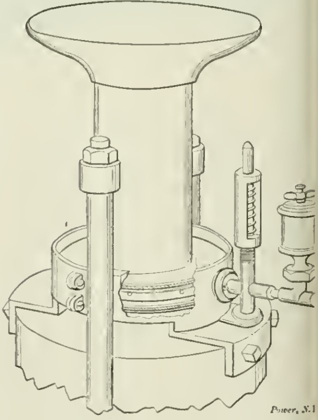


CROSBY REDUCING WHEEL AND RECORDING COUNTER

served and filed with the diagrams take by the indicator.

## "Sterling" Automatic Lubricator

The accompanying illustration show the "Sterling" automatic lubricator as a plied to the plunger of a hydraulic el vator. The grease, or lubricant, is force into the grease lantern when the elevat



"STERLING" AUTOMATIC LUBRICATOR

is at the extreme end of the down run an resting on the bumpers. The lantern a fit on the plunger rod and floats with i

It is simple in construction, has nothin to get out of order and, requiring n special tools to attach, it can be put o by anyone. It is also claimed that it wi not rust or pit the rod, but will sa acking, and will feed only when the levator is in motion; also, that it will leposit the grease on all parts of the rod equally at all times.

It is a forced feed and is adjustable and ntirely automatic in operation, and designed to feed any kind of grease without lashing, spattering or waste. This lubricator is manufactured by Germain Hogan, Troy, N. Y.

## The Venturi Meter in Power House Work

The Venturi meter was invented in 887, by Clemens Herschel, Mem. Am. Civil Eng. and Mem. Inst. Civil , for measuring water in large quan- s for hydraulic companies, water rks, etc. The large amounts of water in the modern central station, upon and, and the development of the eter in smaller sizes and capacities, upon ther, have led to its extensive use in wer-house work, and it will be well for steam engineer who has not already to acquaint himself with its riciples and possibilities.

When the water in a pipe is standing ill, the pressure will be the same roughout the length of the pipe for the me level. When the column of water is t into motion, a part of the pressure is anged into velocity, but the sum of the isting pressure and the pressure necessary to produce the velocity at that int will be constant, friction neglected r any point in the same horizontal plane. Venturi, in 1791, observed that when uid or gases discharge through a conted throat, as in Fig. 1, there is a sucn at the small diameter, diminishing as diameter increases on the delivery le. The lesser pressure at this point is e to the conversion of static pressure velocity. The water would not inse in velocity enough to discharge the me quantity through the restricted passe in the same time that it flowed rough the larger pipe without a conderable difference in head between the nt where the diameter was largest and e velocity began to increase, and the roat where the velocity is highest. This fference can only be produced by a fall the pressure at the throat, and it was is diminution of the pressure below that the atmosphere that Venturi observed his Modern experiments.

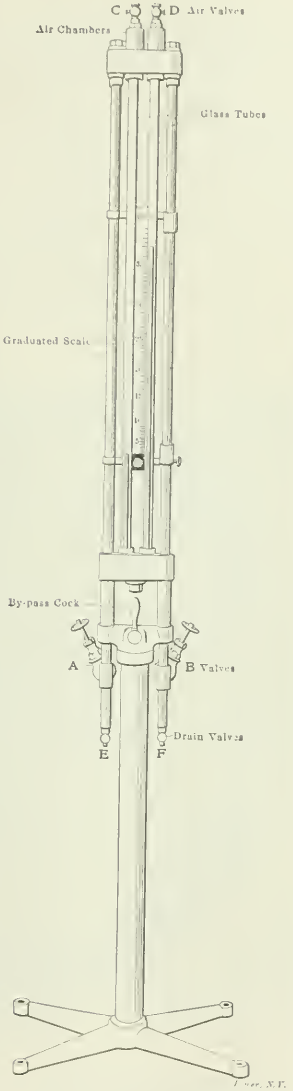


FIG. 2. VENTURI MANOMETER

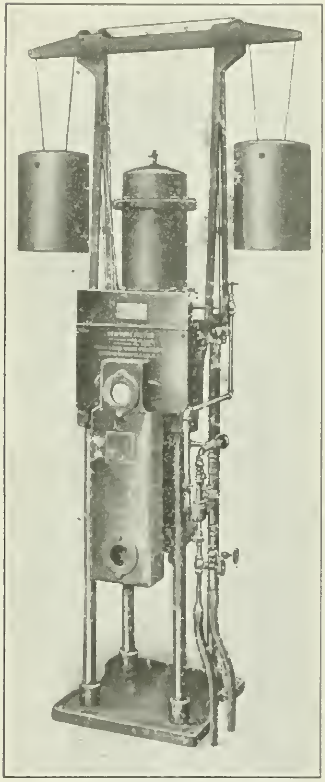


FIG. 3. TYPE D REGISTER FOR VENTURI METER

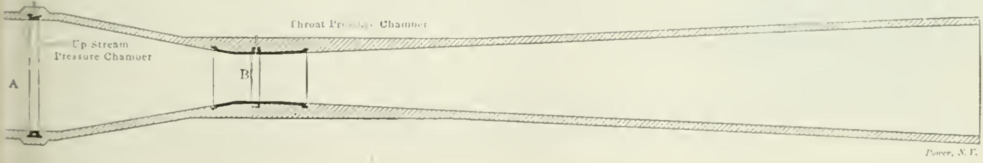


FIG. 1

Mr. Herschel, when hydraulic engineer of the Holyoke Water Power Company, was in need of some method of measuring the water taken from the canal for manufacturing purposes, and thinking that he could find some useful relation between reduction of pressure at the throat and the velocity and hence the quantity of water passing, constructed, in 1887, a one-foot and a nine foot meter embodying this idea, and which for that reason he named the Venturi meter.

At *A*, Fig. 1, the pipe is of the full diameter, at *B* it is reduced to the throat, giving, for a short parallel-walled section, a restricted area requiring the water to move with a considerably increased velocity. Beyond the throat the tube enlarges gradually according to the shape which Francis in his "Lowell Hydraulic Experiments" had determined would give the maximum discharge under a given head and, inversely, would cause the least loss of head with a given discharge, and as the velocity is thus gradually reduced, the velocity head is changed back to pressure head, and there is no change in condition either of velocity or pressure when the normal diameter has been recovered except the slightest loss of head due to friction through the instrument.

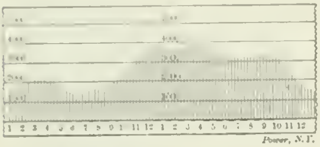


FIG. 4

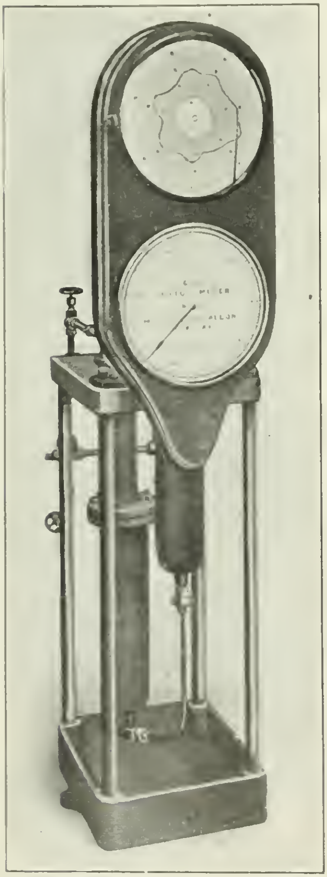


FIG. 5. COMBINED INDICATOR AND CHART RECORDER FOR VENTURI METER

It was found that the differential pressure between the points *A* and *B* was very closely proportional to the square root of the velocity, and thus available as a measure of that velocity and of the volume discharged.

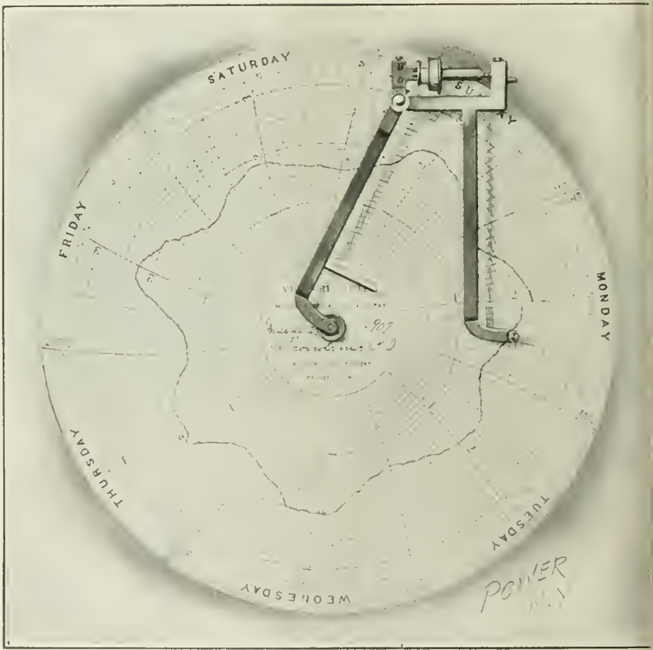


FIG. 6. SPECIAL PLANIMETER FOR CHART RECORDS.

The difference in pressure may be simply indicated by the use of the manometer shown in Fig. 2, which is virtually no more than a mercury U-tube with a scale graduated to read directly in "gallons per minute," or other desired units. The outlet controlled by the valve *A* is connected to the up-stream pressure chamber of the Venturi tube and communicates the pressure existing there to the top of the left-hand column of mercury, while the valve *B* is similarly connected to the chamber at the throat of the meter, the pressure existing in which is communicated to the top of the right-hand column of mercury. The difference in pressure is directly indicated by the difference in the hights of the two columns, and the scale, the zero of which is set to the level of the lower column, is graduated on one side for the medium and low velocities and on the other for the high velocities. By reason of its portability one of these instruments may be used to measure the flow through many meters, and upon meters of various sizes, by making a correction for the differences in throat area.

But to serve the purpose of a meter for power-house work, the supply of water to boilers, condensers, etc., the apparatus must be capable of recording as well as of indicating the rate of flow and quantity passed. Several devices have been evolved for this purpose. Fig. 3 shows the type *D* register, as made by the Builders Iron Foundry, of Providence, R. I
the American manufacturer of the mete
The clock and recording mechanism ar
operated by weights, and the record a
pears in million gallons on the simpl
counter just above the clock. The o
erating mechanism is controlled by floa
in two chambers, the level of the wate
in which depends upon the pressure
the chamber of the meter to which it
connected. One float is thus controlle
by the throat and the other by the pip
pressure, and the difference in their pos
tion is made by a simple mechanical a
rangement to control the register. If
is desired to record at the same time th
variation of the rate of flow an attach
ment can be added which will make record like Fig. 4. The hight of th
closely-ruled verticals, which are in re
ink on the chart, is proportional to th
rate of flow at the time that they wer
drawn. This chart shows how the de
mand varies from hour to hour, the max
mum and minimum, extraordinary call
upon the supply, etc.

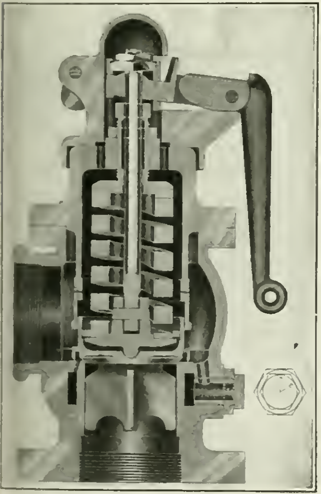
A combined indicator and recorder, als
furnished by the Builders Iron Foundr
is shown in Fig. 5. The two water cham
bers containing the floats show betwee
the columns of the frame, the lower di
indicates the rate of flow in the desire
units, while above is a circular cha
recorder upon which the rate of flow
recorded, making a diagram as shown.
special planimeter, Fig. 6, is furnished fo

measuring these diagrams, and it is necessary only to multiply the reading obtained by running the stylus of the planimeter around the line of the diagrams by a constant depending upon the size of the meter tube and the scale of the chart to get the total quantity discharged in the time required to make the diagram.

These meters are made in sizes as small as two inches, with a minimum capacity of 4000 gallons in 24 hours, up to practically any size desired, and many have been installed for measuring water for power-plant purposes which they do, irrespective of temperature, with an accuracy rivaling that with which the water could be actually weiged.

## Ashton Lock-up Pop Safety Valve

Herewith is illustrated the Ashton improved lock-up pop safety valve, designed to conform with the latest revised laws of Massachusetts. It is made by the Ashton Valve Company, 271 Franklin street, Boston, Mass., and is particularly adapted for boilers for mills, factories, electric-light and power plants, pumping stations, etc. This valve is made with a compound lifting attachment capable of raising the valve part off the seat one-eighth the diameter of the valve opening. The seat is beveled at an angle of 45 degrees. The valve is provided with a long spring of Jessop's Sheffield steel which is incased to protect it from the steam and prevent back pressure. It has a spherical or ball-bearing pressure screw and bottom spring disk. The inlet and outlet connections are full size.

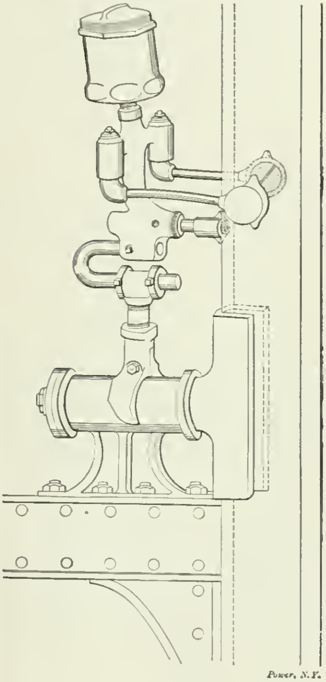


ASHTON LOCK-UP POP SAFETY VALVE

Other Ashton features embodied in the valve are the knife-edge pop lip, which wears evenly with the seat, and an outside screw-plug pop regulator, which affords quick and ready means of adjustment of pop while pressure is on the boiler and without taking the valve apart. The working parts are of high-grade steam metal.

## "Parks" Automatic Elevator Guide Lubricator

A device for automatically lubricating the guides of elevators is found in the Parks nonfriction automatic elevator-guide lubricator. The device consists of an air-compression grease cup with suitable attachments for conducting the lubricant to three surfaces of the guide at the same time; that is, both sides and the edge. The grease cup is filled with grease and the cap of the cup screws down and becomes perfectly air-tight, the joint being sealed in grease. This compresses air in the top of the cup, and as the cap is screwed down the compressed air therein forces the grease out through the three separate grease tubes to the wipers, which are provided with slots as shown, through which the grease emerges and is automatically applied to the sides and faces of the elevator guides.



"PARKS" LUBRICATOR FOR ELEVATOR GUIDES

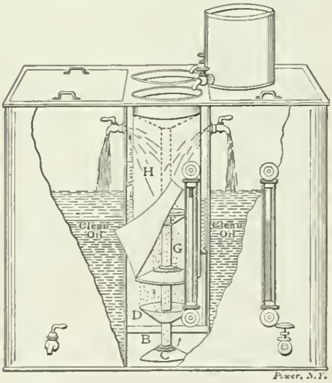
These distributors are fitted with special fiber washers, in which the grease slots are cut, which will withstand a large amount of wear before it is necessary for them to be renewed. As soon as the car stops the feeding of the grease stops, and owing to the constant application of a small amount of grease to the guides of the elevator they are constantly kept well lubricated, although no grease is wasted to be thrown on the walls of the elevator shaft.

This device is easily attached to any elevator car, regardless of make, and as there is nothing to get out of order it makes a simple automatic lubricator. It is manufactured by the Special Equipment Manufacturing Company, 45 West Thirty-fourth street, New York City.

## Sims Duplex Oil Filter

A type of duplex oil filter, built by the Sims Company, Erie, Penn., is illustrated and described herewith. The interior structure of the filtering section consists of two tanks, each containing a tube having attached to it cone deflectors. Connected to the bottom of the tank is a coarse-meshed wire-screen cylinder, covered with suitable filtering material, shown at *H*, through which the oil must pass on its way to the clean-oil section. Inside of the tank on top of the filter, is a perforated bucket in which the dirty oil is poured and from which it drains to the filtering cylinders. The operation of the filter is as follows:

The filtering section is filled with water to the point indicated in the illustration and marked on the filter. Then the oil to be filtered is poured into the top tank to remove the coarse impurities, and the oil then descends to the cone *C*. Next it ascends through the perforations and gathers on the cone *D*. Leaving this, it gathers on the inside of cone *G*, the diameter of which is greater than that of *D*, and leaving through the perforations it gathers on the cone *F* and ascends into the body of oil floating on the surface of the water. The oil is distributed in a thin film over a large surface as it passes upward through the water, thus giving a better opportunity for washing.



SIMS DUPLEX OIL FILTER

# Inquiries

*Questions are not answered unless they are of general interest, and are accompanied by the name and address of the inquirer.*

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*Amount of Free Air Required to Burn Coal.*

Assuming that 1⅔ times the theoretical quantity of air is used to burn a given quantity of fuel, how many cubic feet of air would be required to burn 100 pounds of coal having the following composition: Hydrogen, 6 per cent.; carbon, 88 per cent.; oxygen, 3 per cent.; ash, 3 per cent.?

L. P. D.

When hydrogen burns to form water vapor, the formula of water is $H_2O$, and as the atomic weight of hydrogen is 1 and of oxygen 16, the water formed will be in the proportion of 2 pounds of hydrogen to 16 pounds of oxygen, or in other words, 1 pound of hydrogen will require 8 pounds of oxygen for its complete combustion, forming 9 pounds of water. To burn carbon to carbon dioxide, $CO_2$, the atomic weight of carbon being 12, 12 pounds of carbon will require 32 pounds of oxygen, or 1 pound of carbon will require 2.66 pounds of oxygen for its complete combustion to carbon dioxide.

From the analysis of the combustible, or rather of the fuel, we have in every 100 pounds of fuel 6 pounds of hydrogen, 88 pounds of carbon and 3 pounds of oxygen. The ash, of course, does not enter into the combustion. To burn the 6 pounds of hydrogen according to the figures already given we have 6 × 8, or 48 pounds of oxygen required. To burn the 88 pounds of carbon we have 88 × 2.66, or 234 pounds of oxygen required. The sum of these two quantities is 282 pounds of oxygen. If the combustible itself contains 3 pounds of oxygen to every 100 pounds of fuel, this goes to help the combustion and consequently the oxygen does not have to come from the atmosphere. Therefore, we may deduct this quantity from the total quantity of oxygen required, leaving a net amount of 279 pounds of oxygen required to burn this fuel.

The problem states that 1⅔ times the theoretical quantity of air or oxygen will be required. Consequently, multiplying 279 pounds of oxygen by 1.66 we have 465 pounds of oxygen required. As the atmospheric air is only 23 per cent. by weight of oxygen, this 465 pounds of oxygen will represent only 23 per cent. of the weight of air required to burn the fuel. Consequently, dividing 465 by 23 and multiplying by 100 we have 2020 pounds of air required to burn the fuel in question.

As atmospheric air at 60 degrees Fahrenheit occupies 13.1 cubic feet per pound, this 2020 pounds of air will occupy a space of 2020 × 13.1 or 26,500 cubic feet of space. This is the quantity of free air at 60 degrees Fahrenheit required to burn the fuel in question when it is assumed that 1⅔ times the theoretical quantity of air will be required.

*Temperature of Air Discharged from a Dry-vacuum Pump.*

Will you inform me what the temperature of air is at discharge from a dry-vacuum pump connected to a surface condenser working under a vacuum of 20 inches? Also, please give the formula for calculating the same.

W. H. L.

All of the energy applied to compression will appear as heat in the compressed air unless it is given up to the containing walls or otherwise abstracted. Assume the process to take place without such transference, the final temperature $T_2$ will be:

$$T_2 = T_1\left(\frac{P_2}{P_1}\right)^{0.29},$$

where pressures and temperatures are all absolute and the subscripts *1* and *2* refer, respectively, to the initial and the final conditions. Assume that for your case

$P_1$ = Pressure in condenser,

$P_2$ = Discharge pressure of air pump,

$T_1$ = 95 + 460 = 555 degrees.

The temperature corresponding to 28 inches is 100 degrees, and the temperature of the condenser is that corresponding to steam of a somewhat lower pressure, as the pressure in the condenser is the pressure of the steam plus that of the air. Substituting these values:

$$T_2 = 555\left(\frac{15}{1}\right)^{0.29}.$$

That is, the desired absolute temperature equals 555 times the 0.29 power of 15.

The logarithm of 15 multiplied by 0.29 will be the logarithm of the 0.29 power of 15. Adding the logarithms of two quantities gives the logarithm of their product.

*log* 15 = 1.1760913
0.29

*log* $15^{0.29}$ = 0.3410665
*log* 555 2.7442930

*log* 555 × $15^{0.29}$ = 3.0853595
*nearest in table* = 0.0853619 = 1217 — *abs. temp.*
460

757 = *temp. Fahr.*

The temperature will be something less than this on account of the transference of heat to the cylinder walls, and of the application of heat to the evaporation of suspended moisture with which the air is liable to be charged.

*Steaming Out Absorption Machines.*

What is it best to do in regard to steaming out an absorption machine, to expel the air before charging with ammonia, after repairs have been made and the machine overhauled? What would be the advantage of pumping a vacuum on the machine before charging?

B. I. J.

After overhauling absorption systems it has been customary simply to fill the generators with water, which is heated up by turning steam into the coils, as is done under the usual conditions of operation. The steam from the water is then allowed to pass through the different parts of the compression side of the system, driving the air before it, after which the generator may be given its charge of ammonia as usual.

We do not think it advisable to endeavor to expel the air from the expansion side by steam. As a matter of fact, we do not believe that it is necessary to adopt any measures for the expulsion of this air except the usual one of "purging" after the system is put in operation. We assume that your absorber is provided with the customary purger valve, which will enable you to blow off any air present in the low-pressure side of the system after the system has been put in operation.

In compression systems a vacuum is pumped on the high and low-pressure sides in order to reduce the amount of air remaining in the system. The remainder of the air is then purged from the condenser after the system is put in operation, or, in some cases, the air is driven out of the local parts of the system by opening appropriate ammonia valves and allowing a flood of ammonia to expel the air, just as is done by the steam in the case of the high-pressure side of absorption systems. We do not think it is necessary to go to the trouble of employing the vacuum in exhausting the air from absorption systems.

*Requisite Weight of Safety-valve Ball.*

The area of a safety valve is 10 square inches and its weight is 14 pounds. The weight of the lever is 22 pounds, and the center of gravity is 28 inches from the fulcrum. The length of the lever is 40 inches, the distance from fulcrum to the point of attachment to the valve is 4 inches. What will be the weight of the ball that just balances a pressure of 90 pounds if the ball is placed at the end of the lever?

F. L. J.

The solution of this problem is simply a matter of equating all the moments tending to hold the valve down on its seat to all moments tending to lift it off its seat. Then the moments tending to hold the valve down are *W* (weight of the ball) times its distance to the fulcrum (40 inches) plus the weight of the lever (22 pounds) times its distance to the fulcrum (28 inches) plus the weight of the valve (14 pounds) times its distance to the fulcrum (4 inches), which must equal the moment of the steam tending to raise the valve, or 90 pounds × 10 square inches × 4 inches (the distance to the fulcrum). Solving this equation and solving for *W*, the weight of the ball, we find that this weight is 73.2 pounds required to hold the valve down upon its seat.

# Book Reviews

**Steam Turbines.** Compiled and written by Hubert E. Collins. Published by The Hill Publishing Company, New York and London, 1909. Cloth; 180 pages, 4¾x7 inches, illustrated. Price, $1.

This is the tenth of the series of useful Power handbooks. It is intended to be helpful to the engineer who wishes to inform himself quickly and easily about steam turbines. It is essentially practic and uptodate. It is a compact manual or ok of instruction for the operation and djustment of the principal types of steam turbine. There are eight chapters under the following headings: "Curtis Steam Turbine in Practice," "Setting the Valves of the Curtis Turbine," "Allis-halmers Steam Turbine," "Westingouse Parsons Turbine," "Proper Meth- of Testing a Steam Turbine," "Testing a Steam Turbine," "Auxiliaries for Steam Turbines," "Trouble with Steam Turine Auxiliaries." Some of the subject natter has been published in Power; the est was especially prepared, with the aid f the manufacturers. The work cannot ail to be of value to any engineer who ossesses it.

**The Theory of Electric Cables and Networks.** By Alexander Russell. Published by D. Van Nostrand Company, New York, 1909. Cloth; 274 pages, 6x9 inches; 71 illustrations. Price, $3.

We had supposed that every manner f treatment of the theory of electrical nductors had been employed, until the ceipt of Dr. Russell's masterly work monstrated that the most scholarly exsition of the subject was heretofore ssing. From Chapter I, on fundamental rinciples, to Chapter XII, on lightning nductors, the lucidity and crisp conseness of the author's style evoke connuous admiration. The scope includes nductivity, insulativity, planning netrks, total insulation of networks and interior wiring, locating faults in netrks, dielectric strength of insulating terials, the heating of cables and gradg of their insulation, lightning "arsters," which the author felicitously rms electrical safety valves; and the o subjects previously mentioned.

The book is one to delight men of the nnelly and Mailloux types, but the thematics in it will probably bar its e by the ordinary contractor and tral-station construction superintendent.

**The Smokeless Combustion of Coal in Boiler Plants; with a chapter on Central Heating Plants.** By D. T. Randall and H. W. Weeks. Bulletin No. 373 of the United States Geological Survey, Washington, D. C. Paper; 188 pages, 6x9 inches; illustrated. Free on application.

Some time ago the United States Geological Survey issued a preliminary report on smoke abatement (Bulletin No. 334), treating the subject from the theoretical point of view, detailing the steps that are now being taken to stop the evil and showing the possibilities of a clean city. The present bulletin shows from the examination of a large number of plants and the study in detail of a large number of cases that bituminous coals high in volatile matter can be burned without smoke, and that variable loads can be carried by stations burning such coals without making smoke to an objectionable extent. It gives a detailed discussion of numerous tests made at the steaming station of the United States Geological Survey's testing plants at St. Louis and at Norfolk, Va., deals with the equipment of particular boiler plants which have been found to be burning coal without smoke and with the essentials of good furnace design in various parts of the country. Some of the conclusions drawn from the tests at the Survey's own stations are that:

A well-designed and operated furnace will burn many coals without smoke up to a certain number of pounds per hour, the rates varying with different coals, depending on their chemical composition. If more than this amount is burned, the efficiency will decrease and smoke will be made, owing to the lack of furnace capacity to supply air and mixed gases.

High volatile matter in the coal gives low efficiency and, *vice versa*, the highest efficiency was obtained when the furnace was run at low capacity. When the furnace was forced, the efficiency decreased.

With a hand-fired furnace, the best results were obtained when firing was done most frequently with the smallest charge.

Small sizes of coal burned with less smoke than large sizes, but developed lower capacity.

Peat, lignite and subbituminous coal burned readily in the type of tiled-roof furnace used and developed the rated capacity with practically no smoke.

Coals which smoked badly gave efficiencies of from 3 to 5 per cent. less than the coals burning with little smoke.

Briquets were found to be an excellent form for using slack coal in a hand-fired plant. They can be burned at a fairly rapid rate of combustion with good efficiency and with practically no smoke. High-volatile coals when briquetted are, perhaps, as valuable as low-volatile coals when not briquetted.

A comparison of tests on the same coal washed and unwashed, shows that under the same conditions washed coal burns much more rapidly than the raw coals, thus developing high rated capacities. In the average hand-fired furnace, washed coal burns with lower efficiency and makes more smoke than raw coal. However, washed coal offers a means of running at high capacity with good efficiency in a well designed furnace.

Forced draft will not burn coal any more efficiently than natural draft. It supplied enough air for high rates of combustion, but as the capacity of the boiler increased, the efficiency decreased and the percentage of black smoke increased.

Most coals that do not clinker excessively can be burned with from 1 to 5 per cent. greater efficiency and with a smaller percentage of black smoke on a rocking grate than on a flat grate.

Air admitted freely at firing and for a short period thereafter increases efficiency and reduces smoke.

As the CO in the flue gas increases, the black smoke increases. The percentage of CO in the flue gas is therefore in general a good guide to efficient operation. However, owing to the difficulty of determining this factor, combustion cannot be regulated by it.

The simplest guide to good operation is pounds of coal burned per square foot of grate surface per hour.

The work then goes on to consider in detail representative boiler plants burning coal without smoke, dividing them into plants with mechanical stokers and hand-fired plants. This is followed by some observations at the Survey's fuel-testing plants; a chapter comparing methods of supplying air for combustion and another upon central heating stations. Copies of the bulletin may be obtained by applying to the United States Geological Survey at Washington, and it contains more and better information upon the subject than many books for which a considerable charge is made.

# Books Received

"The Design and Construction of Induction Coils." By A. Frederick Collins. Munn & Co., New York. Cloth; 272 pages, 5¾x9 inches; 160 illustrations; tables; indexed. Price, $3.

"Internal Combustion Engines." By William M. Hogle. McGraw Publishing Company, New York. Cloth; 256 pages, 5½x8½ inches; 106 illustrations; tables; indexed. Price, $3.

"Practical Alternating Currents." By Charles F. Smith. The Scientific Publishing Company, Manchester, England. Cloth; 461 pages, 5½x8½ inches, 235 illustrations; indexed. Price, six shillings.

"Practical Testing of Gas and Gas Meters." By C. H. Stone. John Wiley & Sons, New York. Cloth; 337 pages, 5½x9 inches; 51 illustrations; tables; indexed. Price, $3.50.

"Electric Railway Power Stations." By Calvin F. Swingle. Frederick J. Drake & Co., Chicago, Ill. Cloth; 718 pages, 5x7½ inches; 368 illustrations; tables; indexed. Price, $2.

# Business Items

Some very neat and attractive circulars are being distributed by the Trimont Manufacturing Company, 55 Amory street, Roxbury, Mass. They illustrate and describe their pipe cutters, pipe wrenches, chain wrenches, basin wrenches, etc., giving sizes and other information.

David H. Cuyler, late New England manager of the Johnson Service Company, of Milwaukee, Wis., has associated himself with the F. W. Foster Manufacturing Company, 97 and 99 Haverhill street, Boston, Mass., and will handle its line of steam and water specialties in New England.

The York Manufacturing Company, York, Penn., manufacturers of ice-making and refrigerating machinery, have closed thirty-nine recent contracts, aggregating six hundred and ten tons of refrigeration. The machines included in the above orders range in capacity from two to ninety tons.

Ray D. Lillibridge announces the removal of his office to 100 Broadway, New York City, suite 20, 21 and 22, eleventh floor. He also announces that he has taken into partnership William L. Rickard, but the business [illegible] of technical publicity) will continue to be conducted under the style of Ray D. Lillibridge.

The Government recently placed an order with the Foos Gas Engine Company, of Springfield, Ohio, for six of [illegible] vertical engines to be used in the operation of locks on the Ohio river. The locks are operated [illegible] air, the four engines for driving the compressors being 100-horsepower each, and the smaller [illegible] used for auxiliary apparatus. The engines specified are the regular Foos vertical [illegible]-cylinder single-acting engines, using natural gas for fuel. The power requirements will be very exacting, and the reliability of the engines installed must be beyond question.

"Twenty-five Years of Rope Driving" is the title of a new book, 9x12 inches, 1[illegible] pages, published by the Dodge Manufacturing Company, Station G-10, Mishawaka, Ind. It reviews the development of the American system of rope transmission from its in[illegible]tion [illegible] to the present time. The book contains valuable information for the mechanical engineer and power user generally. It is profusely illustrated with views of actual installations, and also contains numerous line drawings showing the designs and arrangements of the drives. A copy of this very handsome book will be sent free to any manager, superintendent or engineer who is interested in the mechanical transmission of power.

On account of the great increase in the fan and blower business of the B. F. Sturtevant Company, it has been found necessary to enlarge its capital to handle the increased business. The capital has been increased from $500,000 to $2,500,000. The corporation is organized under Massachusetts laws with $1,250,000 six per cent. cumulative preferred stock and $1,250,000 of common stock, and the stock has all been taken by a few of the large owners. John Carr, chairman of the board of directors of the First National Bank, is president, Eugene N. Foss is treasurer and E. B. Freeman has been elected general manager. The increased capitalization represents capital expenditures during the past year, largely in the erection of the new plant in Hyde Park which cost over $1,500,000. The B. F. Sturtevant Company has been doing a business of about $3,000,000 a year. It is the intention to add still further to the plant next spring.

The C. & G. Cooper Company, Mt. Vernon, Ohio, has developed and is now building a line of large gas engines of the horizontal double-acting, twin-tandem, 4-stroke cycle type, in addition to its well known line of Corliss engines. The engines are being built in sizes ranging from 400 to 5000 brake horsepower, and are especially adapted to the use of blast-furnace and waste gases. Several distinctive features of construction have been developed with the idea of simplicity, accessibility and uniformity in all parts and the ability to make long runs and give continuous and reliable service. The Cooper Company reports a recent sale of a gas-engine-driven gas compressor to the Wheeling Natural Gas Company, to be installed in one of the latter company's pumping stations near Wheeling, West Virginia. This engine is to be of the horizontal twin-tandem double-acting type, driving gas compressors for the long-distance transmission of natural gas.

The Huron Light and Power Company, Huron, South Dakota, has given the contract to the Minneapolis Steel and Machinery Company for furnishing the new engines for the electric-light plant. They will install one 100-horsepower and one 150-horsepower Muenzel producer gas engine, together with two 150-horsepower Muenzel gas producers to replace the present steam equipment. Both of the engines will be belted to alternating-current generators.

The New York Leather Belting Company, 51 Beekman street, New York, issues a little monthly publication known as *The Phoenix*. This paper takes up technical discussions, with illustrated descriptions of transmission problems. It shows comparative tests of the efficiency of various types of belting for different classes of machinery. Technical descriptions of peculiar transmission conditions and the best methods of meeting them are among the features found in recent issues of this publication. Copies can be obtained without charge on application.

The Lagonda Manufacturing Company, of Springfield, Ohio, makers of the Weinland boiler tube cleaners, automatic cut-off valves, and other boiler room specialties, announce the opening of a new branch office in the Postal Telegraph building, Chicago, Ill. J. P. Maloy, who takes charge of the new office, is probably one of the best known boiler cleaner men in the country. He is thoroughly familiar with all types of boilers and different conditions of scale and has travelled extensively throughout the United States and made several trips to the Hawaiian Islands. His familiarity with scale conditions enables him to give advice upon the cleaning of boilers and the selection of proper tube cleaners. Mr. Maloy is ready to discuss boiler scale with anyone and will tell you how to meet the toughest scale proposition. In this department he will be ably assisted by F. H. Field, who was formerly connected with the St. Louis office of the Lagonda Manufacturing Company, and who has had several years' experience in cleaning boilers.

The *Technical Index*, a comprehensive record of current technical literature published in Belgium, announces that hereafter it will be represented in the United States by the George H. Gibson Company, Tribune building, New York City. The *Technical Index* appears monthly and gives a systematic descriptive record of all original articles appearing in more than 200 engineering and technical journals and reviews; also indexing the proceedings of technical societies and technical books issued in all countries. The method of indexing covers the name of the author, the title of the article in full, an explanatory note stating the contents of the article, the name and date of the publication in which the article appeared and the length of the article. Two editions are printed, one upon both sides of the paper and one upon one side only for card index purposes and for further convenience all items are arranged according to the Dewey decimal system. Clippings or copies of articles, also books, are supplied by the publishers of the *Index*, the price being indicated in each case. It is stated that more than 1000 original articles are indexed each month, covering all lines of engineering and technology. The American agents offer to send free sample copies upon request and will also receive orders and subscriptions.

# New Equipment

The [illegible]go Mills, Gloucester, N. J., will increase its power plant.

Stevens & Hays, Pottsville, Penn., are erecting an ice plant.

The Smith Fuel Company, Staunton, Va., will erect an ice plant.

Fric[illegible]uk & Bremmel, Warsaw, Wis., will establish a candy factory.

The Kimberly Clark Company, Neenah, Wis., will remodel its engine room.

An electric-light plant will be erected at Sayre, Okla. W. Ben Turner, city clerk.

Willinger & Flanders, Flint, Mich., will erect an ice making plant to cost $50,000.

The Kearney & Trecker Company, Milwaukee, Wis., is building a new power house.

The Grand Rapids (Wis.) Electric and Water Company will increase capacity of plant.

Paul C. Horine, Reading, Penn., will establish an ice plant of 100 tons daily capacity.

C. T. Thorbus has purchased the Sparta (Wis.) Grain Separator Company and will enlarge plant.

It is proposed to erect waterworks at Elkhorn, Neb., to cost about $10,000. C. White is village clerk.

The citizens of Ryan, Okla., voted to issue $6,000 for electric-light plant and $45,000 for waterworks.

The Wolf River Chair Company, New London, Wis., expects to make changes in the engine room shortly.

The Central Oakland Electric Light and Power Company, Oakland, Cal., will erect a new power house.

The Union Ice and Cold Storage Company, Minersville, Penn., is building an ice plant of 40 tons daily capacity.

The Antigo (Wis.) Electric Light Company will make a number of changes in equipment by modernizing plant.

Permit has been granted for the erection of new power house for the Curtis Publishing Company, Philadelphia, Penn.

The citizens of Pella, Ia., have voted to issue $60,000 bonds for electric-light plant and waterworks. N. C. Kuyper, city clerk.

The Cedar Rapids & Iowa City Railway and Light Company, Cedar Rapids, Iowa, will make extensive additions to power plant.

The North Adams (Mass.) Gas Light Company has had plans prepared for a new power house, which, with equipment will cost $100,000.

The City Council, Peak's Mill, Ky., is said to have decided to construct electric-light plant and waterworks at a cost of about $40,000.

The North Adams (Mass.) Gaslight Company has had plans prepared for new powerhouse. This, with machinery, will cost over $100,000.

The Louisville Lighting Company, Louisville, Ky., has completely overhauled its Tenth street location and is preparing to install a new battery of boilers.

The Memphis (Tenn.) Street Railway Company is said to be considering building an addition to power house and install engine, generators, etc.

Plans for the new power plant at Joplin, Mo., to be constructed by Henry L. Doherty & Co., 60 Wall street, New York, have been completed. This is to cost $2,000,000.

The White City Ice Company, Broad Ripple, Ind., has been incorporated to manufacture ice. Capital, $12,000. Incorporators, Frank D. Heaton, J. W. Heaton, A. G. Cunningham.

Sealed proposals will be received until 10 a.m., August 16, by the Department of Justice, Superintendent of Prisons, Washington, D. C., for finishing and installing heating and ventilating apparatus in the hospital buildings at the penitentiaries at Atlanta, Ga., and Leavenworth, Kan.

# New Power Plant at Williamsport, Penn.

## A Modern Plant Featured by Its Condenser Arrangement, Coal-handling Apparatus and Novel Layout of Steam and Feed-water Piping

At Williamsport, Penn., the power plant shown in Fig. 1 has recently been erected by the Edison Electric Illuminating Company. The station is well equipped with uptodate machinery and has a generating capacity of 2200 kilowatts to supply railway, lighting and stationary-motor loads. The railway load is handled by two 575-volt direct-current units consisting of a tandem-compound Nordberg engine, 16x32x42 inches, driving a 325-kilowatt Westnghouse generator at 100 revolutions per minute, and a cross-compound Nordberg ngine direct-connected to a 600-kilowatt General Electric generator of the same speed and voltage as the Westinghouse machine.

The principal part of the business section of the city, about a mile square, is upplied with direct current distributed on he Edison three-wire system. Two 135-olt dynamos direct-driven by a horintal Curtis turbine are operated on this ystem. The remainder of the city uses lternating current distributed by primary rcuits at 2300 volts. For this service wo 500-kilowatt vertical Curtis turbine-generators have been installed, the genrators being two-phase, 60-cycle mahines running at 1800 revolutions per minute. The step bearings of the turbines re supplied with water from a 50-gallon ccumulator, equipped with concrete weights which give a pressure of 350 ounds per square inch. Each feeder suplying lights is equipped with an induction regulator which is adjusted by a motor, the latter being controlled automatically by solenoid switches closed and opened by a sensitive relay connected across the feeder terminals.

Besides the main generating units previously enumerated, the station is equipped with a number of motor-generator sets which draw from the alternating-current system and supply direct current. The largest of these is a 325-kilowatt two-phase synchronous motor taking current at 2300 volts and driving two 150-kilowatt direct-current generators, one on either side of the motor; this outfit is used to transfer energy from the alternating-current system to the direct-current three-wire system, when necessary.

Three 100-lamp Brush machines supply the arc lamps, which are 4-ampere magnetite lamps taking 80 volts each. Two of these machines are driven by a 125-horsepower two-phase induction motor and the third by a 75-horsepower motor of the same type.

For excitation the motor generator is again called into service. The alternators are excited by a 25-kilowatt 150-volt, direct-current generator driven by a 37-horsepower 480-volt induction motor, and the railway generators receive their field current from two 7½-kilowatt generators driven by one 25-horsepower direct-current motor. Regulation is maintained by Tirrill regulators. Most of this machinery is shown in Fig. 4, a general view of the engine room, which is 56x190 feet and, as may be noted, presents a very handsome appearance, due in part to the tile floor, white-enamel brick wainscoting and buff-colored brick above. A 20-ton crane serves the room, and the tracks on which it runs are supported on pilasters.

### Boiler Plant

To supply steam to the generating units, the usual number of pumps and auxiliary apparatus, the boiler room is equipped with seven boilers; six are 300-horsepower Keeler boilers equipped with Potter superheaters, and the other is a 600-horsepower Edge Moor boiler. All are provided with Roney stokers and carry a pressure of 160 pounds, gage. The Keeler boilers are arranged in batteries of two and are connected to the brick stack shown in Fig. 1 by a steel breeching. A Sturtevant 10-foot blower is also used in connection with these boilers. The Edge Moor boiler is independently served by the steel stack shown in Figs. 1 and 6.

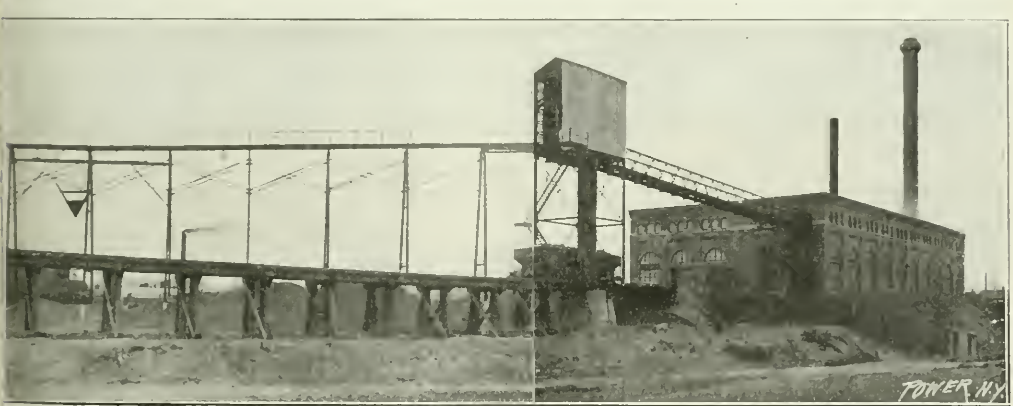
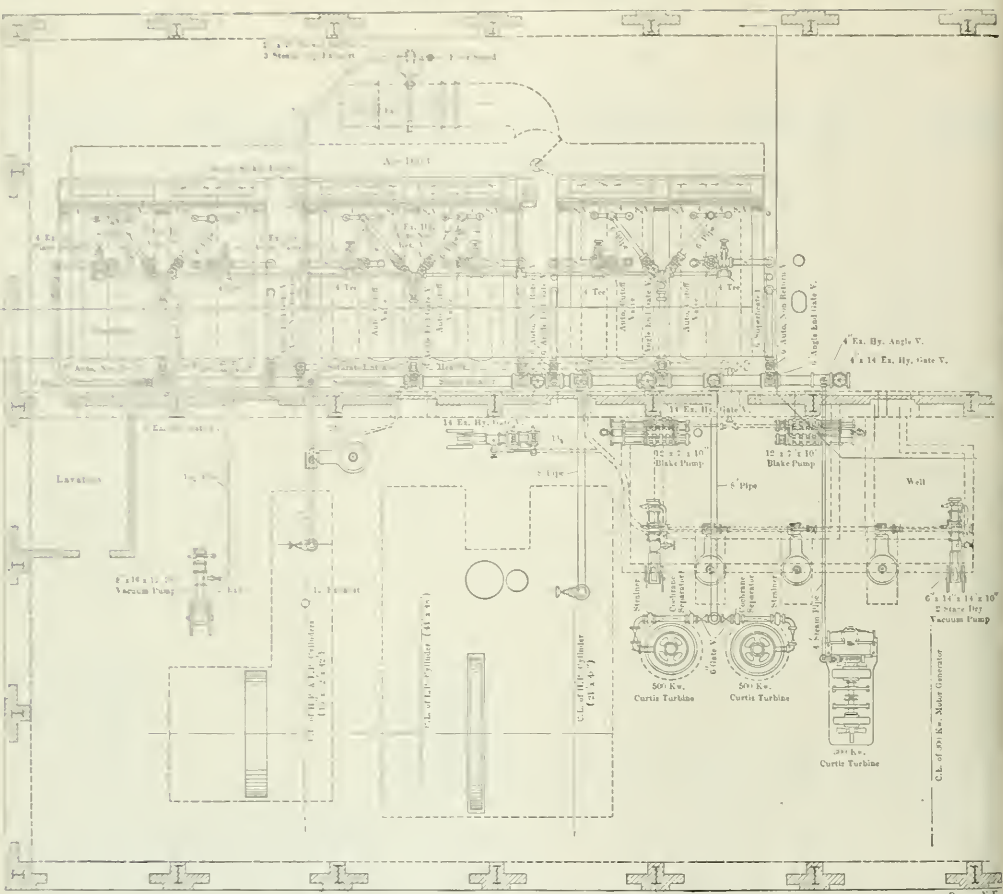


FIG. 1. POWER PLANT AND GRAVITY-CAR SYSTEM OF HANDLING COAL

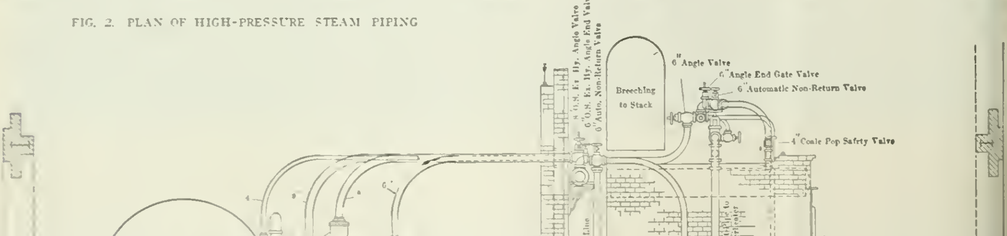
### Coal-handling Apparatus

For this purpose, the gravity-car system shown in Fig. 1 is used; it was installed by the Monongahela Manufacturing Company, of Pittsburg. Coal is delivered in a railway car, as shown in Fig. 1, and is dumped into a hopper immediately below the track. By means of a bucket elevator, which is operated by a direct-current motor, the coal is elevated



Power, N.Y.

FIG. 2. PLAN OF HIGH-PRESSURE STEAM PIPING



Power, N.Y.

FIG. 3. ELEVATION THROUGH ENGINE AND BOILER ROOMS

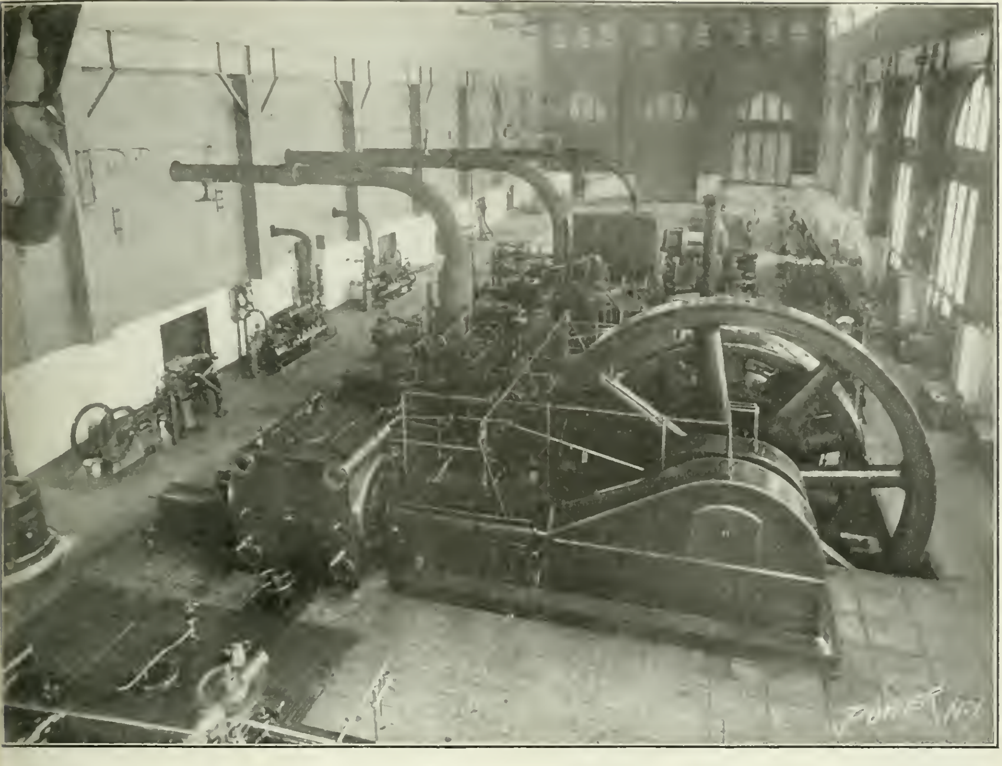


FIG. 4. GENERAL VIEW OF ENGINE ROOM

) a second hopper above, and from here discharged to a small gravity car. The ack is 20-inch gage and has sufficient h to carry the car at a high rate of ed to the dumping point which may be any point along the line of track. When e car arrives at its destination, it strikes chuck connected by means of a cable ith the V-shaped counterweight shown w the track. The impetus of the car and its load of coal raises this weight and at the same time a trip opens the sides of the car and allows the coal to roll out. The counterweight then comes into action and gives the car a kick of sufficient magnitude to carry it back to the starting point. In the present installation arrangement is made to carry the coal to the overhead bunkers in the boiler room, from which it is discharged into a Fairbanks automatic weighing hopper and delivered to the stoker chutes, or the car may be run out in the opposite direction and the coal dumped in the storage yard.

### Feed-water Piping

The feed-water piping is unusually complete, and its arrangement is shown to advantage in Fig. 7. The entire supply is

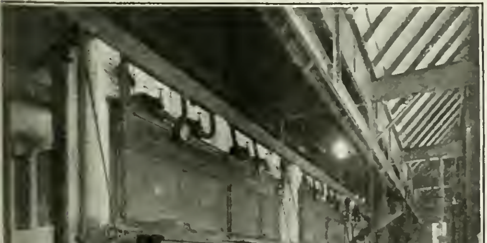


FIG. 5. BOILER INSTALLATION

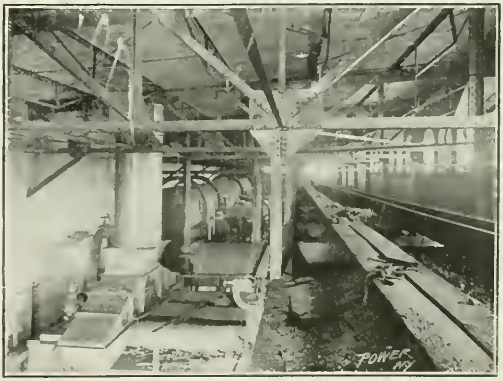
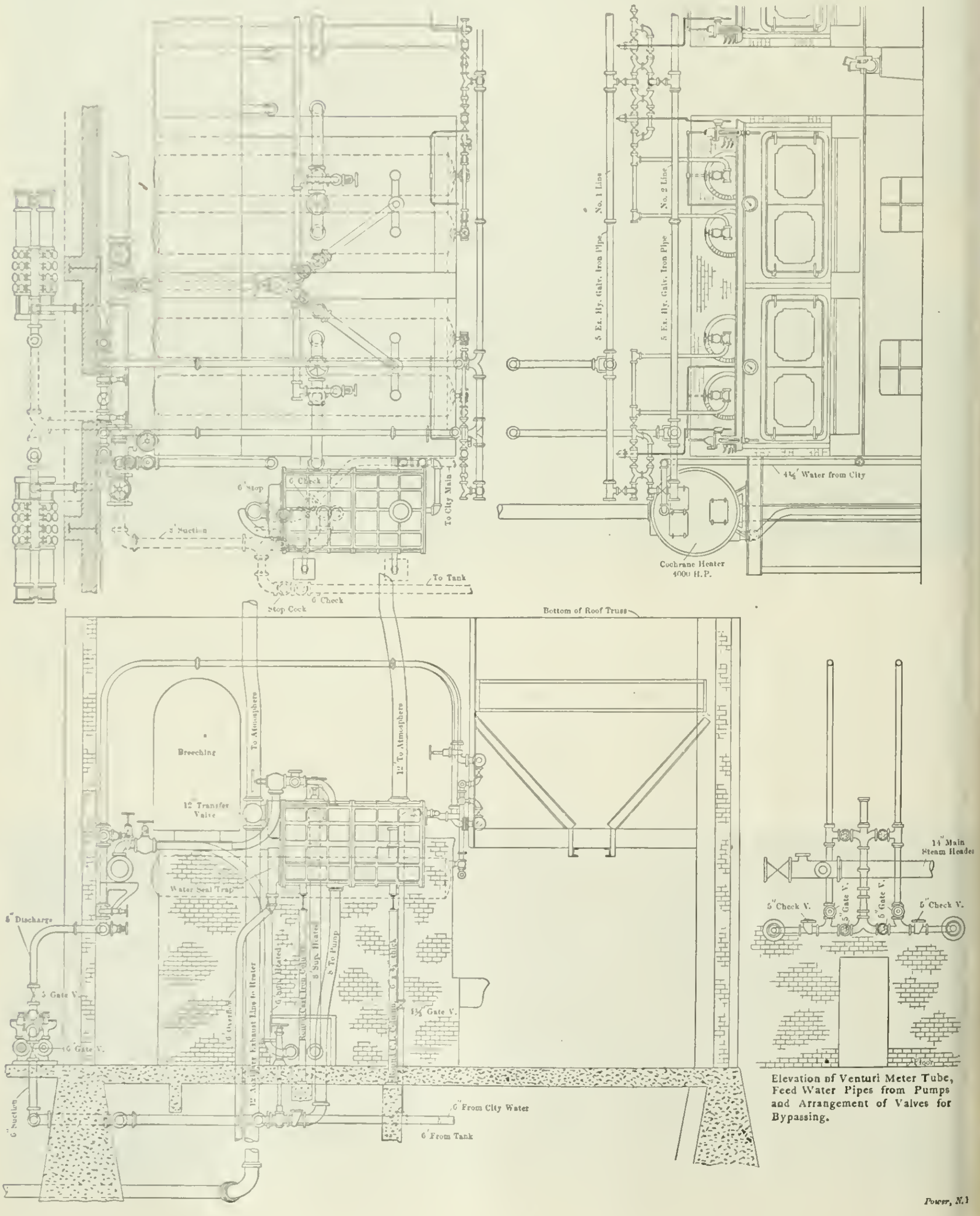


FIG. 6. TOP OF BOILERS AND COAL BUNKERS

handled by two Blake outside packed plunger pumps. These may draw from a large supply tank or from a connection to the city mains, and before reaching the pumps the water may pass through a 4000-horsepower Cochrane heater, or the heater may be bypassed and the pumps supplied with cold water. From the pumps the discharge pipes are carried in the form of a double main and connected substantially as shown in the illustration.

A most ingenious arrangement has been provided to determine the amount of feed water used. This is shown in the detail view in Fig. 7, and consists of a Venturi meter installed between the two 5-inch mains, and a piping layout such that either pump can feed direct to the mains of the boilers or through the meter, as desired. The meter indicates the current rate of feed, a Bristol type of chart



**Elevation of Venturi Meter Tube, Feed Water Pipes from Pumps and Arrangement of Valves for Bypassing.**

*Power, N.Y.*

FIG. 7. FEED-WATER PIPING IN DETAIL

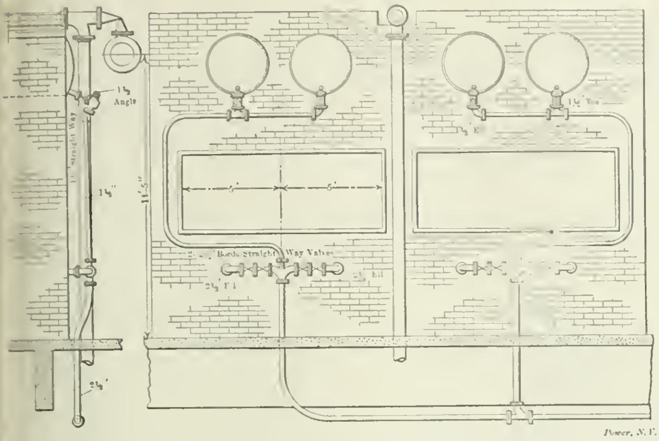


FIG. 8. BLOWOFF CONNECTIONS

rds the rate continuously and a meter l system registers totals. With this rangement it is possible to note the w at any moment desired or to observe fluctuations during that part of the hour period which has elapsed and the tal amount of water fed to the boilers.

Two 5-inch mains run the entire length the boiler installation, and by means the piping interconnecting the two s it is possible to feed any boiler n either line. It is also possible to the water through the feed-water gulators indicated in the drawings, and is just as easy to bypass them if nec-ry. An inspection of the drawings l show the valves and fittings employed the operation of the system. Fig. 8 shows the method of connecting the blowoff piping to each boiler.

### Steam and Exhaust Piping

The high-pressure piping system, shown in Figs. 2 and 3, comprises two headers and the supply pipes furnishing superheated and saturated steam, respectively. All of the generating prime movers, both turbines and engines, use superheated steam, and the boiler feed pumps, dry-vacuum pumps and auxiliaries are supplied from the saturated-steam main.

It will be noted that the usual path for the saturated steam is from the front connections on the drums back through the 6-inch leaders from each boiler to a 6-inch pipe common to both leading toward the rear of the boilers. This pipe ordinarily delivers its contents to the 8-inch saturated-steam header below the boiler-room floor, but if occasion demands, a special valve will admit the steam to the large 14-inch header generally used for superheated steam. Near the middle of the drums a second connection is made to the boilers, and the steam from these outlets is passed through the superheater and thence to the superheated steam header. With these arrangements, either saturated or superheated steam may be supplied to the larger header, and by proper manipulation of the gate valves in the header, it would be possible to use both, that is, one section receiving and supplying superheated steam to the turbines, and the other section delivering saturated steam to the engines. The method of connection to the various units will be evident.

Fig. 9 shows a plan of the exhaust and condenser piping, and Fig. 10 an elevation of this piping to one of the turbines, the arrangement of jet condenser with centrifugal pump on the tank pipe being practically the same for the other units. The large atmospheric exhaust main is 24 inches in diameter, and connection is made to this from the various units, although each is equipped with an Alberger jet condenser and the usual path of the exhaust steam is, of course, through the condenser. Injection water for the condensers is drawn from the river by a centrifugal pump driven by a hydraulic turbine, and delivered to intake wells from which it is drawn up into the condensers by the vacuum maintained. From the condensers the water and condensed steam are delivered to centrifugal pumps, driven

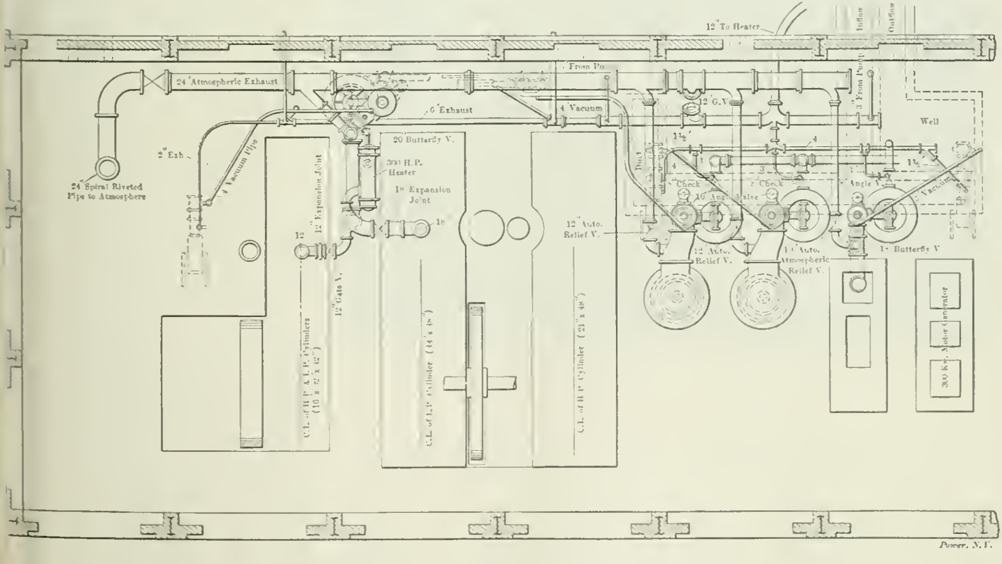


FIG. 9. EXHAUST STEAM AND CONDENSER PIPING

by Valley Iron Works engines with vertical shafts, and discharged to the river at a point below the low water level. The connections of the Alberger dry air pump are shown in the illustrations, also those of the Goubert 300 horsepower secondary heater of the closed type, which is in the exhaust line from the two Corliss engines.

The entire system of high pressure steam piping, as well as the piping carrying hot water, is covered with 85 per cent. carbonate of magnesia pipe covering. In the case of the superheated-steam mains, the covering is 2½ inches thick and is made up by wiring magnesia blocks to the pipe, filling the various interstices with plastic 85 per cent. magnesia, covering the whole with poultry netting of suitable mesh and then applying a final coating of plastic magnesia, which is covered with canvas. The saturated-steam lines are covered in the same way to a thickness of 2 inches and a thickness of 1 inch was considered sufficient for the hot-water piping.

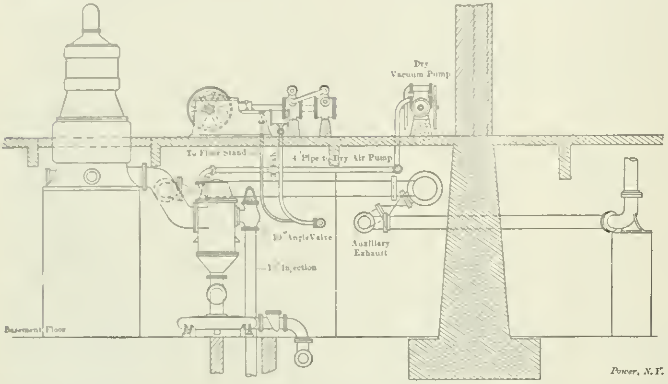


FIG. 10. EXHAUST AND CONDENSER PIPING TO TURBINE UNIT

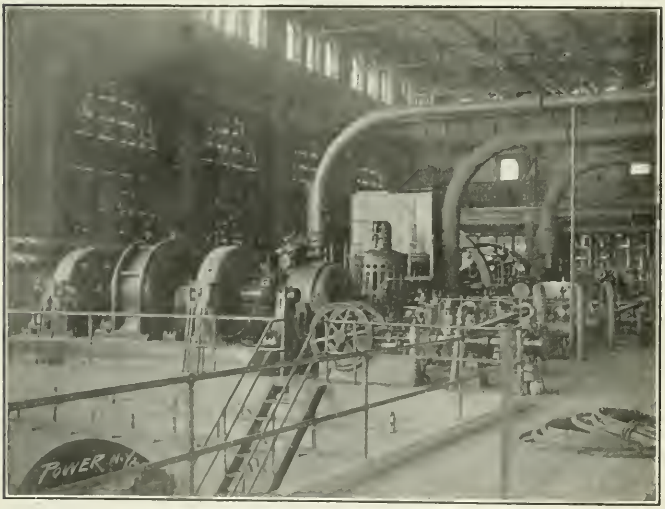


FIG. 11. TURBINE UNITS AND AUXILIARY MACHINERY

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## Boiler Room Economies *

By N. B. Ayers

Economy has been defined as going without something you need to save money to buy something you do not want. With this definition the subject of boiler-room economies becomes very simple: You go without efficient labor, needed repairs or proper fuel and save money to pay for breakdowns, interruptions to service and excessive coal bills. Boiler rooms throughout the country bear mute witnes to the literal application of this definitio The usual idea of effecting economy i along the line of retrenchment. Th axiom: "A dollar saved is a dolla earned" is continually held up to us, bu unless the dollar saved has just as muc mental effort behind it as the dollar whic is spent, it is going to reappear, raise to the *n*th power, on the wrong side of th balance sheet.

How many boiler plants are deliverin 70 per cent. of the energy supplied t them? How many are delivering even 5 per cent.? How many managers kno what per cent. of the energy purchased i their coal their boilers are delivering How many even know how much energ they receive in the fuel they purchase Additional proof of low average efficienc is afforded by the number of stoker forced-draft systems, induced-draft sys tem, shaking grates, improved furnace etc., which in four out of five cases ar making good the claims made for the of 10 or 15 per cent. increase in eff ciency in any plant. It has been state that there are 2700 patented boiler con pounds, most of which are on the marke No one has ventured to enumerate th smoke consumers and other devices pe taining to every feature of the boil room. A canvass of one of the easter States failed to disclose a single boil room that did not possess, in the scra pile, at least one exhibit testifying t unsatisfactory conditions and lack c knowledge of the art of combustion.

There are two classes of conditions a fecting boiler-room economies: thos which are apparent to an average fir man, and those which are dependent upo special skill and training in this line. Th first class includes the condition of hea ing surfaces. A man carefully cove his steam lines to prevent the transmi sion of heat through the iron wall of th pipe. Why, then, cover his boiler tub with scale on one side and soot on th other and expect to maintain the san transmission? The advantage of hot fe water is apparent when exhaust stea which would otherwise be wasted is avai able, but the use of live steam in this co nection, while of value, is not so we known because its chief economy li not in direct saving, but in decrease maintenance cost due to lighter scale d posit in the boiler and to fewer strai from sudden changes in temperature. Th average office is safeguarded again drafts by storm windows and weath strips, with a difference in temperature perhaps 30 degrees on the two sides the wall, while the leakage of air throug the average boiler setting is neglecte although the difference in temperature twenty or thirty times as great. The impor ance of this point is illustrated by a seri of tests made on a 650-horsepower Bal cock & Wilcox type of boiler, first wit plain brick setting then with a ½-inc

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*Abstract of a paper read before the Ohio Electric Light Association.

coating of cement over the brick. The increase in efficiency in the latter case was sufficient to justify the engineers in recommending an air-tight sheet steel casing outside the brickwork. The economy from well covered steam and hot-water pipes is too well known to be more than mentioned and the need of furnaces and grates, of whatever type, being in perfect condition is equally obvious.

The second division of economies, those which result from the use of ability, may well begin with fuel, the chief item of expense. A certain coal is frequently contracted for because the same coal was used last year, because John Smith uses it, because the dealer is a stockholder, because it costs less per ton, and sometimes because it is the cheapest coal to use in the particular plant. The cost of sampling and analyzing, the reluctance of dealers and their desire to protect themselves from possible loss by increased prices per ton, render the guaranteed B.t.u. basis somewhat unsatisfactory in the vicinity of Dayton, O., while the time and expense attendant upon the careful testing under actual conditions of a number of coals make this method also prohibitive in many cases. A coal should be adapted to the needs of the plant; it should be of sufficient heat value to develop the maximum power required. As most contracts are made in the early summer, this must be considered, for a low-grade fuel in a limited-capacity plant might be cheap in June and prohibitive in December. If stokers are in use, the amount of iron and sulphur in the coal becomes important, often the determining, factor. Most stoker builders will undertake to burn any coal and will usually succeed, but the cost of maintenance on high sulphur coals will wipe out any but a wide margin in price.

There is only one coal to be considered, the one which will do that particular work with the least cost, bearing in mind the capacity required, cost of handling, maintenance of equipment and removal of ashes. In its selection probably a combination of methods is best. Proposals on a guaranteed analysis will narrow down both the number of dealers and the number of coals, as none but reputable firms whose product is uniform in quality will submit figures on this basis. With these in hand, it is an easy matter to select the two or three which are suitable in quality and price and try them out under working conditions. A point of considerable interest will be developed in figuring on a guaranteed B.t.u. basis and this is the difference in values between run-of-mine coal and slack, or nut and slack. In this system the guarantee is to deliver so many net British thermal units for one cent, and in the majority of cases it will be found that the purchaser is paying an exorbitant price for the privilege of having his fireman break up the lumps.

Having purchased the coal there remains but one thing, to burn it. This is comparatively simple in itself, but the utilization of 70 or 80 per cent. of the heat units contained is more of a problem. In this, economy is entirely a question of the man in charge. I say man, rather than men, because it is a question of one man. It is impossible to retain in the ranks firemen who have the ability economically to operate a boiler room; if they are bright, intelligent men they graduate to the engine room, leaving behind the young and inexperienced and the old and unintelligent. But any plant of any size can afford one good man in the boiler room. He should rank with or above the engineers, both in ability and wages, for while it is a fact that boilers will operate with less attention than anything else in the plant, and it is customary to attach the boiler room to the chief engineer's responsibilities, like a second tail to a kite, yet the simple comparison of the daily costs of the two departments should be proof enough of the opportunities for better men in the steam-generating end. In this connection I believe the Taylor system, which has done so much for other branches of manufacturing, will prove effective. The few instances in which it has been tried have been entirely satisfactory and while its adoption will be slow, eventually central stations will have to assume the same attitude toward labor that other industries find most satisfactory.

Owing to diversity of equipment and conditions few general rules can be formulated for economical operation. The type of boilers, furnaces, drafts, stokers, load conditions and fuel are variables in the problem which must be solved by the man in charge. Moreover, there are radically different methods of operation, each warmly supported by its followers, each giving excellent results, which further tend to render generalities impossible. There are a few principles of general application, however, one of which is regulation of the amount of air supplied to the furnace. Inasmuch as all the heat escaping up the chimney is wasted, both the temperature and volume of the escaping gases should be kept as low as possible. No more air should be admitted to the furnaces than is necessary to burn the fuel, remembering, though, that too little air will result in loss of unburned fuel in the gaseous state. Flue-gas analyses or records will aid in this regulation.

Records should be kept of the fuel and water, or if this is impossible, frequent evaporative tests should be made in order to establish and maintain a standard of operation. Boilers, like engines, yield efficiency curves, although the average boiler will operate at a remarkable overload without decrease in efficiency. The character of the efficiency curve should be determined and the boiler operated at the highest possible point. This information is important in determining at what overload the boilers should be operated on the peak and the point at which it becomes more economical to cut in another boiler. Frequently boilers can be operated at or near 100 per cent. overload for a few hours with a remarkable gain over the cost of firing up another boiler, but the increase in maintenance may overbalance the saving in fuel.

In general the tendency is toward high furnace temperatures, high rates of combustion and high overloads and the results indicate that this tendency is in the right direction. A firebox temperature of 2800 degrees is not uncommon, the burning of 40 pounds of bituminous coal per square foot of grate per hour is an everyday occurrence and boilers are operated continuously at 200 per cent. of the builders' rating, developing a horsepower for each 5 square feet of heating surface.

A feature which depends entirely upon the judgment of the man in charge is the frequency of cleaning. Cleaning a boiler is an expensive process; add to this the exigencies of the service requirements, and the problem of determining just how much scale must accumulate before the loss due to it will offset the cost of cleaning is not a simple one.

The generation of steam has not kept pace with the generation of electricity. Combustion is no farther advanced than it was 10 years ago. Turbines, engines and generators are improved year by year, but the steam to operate them, representing the major portion of their expense, is produced in practically the same way it was 10 or 15 years ago. Why not, then, apply to this department the ability and energy that are so essential in all other lines of central-station effort and raise it to a corresponding level of efficiency?

## Liquid Gas

Liquid gas is made by compressing and freezing the gas obtained from the dry distillation of crude oil. The first plant for its commercial manufacture was established at Augsburg, Bavaria, in 1904, under the Blau process. In 1907 a plant was established at Bassensdolf, near Zurich, to use the Wolf process. After manufacture the gas is placed in steel tubes holding 20, 40, 60 and 80 pounds, which are accepted by the railways with no restrictions, as the gas is claimed to be nonpoisonous and much less explosive than ordinary gas. It is used for heating, lighting, cooking and soldering and welding. Over 100 installations have been made in Switzerland, and one is being built in Paris and one in Boston.

* * *

Useless rubber should not be allowed to remain on pump gaskets, as it will eventually get into the valves and parts and cause trouble.

# Curves for Engineering Calculations*

## An Interesting Method of Plotting and Combining Curves. Their Accuracy and Value as Time Savers in Making Difficult Calculations

BY J. M. SPITZGLASS

A comprehensive test of a single instrument or machine may require a great number of difficult calculations, and mistakes often escape notice. Checking is therefore essential, and usually by laborious recalculations. The use of curves, wherever possible, as devices for calculating results of a test, eliminates both hard work and gross mistakes, and in addition affords a great saving in time. Therefore a little study of an interesting method for the plotting and use of curves for this purpose will be of great advantage to the practical engineer, and each hour spent by him on this subject may save him weeks and months of hard calculations.

The curves used in practical engineering calculations are very simple indeed. There is no limit to the work which can be done by a series of straight lines alone, and if a curved line is sometimes brought in, it is usually a simple curve. Now the straight-line curve requires only two points, and one of them, in general, is to be found at the origin. Take the other one at a numerical value in the table of tens and the line is determined. In the course of the present and following articles, sets of curves will be used to compute the results of complicated tests, and full instructions will be given for the construction of similar sets for each special case. As an introduction to that work let us consider a few simple cases and see what can be done by straight lines alone.

Take a sheet of coördinate paper, preferably one divided in tenths. Call each division on the abscissa, or horizontal dimension, one foot of water head, and each division on the ordinate, or vertical dimension, one pound pressure per square inch. Lay off 100 feet of water on the abscissa, as in Fig. 1. Any reference book will show you that this is equivalent to 43.3 pounds per square inch. Lay off this amount on the ordinate, locate the point and draw a straight line through it from the origin. You have now a very convenient table interchanging either one of the quantities into the units of the other, the accuracy depending on the scale of the diagram.

Now call each division on the same ordinate one inch of mercury. Lay off 34 feet of water on the abscissa, and 30 inches of mercury on the ordinate. A line from the origin through this point will give you a table interchanging the units of these two quantities. But the two lines on the same sheet form a selection of three quantities to be used two at a time, and therefore you have implicitly a third table interchanging inches of mercury to pounds per square inch, and the opposite. The dotted lines on Fig. 1 show an example of this kind. From any point on one line, say 30 inches of mercury, go vertically to the other line, and read off its ordinate 14.7 pounds per square inch.

Now add a third line in the same manner, calling each division on the ordinate 1000 feet of air at 62 degrees Fahrenheit, the abscissa remaining the same. The three lines form a selection of four quantities to be used two at a time, and the possible number of combinations is at once increased from three to six. This is made possible by the interchange of feet of air to any one of the previous three quantities. If you put in a fourth line for centimeters of mercury, you will add four new possible interchanges, and a fifth line of tenths of atmospheres will bring the total number of combinations to fifteen.

Fig. 2 shows the outline of such a diagram, the dotted lines indicating the value of one atmosphere in each of the other units of pressure. If you plot such a diagram to a proper scale, each one of the lines will have more value than a long row of numerical tables, and the value of the whole combination cannot be overestimated, while the time required to make this diagram is only one-half hour.

Suppose you have a testing laboratory in which a number of prony brakes are used every day, the following variables affect the horsepower: Speed of pulley friction load and length of brake arm Each one of the numerous conditions therefore requires a separate curve, and each curve plotted in the usual manne requires a great many points to be solve in order to make it approximately correc

Here is a method for plotting this dia gram from the solution of one singl point, to cover all possible conditions, fo any number of brakes, and consisting c straight lines only. Referring to Fig 3, divide the upper abscissa to read nc load in pounds to any convenient scal and the lower abscissa to read horse power to the same scale, one horsepow against each pound of load. Plot on th ordinate revolutions per minute, and tak the arm length of one of the brake measuring a whole number of feet, o

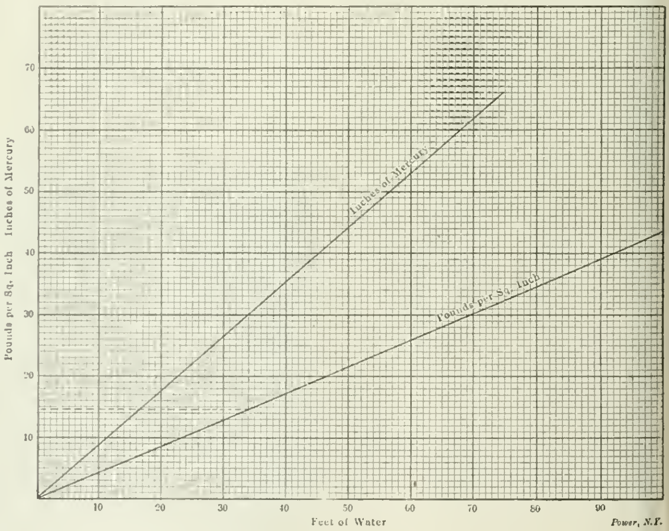

FIG. 1. DIAGRAM TAKING THE PLACE OF THREE TABLES

take any length, say 3 feet. The equation of the brake is:

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*Copyright, 1909, by J. M. Spitzglass.

$$Horsepower = \frac{2\pi RNW}{33,000},$$

where

$R$ = Length of the brake arm, 3 feet in this case;

$N$ = Number of revolutions per minute;

$W$ = Friction load on the scale pan;

$\pi = 3.1416$

Divide both sides of the equation by $W$. Then

$$\frac{Horsepower}{W} = \frac{2\pi R}{33,000} \times N = \frac{6\pi}{33,000} \times N.$$

Now the only condition necessary to make t horsepower numerically equal to $W$ i that

$$\frac{6\pi}{33,000} \times N$$

ɛals unity, or

$$N = \frac{33,000}{6\pi} = 1750\ R.P.M.$$

ssume that the brake is running all t time at this constant speed. Then the h·sepower on the lower abscissa of the dgram corresponds numerically to the l·l on the upper abscissa. Lay off 1750 r·olutions per minute on the ordinate. rk a horizontal line and call it the li· of constant speed. Now, for any g·n load the horsepower varies directly h the speed, down to zero and up to infinity. This is a condition for a straight line. One point is at the origin, the other point at the load on the line of constant speed. Join the two points. Let the speed vary in either direction. To find the horsepower developed, follow the line from the given load to the intersection with the given speed, the abscissa of the point of intersection will necessarily give the horsepower required.

Keeping the other factors constant, the horsepower must vary directly with the length of the brake arm. To provide for different lengths, continue the line of ordinates downward and plot horsepower on it to any convenient scale. Locate for each brake one point having an abscissa equal to 3, and an ordinate equal to the length in feet of the brake arm, and draw straight lines from the origin through the points. To find the horsepower developed for any particular brake, locate the number given for the 3 foot arm brake at the given conditions. The ordinate at this point from the lower abscissa to the intersection with the line of the proper brake will give the horsepower required. An addition of another brake to the laboratory means only an addition of one more line to the diagram.

Fig. 3 represents the outline of such a diagram including all possible conditions. The following example is indicated by dotted lines on the diagram:

| | |
|---|---|
| Friction load on scale, pounds | .845 |
| Speed of pulley, r p. m | 840.0 |
| Length of brake arm, feet | 4.5 |

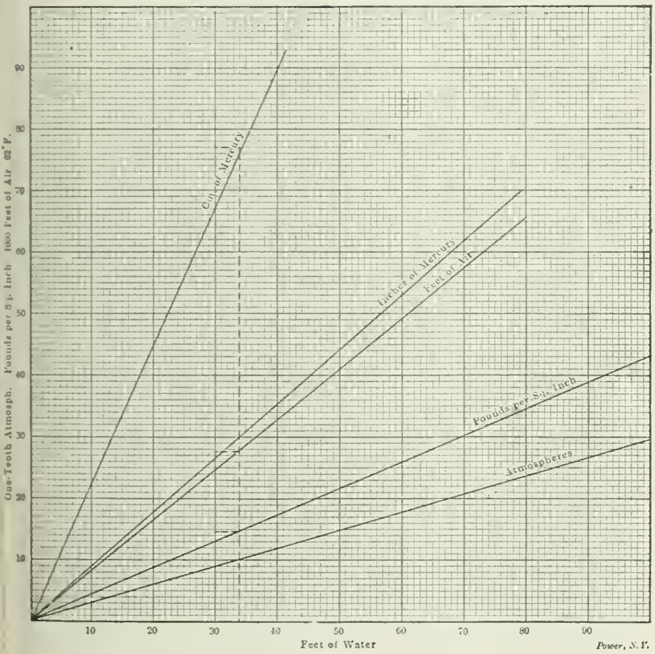
The horsepower developed is indicated by the lower ordinate intersecting the line for the given length of arm, and reads 60.75 horsepower. It can easily be seen by inspection that the diagram affords a solution for any one of the four variables when the other three are given. It is now possible to follow through the set of curves given in Fig. 4 and see how they are combined to give the results sought for.

The system was used by the writer in computing the results of an experiment on a 3-inch Dayton centrifugal pump at the Armour Institute of Technology, and it worked out very satisfactorily. Besides saving a great deal of time it made it possible to complete the test and determine several doubtful points on the subject, simply because an additional dozen of runs did not add much to the work.

As the diagram was designed for a 3-inch centrifugal pump, and therefore all of it can be used for such a pump only, an alteration in the few curves, depending upon dimensions, will make it applicable for any pump. As drawn now it is divided into five sections marked *A*, *B*, *C*, *D* and *E*, respectively. Sections *A* and *D* consist of single curves, some of them plotted from experimental data, and the others drawn after the methods given for Figs. 1 and 2. Sections *B*, *C* and *E* were constructed after the method given for the prony-brake diagram; *B*, for the solution of pump horsepower from the computed quantity and total head; *C*, for the ratio of pump horsepower to motive horsepower delivered, also for the solution of percentages in general; and the lowest section, *E*, is a provision for indicating the per cent. lost in slip when the pump is belt-driven. In fact section *B* alone is sufficient to answer the purpose of the other two also. But in such a case the subdivisions would have to read odd numbers, and the diagram would be too crowded.

Each curve on the diagram is designated and its purpose fully indicated. The method of combining those curves and reading the desired results will be best illustrated by following through a specific example computed for the following conditions and indicated by dotted lines on the diagram:

A 3-inch centrifugal pump was belt-driven by a 10-horsepower motor, the respective pulleys on the motor and pump being 20 and 10 inches. The impeller has a diameter of 11⅛ inches, the suction pipe 4 inches standard and the discharge pipe 3 inches. The water delivered was measured by passing through two weir notches, in parallel, one 10 inches marked *A*, the other 12 inches marked *B*. The suction head was indicated by a mercury manometer reading



Power, N.Y.

FIG. 2. CURVES REPLACING 15 TABLES

in inches, and the delivery head by a pressure gage in pounds per square inch. The power input to the motor was measured by an ammeter and a voltmeter connected to the terminals of the machine.

### DATA GIVEN FOR RUN

| | |
|---|---|
| Ammeter reading, amperes | 55 |
| Voltmeter reading, volts | 111 |
| Motor speed, r.p.m. | 650 |
| Pump shaft speed, r.p.m. | 1250 |
| Discharge gage, lb. per sq. in. | 14.5 |
| Suction gage, in. of mercury | 8.5 |
| Distance between gages, feet | 1.5 |
| Head on weir *A*, thousandths | 254 |
| Head on weir *B*, thousandths | 232 |

### RESULTS REQUIRED FOR COMPLETE ANALYSIS

#### CAPACITY

Cubic feet per second on weir *A*.
Cubic feet per second on weir *B*.
Total quantity in cubic feet per second.
Total quantity in gallons per minute.
Total quantity in 100 pounds per hour.
Velocity of water in inlet pipe.
Velocity of water in discharge pipe.
Peripheral velocity of impeller.

#### HEAD, IN FEET OF WATER

Suction head . . . . . . feet.
Delivery head . . . . . . feet.
Total head . . . . . . feet.
Inlet velocity equivalent head . . . feet.
Discharge velocity equivalent head feet.
Peripheral velocity equivalent head feet.

#### POWER

Watts consumed from line (input).
Horsepower delivered by motor (output).
Per cent. left after belt slip.
Net motive horsepower.
Pump horsepower.
Power rejected in discharge velocity.

#### RATIOS AND EFFICIENCY

Ratio of total head to peripheral velocity head, per cent.

Ratio of suction head to total head, per cent.

Ratio of rejected head to total head, per cent.

Net efficiency of pump, per cent.

These results follow along the dotted lines on the diagram; the number in order, as given below, corresponding to each result is encircled near the point on the respective curve.

1. Cubic feet per second on weir *A* is given directly on its curve (Section *A*) by the abscissa corresponding to the head of 254, and reads 0.347 cubic foot.

2. Same on weir *B* is given on its curve by the abscissa corresponding to the head of 232, and reads 0.391.

3. Total discharge in cubic feet per second is the sum of these two abscissas, *a* and *b*, and reads 0.738 cubic foot. (The reason for scaling instead of simple addition is to have the sum at once located on the diagram).

4 and 5. Gallons per minute and 100 pounds per hour are given directly under the quantity on their respective scales, and read 332.1 and 1660.5 respectively.

6. Velocity of water in inlet pipe given by the ordinate of its curve co responding to the abscissa of the tot quantity, and reads 8.4 feet per second.

7. Velocity of water in discharge pi is given by the ordinate of its curve

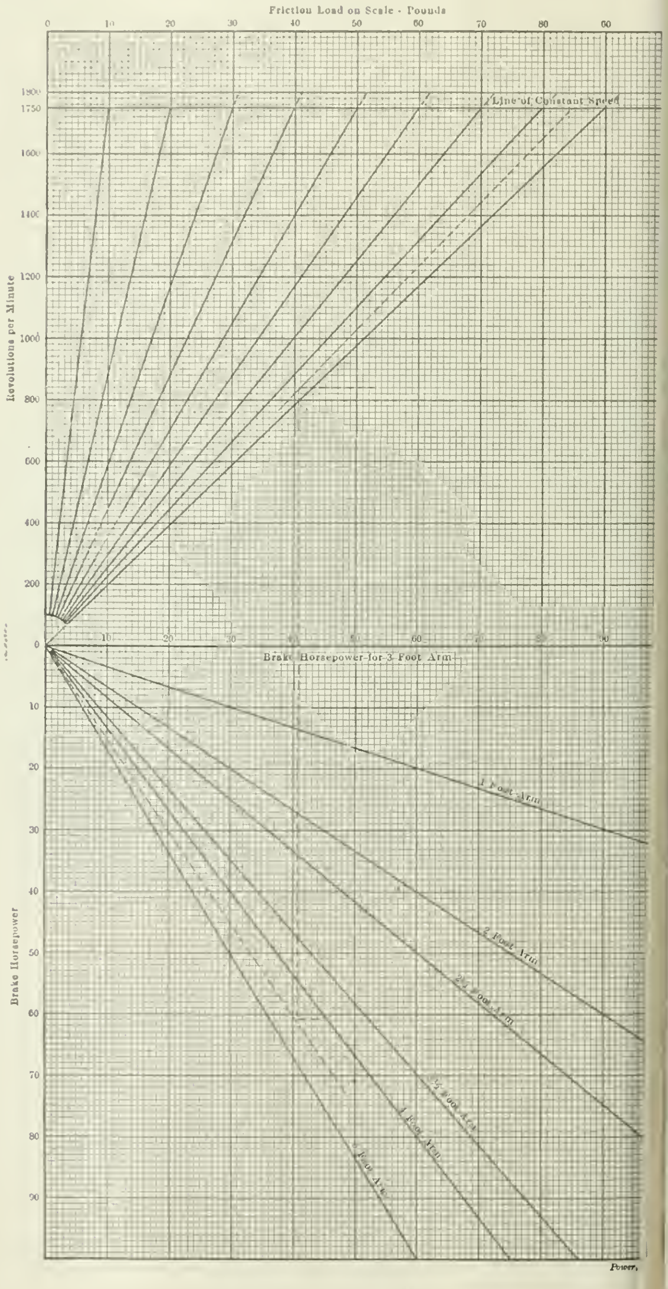


FIG. 3. GENERAL PRONY-BRAKE CURVES

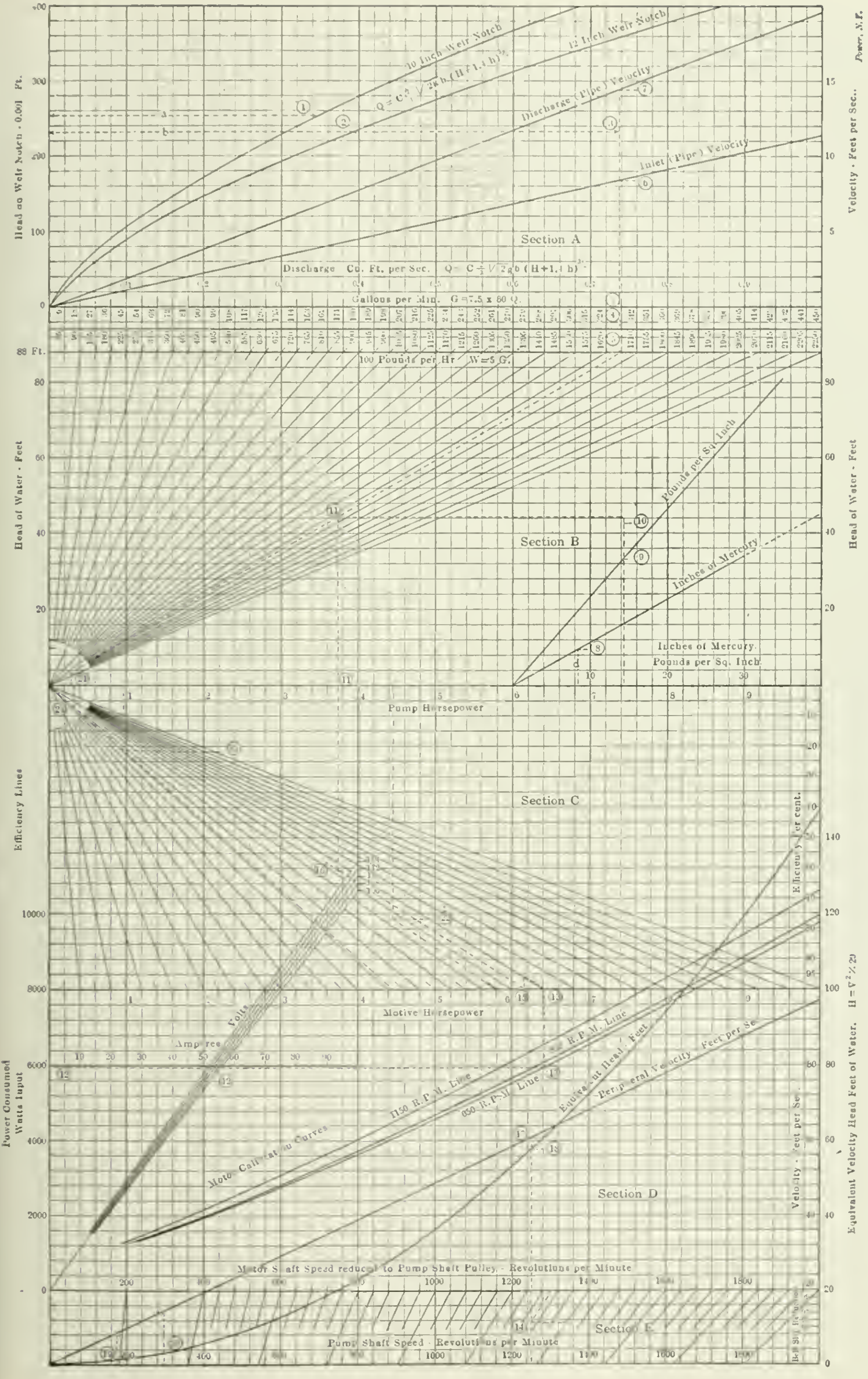


FIG. 4. DIAGRAM FOR CALCULATING RESULTS OF TESTS ON A 3-INCH CENTRIFUGAL PUMP

the pump abscissa, and reads 14.4 feet per second.

8. Suction head in feet of water is given by the ordinate corresponding to 8.5 inches of mercury on the respective curve in Section B and reads 9.6 feet of water.

9. Delivery head in feet of water is given by the ordinate corresponding to 14.5 pounds per square inch on the respective curve in the same section, and reads 33.4 feet of water.

10. The total head in feet of water is located on the diagram by adding the distance between gages, 1.5 feet, to the sum of the two ordinates *c* and *d*, being a total of 44.5 feet of water.

11. For pump horsepower follow the ordinate of the total head to the intersection with the horsepower curve corresponding to the total quantity, and read the abscissa 3.74 horsepower.

12. Power consumed from line is given by the intersection of the ammeter and voltmeter readings (Section *D*), showing 5040 watts.

13. Horsepower developed by motor is given by the abscissa corresponding to the watts ordinate on the 650 revolutions per minute motor curve. It reads 6.42 horsepower.

14. Per cent. left after slip is given in Section *E* by the ordinate from the shaft speed (1250) to the converging line from the reduced motor speed (650x2). It reads 96 per cent.

15. To obtain net motive horsepower, follow the 96 per cent. ordinate in Section *C* to its intersection with the line converging from the developed horsepower, and read the abscissa 6.16 horsepower.

16. Efficiency per cent. is given directly by the percentage ordinate from the pump horsepower (3.74) to the converging line of the net motive horsepower. It reads 60.7 per cent.

17. Peripheral velocity of impeller is given by the ordinate of its curve (Sections *D* and *E*) corresponding to the pump shaft speed. It reads 60.6 feet per second.

18. Head equivalent to peripheral velocity is given by the ordinate of its curve (Sections *D* and *E*) opposite the respective velocity, and reads 57.9 feet.

19 and 20. Inlet and discharge velocity heads are given by the ordinates of the equivalent head curve at the respective velocities on the velocity curve, reading 1.1 and 3.2 feet, respectively.

21. Power rejected in discharge velocity is given by the intersection of the horsepower curve from the total quantity with the discharge velocity equivalent head, and reads 0.28 horsepower.

22. Ratio of total head to peripheral velocity head is given by the percentage ordinate (Section *C*) from 4.45 to the line converging from 5.79, the decimal point being shifted in both one place. It reads 76.7 per cent.

23. Ratio of suction head to total head is given in the same way by the percentage ordinate of 0.96 to the line converging from 4.45, reading 21.5 per cent.

24. Ratio of rejected head to total head is given by the percentage ordinate of 0.32 to the line converging from 4.45, reading 7.2 per cent.

It is evident that the accuracy of the computations depends mostly upon the scale of the diagram. In any case it is just as accurate as the ordinary slide rule. The only objection which can be made at first sight is that it is hardly worth while to construct a set of curves for one single case. Well, don't do it unless you have a few cases to apply it for. But this diagram can hardly be limited to a single case, even if desired. The weir curves are always good for the same notches; the horsepower curves are good for any pump, the limit being extended by shifting the decimal point, and the percentage curves are always good. Above all, the training acquired by combining a similar set of curves is more than enough to compensate the time spent on it, no matter how valuable that time may be.

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# The Law of Mixed Vapors Applied to the Steam Plant

By W. H. Booth

The law as to the pressure exerted by two gases inclosed in a space is that the pressure will be the sum of the pressures exerted by each gas if separately inclosed, that is to say, that if a pound weight of oxygen exerts a pressure of 14 pounds per square inch when inclosed in a given cylinder and if a pound of nitrogen exerts a pressure of 16 pounds when separately inclosed in the same vessel, then if both these gases be inclosed together the two pounds of mixed gas will have a pressure of 30 pounds per square inch. From this fact it may be argued that gases are not similar in constitution to light porous bodies, in the cavities of which other gases may be hidden away like so much sand poured in amongst a lot of round pebbles. The fact may be argued to add support to the kinetic theory of gases, which lays down that a gas is simply an aggregation of atoms possessed of violent automobile properties, that gas pressure is but the combined effect of the bombardment of these atoms upon the containing walls. It explains why gases diffuse and it explains many other peculiar matters connected with their behavior.

Some gases can be thus mixed and will be found not to obey the above law. When such is the case the conclusion to be drawn is that they are not inactive toward each other, but that they combine and have combined by the simple process of mixing or they have so far come into closer relations as to indicate that they are ready to combine. Thus, ordinarily gases
do not go into solution with each other i
the same way that they and solid bodie
pass into solution with water. Salt, fo
example, will disappear from sight i
placed in water, but a cubic inch of sal
may be added to 99 cubic inches of wate
and 100 cubic inches of salt water wil
not be obtained. The reason is that i
some way the atoms of salt have hidde
themselves in the pores of the water. I
it is assumed that all bodies are built u
of numerous atoms or molecules, and tha
the molecules of a liquid are shaped lik
flat disks and rotate about a diametra
line, then each molecule will occupy th
space of a sphere of which the disk i
simply an equatorial slice. It is clear tha
such a disk, when rotating and generatin
a spherical space, does not fill that spheri
cal space, but that on its flat faces i
could carry a smaller molecule of sal
and continue to rotate inside the sam
spherical space.

Many salt solutions deposit their dis
solved salts at high temperatures. I d
not know if any explanation has bee
put forward which satisfactorily explain
why this is so, but it might be suggeste
that since heat adds mobility to molecule
it is possible that the molecules of th
liquid begin to acquire some of the aut
mobility they will fully possess wh
thoroughly gasefied by a continuance
heat application, and that being done i
rapid movement to and fro the molecul
of salt are rubbed off in the collision
However, I am traveling into fields not
immediate interest in connection with th
subject in hand.

Dalton's law of mixed gases does n
hold good when there is present the liqu
from which, say, one of the gases has bee
evolved. If water at a temperature of 2
degrees Fahrenheit is present in a bo
which is otherwise empty, the vapor
that water will fill the box at a pressu
of 12 pounds absolute per square inc
Assume the box to be full of air at atm
pheric pressure of, in round numbers,
pounds pressure. Close up the box tight
at a temperature of 202 degrees and intr
duce some water, also at 202 degre
Fahrenheit, through a small pipe. No
according to the appearance of the law
mixed gases, one would suppose th
since the tension of water vapor at 2
degrees Fahrenheit is only 12 pounds,
vapor would rise into the space above
occupied by air at 15 pounds, but this
not so. The water vapor would rise a
as much water vapor would occupy ea
cubic foot of the space of the box
would have done so had no air be
present. The pressure would be
pounds. The water must apparently se
off into the space about it a definite qua
tity of vapor per cubic foot, no matt
whether that space be occupied by oth
gases or whether it be empty. This a
pears to show some difference from
law of mixed vapors, which would at fi
thought lead one to suppose that

forcing of air into a vessel containing water vapor would lead to the condensation of some of the water vapor back again to water on the ground that the pressure of the vapor space was already higher than that of the water vapor at 202 degrees Fahrenheit, and therefore that there was no need for the water vapor to be present to the same extent. As Rankine puts it, the space above a liquid must contain a certain weight of the vapor of that liquid, no matter what other gas be present, so that if this be so, the two mixed gases do after all obey Dalton's law of mixed gases, and if this matter is clearly grasped, it will be a great help in understanding some things about steam boilers and condensers that have perhaps appeared a trifle puzzling.

### Air in Boilers

Let us take only two instances. The first shall be the case of the boiler newly started up from cold water. The fire is started and in due time the pointer of the pressure gage begins to move and finally stands at the working pressure. The engine is started and at once pressure falls off in a most remarkably quick manner. A usual explanation of this is that the water in the boiler has not been thoroughly circulated and some of it is less hot than it should be. The opening of the steam valve has caused a better circulation and has brought the colder water into movement and so cooled the remainder as to reduce the steam pressure. This explanation is sound; probably it explains correctly a portion of the drop in pressure and is therefore credited with all the trouble. But the trouble will remain even with such boilers as are fired below and the water in which must be equally hot throughout.

Let us, in the light of the law of mixed vapors, endeavor to find another solution. Suppose the working pressure to be 90 pounds absolute, corresponding with a temperature of 320 degrees Fahrenheit, and the air to be imprisoned at a temperature of 60 degrees Fahrenheit, or say 520 degrees absolute. It is now heated to 320 degrees Fahrenheit or 780 degrees absolute. Its pressure will no longer be 15 pounds, but

$$15 \times \frac{780}{520} = 22 \textit{ pounds, nearly.}$$

Now 90 — 22 = 68, so that it may be concluded that since the air imprisoned in the boiler steam space has a pressure of 22 pounds, that of the water vapor must be 68 pounds. But the temperature of water at 68 pounds vapor pressure is only 301 degrees Fahrenheit, and this must therefore be about the boiler temperature. Actually the boiler temperature will not be far from that corresponding with 69 pounds pressure, or say 302 degrees Fahrenheit, for the air will not be 320 degrees Fahrenheit as first assumed, but only 302 degrees Fahrenheit, and its pressure will be about 21 pounds, thus bringing up the total pressure to 90 pounds absolute.

When the opening of the stop valve lets out the mixed vapor of air and steam and only steam now rises from the water to fill the space, the pressure naturally drops to that proper to the temperature, and we begin to learn that the steam engine is a heat engine working by virtue of heat, and that did we really mean to be scientific and accurate, we should not measure the pressure in a boiler as we do now, but we should employ a thermometer fixed in the steam space, mark this at the working temperature and only when we saw that the temperature was 320 degrees should we open the stop valve, when we had a pressure of mixed vapors of 112 pounds, for the steam would be at 90 and the air would be at 22 pounds. But right here we run against snags. We do not want to have a pressure of 112 pounds in the boiler because the people at Hartford allow only 90 pounds. Nor do we care to employ a thermometer because they are less apt to be mechanically durable than pressure gages. Experience, moreover, has taught firemen that the first pressure got up in a boiler filled cold is apt to be illusory, and he has got to know that if he opens the safety valve he can allow the imprisoned air to escape. But if this be not done he may find when he tries to start the engine that his boiler is still 20 degrees below starting temperature and he will have to fight for steam. Experience has taught him what to do, but unless he has learned something of physical laws he does not know why he does it.

### Increasing Vacuum in Condenser

Let a second example illustrative of the same phenomenon be taken. If no air be present, the temperature of water must always correspond with the pressure of its vapor. If a steam gage shows 20 pounds absolute pressure, which is 5.3 pounds of gage pressure, a thermometer will show 228 degrees Fahrenheit. If not, then one or both of the instruments are wrong, or there is air present with the water vapor. It is not uncommon to see the gage on a condenser showing about 12 pounds vacuum, or say 2.7 pounds absolute pressure, when the condenser discharge is only 100 degrees Fahrenheit, a temperature that corresponds with less than one pound absolute pressure. What can be learned from this contradictory state of affairs? It can be determined from any table of the properties of saturated steam that the vacuum corresponding with a temperature of 100 degrees Fahrenheit is something better than 13.7 pounds, because the absolute pressure corresponding is less than one pound. There is an actual shortage of nearly two pounds of vacuum, or if the mean pressure throughout the stroke be 40 pounds, there is a loss of not less than one-twentieth of the fuel, or 5 per cent. The vacuum ought closely to correspond with the temperature, and whenever such is not the case there must be air or other noncondensible gas present to cause the discrepancy.

In most modern plants the water is used again and again, and is pretty well purged of its air. The fact that so much air is still to be found in the condenser would indicate that there must be some inlet air leakages about the plant. Air may get in at bad pipe joints; it may creep in about low-pressure glands or it may get through the porosities of cast iron pipes, through the spongy metal about chaplets or in various other ways.

Among men in charge of steam plants, especially when their training has been more electrical than mechanical, there is a tendency to look for a vacuum of 26 inches, and if it is not there, to buzz the air pump round until it is there and to run a lot of unnecessary water through the condenser, already amply cold. Now if 26 inches of vacuum is the proper and desirable degree, then the condenser temperature should be about 120 degrees Fahrenheit. Let the engineer shut off the circulation until the air pump discharge shows itself at 120 degrees Fahrenheit, and then note the vacuum. The difference from 26 inches will be due to air, and if great, it must be caused by leakage unless the air pump be ridiculously too small. With any fairly proportioned air pump it should not be far different. If the air pump be of fair dimensions, or in any case, let the vacuum be improved by running the air pump as fast as possible. Then let it be quickly run at normal speed and the vacuum gage watched. If the vacuum falls off very slowly, this will tend to show that the air pump is too small. If, as more probably will be found to be the case, the vacuum quickly goes back again, the trouble is certainly due to air leakage, and the remedy is to stop this. The cure may be the use of softer and better rings in the joints of injection or exhaust pipes, or it may be a few gallons of paint for the pipes. A better packing for the spindles of valves on the exhaust system may be needed.

The modern use of metallic piston and valve-rod packings is often responsible for air leakage at glands under low pressure. Metallic packing was chiefly intended for high temperatures, and is used where high-pressure steam is employed. But low-pressure cylinders are not hot, even if the first cylinder uses superheated steam, and some fibrous packing is a good thing on all low-pressure rods to stop the air leakage at such points. All this is borne upon by the law of mixed vapors. Every ounce of discrepancy between the things which are and those that should be in respect to vacuum is to be explained by this law, and it is no use trying to manufacture high vacua by means of too high an air-pump capacity, for the air pump requires power to drive it and every extra inch of vacuum pumped up costs more than it is worth on this basis.

Generally, as regards air-pump capacity, it must be remembered that if the condenser has a capacity of, say, 10 cubic feet and the pump takes 1 cubic foot, it will empty one tenth of the air out of the condenser every stroke, so that at 100 strokes per minute it will empty the condenser ten times. If the condenser temperature is about 100 degrees Fahrenheit, the pressure of the vapor is one pound, and if the vacuum is 12.7 there is a total absolute pressure of two pounds in the condenser, and the second pound is that of the air which is at one-fifteenth its normal atmospheric density. Now, one-fifteenth of 100 cubic feet is nearly 7 cubic feet. When running at 100 strokes per minute of 1 cubic foot per stroke, the pump draws out 100 feet of air of one pound pressure, or say 7 cubic feet of free air. In such a case as this there must therefore be a total leak of 7 cubic feet of free air per minute. Reduce this leakage to one-half and there would now be air in the condenser at one-half pound pressure and steam at one pound, or a total absolute pressure of 1½ pounds, which shows a vacuum of 13.2 pounds. No amount of air pump capacity could ever improve the vacuum beyond that proper to the temperature, for the water would give off vapor to fill the space.

The vacuum of every system ought to be tested at regular intervals, and it should be possible to keep rods and pipes in such order that during an hour of stoppage not more than 15 per cent. of a high-class vacuum should leak off. It is quite usual in modern plants to put in some kind of a second-stage air pump, the ordinary air pump being fed with air that has been pushed up to it either by a steam jet or by an exhauster similar to the Beales gas exhauster. The addition of a very small pressure additional to that in the main body of a condenser will feed the air to the second-stage air pump at a considerably greater proportionate density. Thus, if only a fourth of a pound be added to an air pressure of one pound, the improved efficiency of the air pump will be 25 per cent., and the vacuum will be improved 10 or 12 per cent. at ordinary condenser temperatures.

A knowledge of the law of mixed vapors helps greatly to put us on our guard in respect to air-pump losses, for it is known thereby to what cause to look for faults, and foolish things are not done to improve a vacuum, the poverty of which is due to some other factor. In nine cases out of ten the trouble with poor vacua is leakage of air inward that might be prevented. One may take the paint pot to some men and they will not listen, because a paint pot and brush appear far too simple as remedies. These are men who want the river of Damascus to flow through their condenser troubles. They are not satisfied with the insignificant stream of Jordan. To satisfy this craving for something big in the way of cure, thousands of dollars may be spent where tens would suffice, and it is against such unnecessary expense that a little acquaintance with natural laws may sometimes put a man on his guard.

# The Relation of the Character of Coals to the Prevention of Smoke*

By D. T. Randall

The semibituminous and bituminous coals are the most extensively used of all the fuels which are available for generating steam. Containing as they do a considerable quantity of volatile matter which is given off when the coals are heated in the furnace, it is difficult to burn them under boilers so as to secure perfect combustion and freedom from smoke. Specially designed furnaces and careful operation are required to get good results.

The difference in the character of coals is only partly shown by the proximate analyses which are commonly used, but to one familiar with coals these analyses indicate in a general way the leading characteristics of the coals.

To show the difference in fuels, Table 1 has been prepared.

TABLE 1. ANALYSES OF FUELS AS DELIVERED AND USED.

| | Coke. | Anthracite Pea Coal. | Pocahontas Coal. | Pittsburg Coal. | Indiana Coal. |
|---|---|---|---|---|---|
| Moisture | 4 67 | 4 75 | 1 12 | 2 48 | 9 62 |
| Volatile matter | 2 82 | 2 90 | 17 24 | 38 74 | 36 14 |
| Fixed carbon | 82 61 | 77 15 | 74 84 | 49 18 | 41 22 |
| Ash | 9 90 | 15 20 | 6 80 | 9 60 | 13 02 |
| | 100.00 | 100 00 | 100 00 | 100 00 | 100 00 |
| Sulphur | ........ | 0 80 | 0 71 | 1 85 | 4 43 |
| B.t.u. | 12,206 | 11,886 | 14,530 | 13,172 | 11,122 |

It will be noted that coals vary both in their composition and in their heating values (B.t.u.), and in consequence they are more or less valuable as fuel, depending on these variations.

Other things being equal, a fuel high in fixed carbon is more easily burned in a common furnace without loss of heat and without smoke than those of lower percentages. Coke and anthracite coals are examples of this class of fuels.

The percentage of moisture is not of great importance except in cases in which the coal is naturally high in moisture, or in which the coal is very wet as a result of washing or exposure to storms. Moisture in small percentages seems to aid combustion, but in larger amounts it retards the ignition of the gases and lowers the furnace temperature. It may or may not increase the smoke, depending on the character of the fuel.

The percentage of ash, and especially the character of the ash, is of importance in connection with the smoke problem. Ash which is fusible and runs down onto the grate bars may cause smoke by shutting off the flow of air through the fuel and by increasing the poking which is necessary to keep the grates free. Coals which clinker badly require more attention from the firemen and poking the fire is a common cause of smoke.

There is a great difference in the behavior of the same coals when burned under different furnace conditions and in different furnaces. Some grates and stokers are adapted to handle coals which are burned with great difficulty on other equipment.

The rate of burning per square foot of grate is often the deciding factor as to whether a given coal may be used or not. This is principally due to the higher temperatures which are obtained with high rates of combustion, and the effect on the fusible portion of the ash of the coal. Investigations are now being made to determine the characteristics of the ash of representative coals as related to the clinker formed at various temperatures.

As far as smoke is concerned the volatile matter is of the greatest importance. The quantity of volatile matter is not a true measure of the difficulty of burning a coal, but to one familiar with the various coal fields it is of great assistance in choosing a suitable coal or in designing a furnace suited to the given coal.

Investigations relating to the nature of volatile matter in representative coals have been carried on at the Government fuel-testing plant at the University of Ohio, and at the University of Illinois.

The results show that the differences in the gases given off from coals may be due to the composition of the coal and to the temperature to which the coal is subjected when placed in the furnace. The higher temperatures tend to distil the volatile matter more rapidly and drive off the heavy hydrocarbon in forms which are difficult to burn without smoke.

Table 2 gives some idea of the complicated relation between the temperature of the coals in the furnace and the compositions of the various gases to be burned. Investigations of this character are necessary to determine the characteristics of coals from each of the representative beds.

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*Read at the Syracuse meeting of the International Association for the Prevention of Smoke, June 24 to 26, 1909.

The combustion of coke or other fuels high in fixed carbon is comparatively simple The greater portion of the fuel is burned on the grate; the remainder in the form of gas burns at a short distance above the bed of fuel. This may readily be observed on a fire of anthracite coal in which there is only a small percentage of volatile matter.

TABLE 2. ABSOLUTE QUANTITIES OF SMOKING PRODUCTS IN TEN MINUTES' HEATING AT DIFFERENT TEMPERATURES.

| Coal. | Temperature, Degrees C. | | Smoking Products. | |
|---|---|---|---|---|
| | Furnace. | Coal. | Tar, Per Cent. | $C_6H_6$—c.c. |
| 3 Connellsville | 600 | 441 | 4.9 | 1 |
| 1 Ziegler | 600 | 410 | 6.8 | 51 |
| 3 Connellsville | 700 | 562 | 11.0 | 145 |
| 1 Ziegler | 700 | 545 | 7.8 | 24 |
| 16 Pocahontas | 700 | 599 | 4.2 | 138 |

*See paper by Porter and Ovitz in *Journal* of American Chemical Society, Vol. XXX.

In burning bituminous coals, however, the difficulties are much greater and for the reasons given. The volatile matter from some coals is set free more readily than from others and with some coals the nature of the volatile matter given off is such as to make it very difficult to secure complete combustion. Smoke is an indication of incomplete combustion and the problem of reducing the amount of smoke is important, not only from the standpoint of the smoke inspector, but also because of the losses in combustible gases such as carbon monoxide (CO) and hydrogen which escape with the smoke.

TABLE 3. SHOWING RELATION OF SMOKE TO CO IN FLUE GASES.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Average per cent. of black smoke | 0 | 7.1 | 15.5 | 24.7 | 34.7 | 43.1 | 52.9 |
| Average per cent. CO in flue gases | 0.05 | 0.11 | 0.11 | 0.14 | 0.21 | 0.33 | 0.35 |
| Number of tests averaged | 37 | 18 | 56 | 51 | 36 | 17 | 4 |

*See United States Geological Survey Bulletin 325, pages 101 and 167.

Experiments by several investigators have shown that whenever smoke is given off there is also a considerable quantity of carbon monoxide gas and that as a rule this gas is accompanied by small percentages of hydrogen and hydrocarbon compounds. The losses due to these combustible gases which are found in connection with a smoky stack may vary between 1 and 10 per cent. of the fuel.

When burning a bituminous coal, the volatile matter must be raised to a high temperature while mixed with a sufficient quantity of air and burned on its passage from the fuel bed to the surfaces of the boiler. In most boiler settings this distance for combustion is very short and when the gases strike the cold surfaces of the boiler shell or tubes they cool below the temperature at which they will burn rapidly and as a result some escape unburned and others are only partially burned, as shown by the heavy deposits of soot. In properly designed furnaces the space provided for combustion is large for coals giving off high percentages of volatile combustible. Even in such furnaces the firing must be carefully done or at times enough air cannot be supplied to the gas, and smoke results for short periods. In most plants the time required for the gases to pass from the fuel bed to the top of the stack is between 10 and 15 seconds. Assuming the velocity to be reasonably uniform at different sections, it will be seen that the gases pass from the fuel bed to a distance of, say, 12 feet in one second. At the end of this period there is but little opportunity for the gases to burn. This will make clear the great importance of a sufficient air supply, properly distributed, and an ample space above or back of the grates in which the gases may thoroughly mix and burn within considerably less than one second of time.

TABLE 4. SHOWING RELATION BETWEEN CO IN FLUE GASES AND OTHER COMBUSTIBLE GASES.*

| | Smoky. | | | | Clear. | | | |
|---|---|---|---|---|---|---|---|---|
| Boiler<br>Furnace | $CO_2$ | CO | $CH_4$ | $H_2$ | $CO_2$ | CO | $CH_4$ | $H_2$ |
| Hand fired | 10.95 | 3.00 | 0.70 | 3.23 | 8.15 | 0.0 | 0.0 | 0.0 |

*See Manchester (England) Smoke Abatement Report.

That there is a loss due to the volatile gases escaping unburned from an ordinary furnace is shown very clearly by the results of tests made on house-heating boilers. Table 5 gives figures obtained on two series of tests for the purpose of determining the fuel values of several coals and briquets,* when burned in a house heating boiler.

The furnace in which the results shown in Table 5 were obtained is best suited to coke, anthracite, or low volatile coals, and, as will be seen, is not adapted for burning bituminous coals with good efficiency, yet many furnaces having practically the same features, such as a grate surrounded by heating surface, and a small combustion chamber, are used in power plants for burning high-volatile coals.

Even with furnaces of improved design it is difficult to charge the coal by hand firing and secure smokeless combustion. This is due to the fact that a comparatively large quantity of gas is liberated immediately after firing. At the same time the fuel bed has been thickened and the air enters with more difficulty and without being well distributed with respect to the gases rising from the bed. With such a furnace the loss of combustible gases may be reduced to 5 per cent., or less, depending on the coal and the operation.

It is because of the advantage in having the coal gradually heated and the gases distilled from it at a low temperature that a mechanical means of feeding the coal to the furnace is usually more successful in the prevention of smoke.

TABLE 5. THE RELATION OF VOLATILE MATTER OF SMOKE AND UNCONSUMED GASES.

| Number of Tests Averaged. | Volatile Matter in the Combustible. | Ash in Dry Coal. | Efficiency | Black Smoke. | CO in Dry Flue Gases. |
|---|---|---|---|---|---|
| 1 | 18.30 | 8.00 | 60.56 | 18.2 | 0.44 |
| 12 | 22.71 | 8.94 | 56.33 | 18.0 | 0.50 |
| 7 | 31.70 | 11.27 | 54.11 | 22.1 | 0.55 |
| 11 | 38.79 | 15.02 | 47.19 | 30.8 | 0.62 |
| 16 | 44.46 | 14.57 | 47.19 | 32.9 | 0.74 |

A good furnace should permit the burning of bituminous coal in sufficient quantities without loss of escaping gases or the formation of smoke when the air supply is about 50 per cent. in excess of the theoretical amount.

It has been found by experience that to approach this performance, the coal

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*See United States Geological Survey *Bulletin* No. 366.

must be fed regularly in small quantities, gradually heated [illegible] an ample [illegible] at [illegible] to mix with the [illegible] gases. [illegible] for burning the gases should be large and preferably enclosed in firebrick.

A furnace suitable for certain coals may be [illegible] unsuited to other coals and it is only after a careful study of all the factors, such as power to be generated, size and kind of boiler to be used and the coals available, that an engineer can undertake to design a furnace which will be satisfactory and at the same time give good economy under operating conditions.

Even after the best types of furnace are installed it is necessary to supervise the operation of the boiler plant closely in order to secure the best results. The proper drafts, the best thickness of fire for any given coal when burned on grates at the rate required for the plant, and the best method for the removal of ash and clinkers to prevent loss of fuel into the ashpit are all factors in securing the highest economy. Failure to attend to these important details may easily cause a loss of as much as 10 per cent. in the fuel fed to the furnaces. In conclusion:

1 Even well designed furnaces may be expected to give off smoke if *improperly operated*, or under any of the following conditions:

(a) When a new fire is built in a cold furnace.

(b) When an excessive amount of coal is burned on the grate, making it difficult or impossible properly to mix the air with the gases and burn them in the furnace.

(c) When the rate of combustion is suddenly changed, due to a change in demand for steam, for the same reasons as under (b).

2 Smoke may be reduced and in most cases prevented.

(d) By burning a fuel having a small amount of volatile matter.

(e) By burning a bituminous coal in a specially designed furnace with more than ordinary care on the part of the fireman, under the supervision of a competent engineer.

In discussing before the Engineers' Society of Western Pennsylvania, the promising field for the steel oil derrick, R. B. Woodworth made mention of the fact that the total of wells drilled in 1907 in the United States for oil and gas was 22,765, apart from which there was a large number of salt wells, artesian wells and other bores of great depth that made the year a notable one in deep drilling.

In an acetylene-gas compressing plant, the job that is refused by the man who knows might be readily accepted by the man who doesn't.

# Waste by Careless Operation of Electric Elevators

By C. M. Ripley

An electric passenger elevator driven by 30 horsepower motor on a 220 volt circuit is generally fused for 150 amperes. Assuming that it requires four seconds for the car to gain its maximum speed, and that electric service costs 10 cents per kilowatt-hour, the cost of merely starting the elevator will figure out as follows:

150 × 220 × 4 = 132,000 *watt-seconds;*
132,000 ÷ 3600 = 36.6 *watt-hours or* 0.0366 *kilowatt hour;*
0.0366 × 10 = 0.366 *cent, or over a third of a cent.*

In a building with, let us say, one elevator, serving six floors continually for eight hours, this waste in power would be considerable if the operator had to make one unnecessary start on each trip, or two unnecessary starts for each round trip. If this car made 84,000 round trips in a year, the power waste would cost over $60. And if this average held good in buildings with ten elevators instead of one, with 24 hour service instead of 8-hour service, and with 20 stories instead of six stories, the loss would mount up to something over $3000! The wear and tear on switch contacts, controller contacts, controller magnets, commutator, armature, steel worm, bronze gear or gears, thrust plates, ball bearings, armature bearings, drum-shaft bearings, the car cables, the counterweight cables and the back-drum cables are all materially increased also by increased starting.

The engineer is the one held responsible if the expenses for repairs of one building average higher than that of another building of similar size and similar service. Therefore, any unnecessary strains and wear will not only damage his reputation, owing to the resulting increased cost of operating expenses and repairs, but his attention will be diverted from the bigger problems of power-plant operation because of the added repairs which demand time and thought.

In business buildings it is my opinion that each car should contain a sign announcing that the car positively will not return to a floor after passing it, until it makes the next regular return trip. Of course this rule could not be enforced with propriety in such buildings as hotels and apartment houses, but even in such buildings, as in fact in all buildings, the operators should be instructed about the double loss which their carelessness will cause, and cautioned about making careless stops which involve one or two extra starts per trip.

In addition to the waste of power caused by unnecessary starts, there is the tremendous strain to which the apparatus and cables are subjected when the car is suddenly stopped on the down trip; there is also the liability of burning out armatures by hasty reversals. Most elevator controllers are designed now so that the current cannot be sent through the motor in the reverse direction until the armature has ceased revolving. But there are many controllers still in use which are not so equipped, and motors operated with such controllers can easily be damaged by suddenly reversing the car switch before the motor has stopped revolving. If an elevator operator reverses his switch to the "down" position before the motor has fully ceased rotating in the "up" direction, the effective voltage at the armature terminals will be practically the sum of the line voltage and the counter electromotive force of the armature instead of the difference between the line voltage and the counter electromotive force, or almost twice the line voltage, with nothing to oppose it but the very low resistance of the armature winding and connections. This would result in a flow of an enormous current—sufficient to burn up the armature in short order—if the safety fuses did not melt promptly.

In this connection—the starting and running currents—the accompanying table of data for some of the standard Otis motors will be of interest.

OTIS ELEVATOR MOTOR DATA.

| No. of Motor. | R.P.M. | H.P. | Running Amperes. | | Starting Amp. | | Torque, Pound-feet. | Fuse Capacity. | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 220V. | 500V. | 220V. | 500V. | | 220V. | 500V. |
| 2 | 800 | 7.5 | 25.5 | 11 | 35 | 15 4 | 120 | 50 | 15 |
| 2½ | 800 | 10 | 34 | 14.7 | 45 | 19 8 | 140 | 50 | 25 |
| 2 | 1000 | 10 | 34 | 14.7 | 45 | 19 8 | 120 | 50 | 25 |
| 3 | 800 | 15 | 51 | 22 | 60 | 26 5 | 240 | 75 | 50 |
| 3½ | 800 | 17.5 | 59.3 | 25.7 | 75 | 33 | 250 | 75 | 50 |
| 4 | 800 | 20 | 68 | 29.5 | 100 | 44 | 330 | 100 | 50 |
| 4½ | 800 | 22 | 74.5 | 32.5 | 110 | 48 | 360 | 125 | 50 |
| 4 | 1050 | 25 | 85 | 36.7 | 110 | 48 | 330 | 125 | 50 |
| 5 | 800 | 30 | 102 | 44 2 | 125 | 55 | 375 | 125 | 75 |
| 5½ | 800 | 30 | 102 | 44.2 | 135 | 60 | 375 | 150 | 75 |

Coals which smoke badly give efficiencies 3 to 5 per cent. lower than coals burning with little smoke.

Smoke prevention is possible. There are many types of furnaces and stokers that are operated smokelessly.

# The Single Phase Induction Motor

## Characteristics of This Type of Machine, Where It Is Used and a Comparison of the Various Methods of Starting, with Connection Diagrams

BY R. H. FENKHAUSEN

Although the various types of single-phase motor have been developed to a high degree of perfection, few, if any, of this general class may be said to equal in performance either the polyphase induction or the direct-current shunt-wound motors. This is due to the fact that the single-phase motor can exert no torque when at rest, excepting, of course, the series type. To overcome this inherent defect, practically all single-phase motors contain some more or less intricate device to render the motor self-starting. Most of these devices give only enough torque to start the motor light, and the load is picked up by some form of centrifugal clutch pulley after the motor has reached about half speed. It is in these auxiliary devices, rather than in the motor itself, that most single-phase motor troubles will be located.

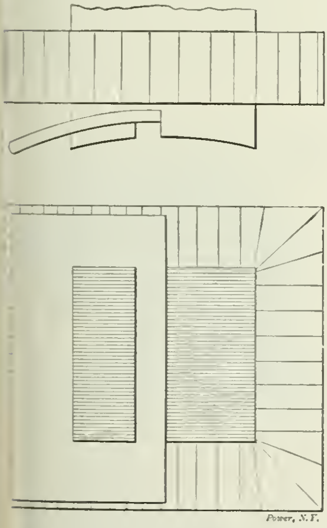


FIG. 2. THE SHADING COIL

The largest field of usefulness for single-hase motors will be found in towns and nall cities, or in the residence portions f the large cities, where direct or poly-hase currents are seldom available, these istricts usually being supplied with 110-20-volt three-wire, or 220-volt two-wire ngle-phase circuits.

Single-phase motors may be broadly vided into three types; the induction motor, which is adapted for constant speed service; the series motor, which is adapted for varying speed service, such as hoisting and railway work, and the repulsion motor, which possesses some of the characteristics of both of the other types.

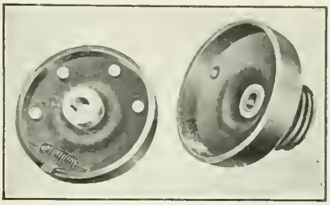


FIG. 1. A TYPE OF CLUTCH PULLEY

Single-phase motors of the induction type are similar in appearance and general construction to the familiar polyphase motor, and are obtainable either for hand-starting or self-starting. The hand-starting motor is made only in sizes of one-half horsepower and under. It starts with equal facility in either direction, and will pick up its full rated load, if the rotor is run up to a speed of about 300 revolutions per minute by a quick pull on the belt. This type of motor is obviously not adapted for direct-connection or for frequent starting and stopping. Its principal advantages are low price and simplicity, its construction being identical with that of a three-phase squirrel-cage motor, with one terminal of the stator winding omitted when intended for use without a starter.

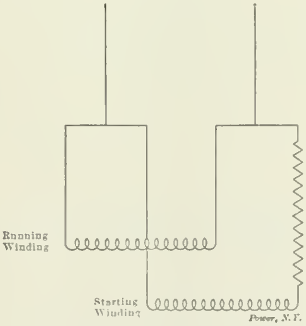


FIG. 3. SEPARATE WINDING FOR STARTING

All single-phase motors of the straight-induction type are rendered self-starting by means of an auxiliary-starting winding in combination with some "phase-splitting" device which causes the current in one winding to lag behind that in the other winding. This sets up a weak, rotating, magnetic field, similar to that of a polyphase motor, and the unloaded rotor starts and speeds up until about half speed is reached. At this speed the clutch pulley, one type of which is shown in Fig. 1, begins to pick up the load, and gradually takes hold until full speed is reached. One valuable feature possessed by these clutch pulleys is that an overload sufficient to slow down the motor will cause them to slip and prevent the motor from burning out.

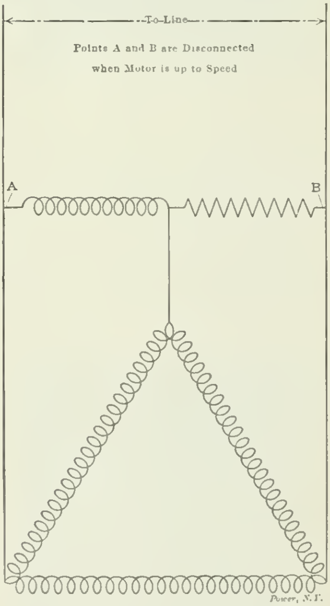


FIG. 4. THREE-PHASE METHOD OF STARTING

The simplest form of "phase-splitting" device is known as the "shading coil." Its use, however, is limited to fans and very small motors, because of its poor starting torque and low efficiency caused by the continuous losses in the shading coils. Reference to Fig. 2 will show the construction, which consists of a heavy copper ring which surrounds about one-third to one-half of the pole tips. The shifting magnetic field is cut by these coils, and this induces in them a lagging current which produces a weak revolving field.

Another means for phase splitting is found in those types of motor with two windings; one of which has a higher inductance than the other. This causes a sufficient phase displacement between the two windings to start the motor. The starting winding is cut out by a centrifugal governor arrangement when the motor attains full speed. The motors equipped with shading coils cannot be reversed, but those equipped with a starting winding may be reversed by interchanging the leads to the starting coils.

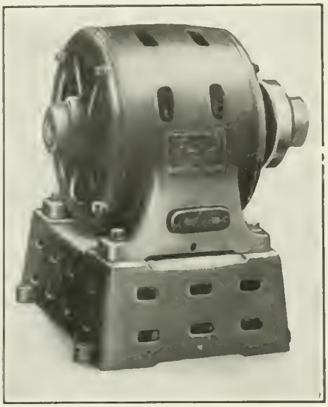
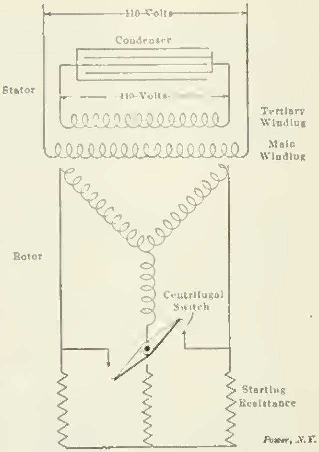


FIG. 5. GENERAL ELECTRIC MOTOR

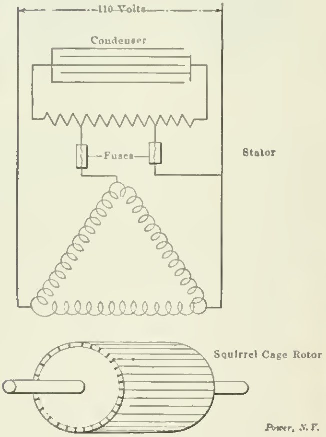
For starting the larger sizes of single-phase motor, one of the two methods shown diagramatically in Figs. 3 and 4 is employed. In Fig. 3, two windings are shown, the main winding and an auxiliary winding for starting. A resistance is inserted in the starting winding of the motor, which puts the current in that winding out of phase with that in the other winding, and the motor starts as an unsymmetrical two-phase machine. In Fig. 4 the motor is equipped with a symmetrical three-phase winding, two terminals, which are connected across the line, and the third connected to the junction of a resistance and reactance in series. The resistance and reactance are cut out of circuit when the motor comes up to speed.'

If a condenser is substituted for the resistance in Fig. 4, the performance will be improved, and some motor manufacturers leave the condenser in circuit all the time, thereby improving both the power factor and the efficiency of the motor.



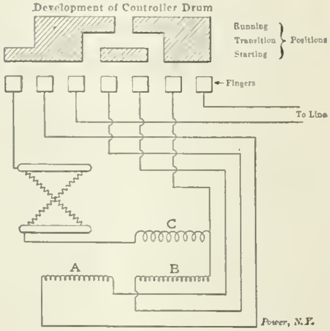
Power, N.Y.

FIG. 6. WOUND ROTOR AND CONDENSER IN BASE



Power, N.Y.

FIG. 7. EXTERNAL CONDENSER AND SQUIRREL-CAGE ROTOR



Power, N.Y.

FIG. 8. WINDING OF UNEQUAL RESISTANCE

Fig. 5 shows a General Electric motor which is connected as shown by the diagram, Fig. 6. The condenser is located in the sub-base of the motor, and the rotor has a three-phase "star" windin with resistance in circuit during the starting period. This resistance reduces th starting current taken by the motor, an is short-circuited by a switch actuated b a centrifugal governor after the moto comes up to speed. The construction o this motor is such that it is not readil reversible, but if reversed rotation is desired it may be accomplished by turnin the rotor end for end with relation t the stator.

In using motors of this type particula attention must be given to the clutc pulley, which will tend to pick up the loa with a jerk unless kept in good order This sudden picking up of the load wil cause severe voltage fluctuations, and consequently much dissatisfaction amon lighting customers on the circuit if no stopped. As no external starting apparatus is required, these motors can b started and stopped from a distance simpl by opening and closing the line switch and cannot be damaged even if the supply is interrupted and turned on agai without attracting the attendant's notice

Fig. 8 is the diagram of connections fo another type of single-phase motor wit three windings. These windings are o unequal resistance, the two running windings, *A* and *B* being of about four time the resistance of the starting winding *C* An oil-immersed drum switch with phase splitting resistance is used with this motor The drum contacts are shown shaded i the drawing. The motor windings, *A* an *B* are in series at starting and the winding *C* is in series with the resistance When the starting drum is thrown to th running position, the windings *A* and *B* are in parallel and *C* is cut out.

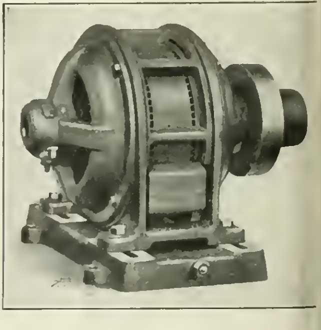


FIG. 9. SQUIRREL-CAGE ROTOR AND STATO WOUND THREE-PHASE

The rotor of these motors is of th squirrel-cage type, and it is equipped wit a clutch pulley of the same general typ as described at the beginning of this article The direction of rotation may be reverse by reversing the terminals of the winding *C*. As this type of motor canno start when the switch is in the runnin position, an attendant should be at han in case the power is cut off, so that the motor will not be damaged when current is again turned on.

Fig. 9 shows a motor which has a squirrel-cage rotor and a stator wound three-phase. The starters for this type of motor operate on the principle of splitting the phase by means of resistance and reactance coils, as described in the previous article. The starter is connected to the motor with either three or six leads, the three-lead starters being used mostly on the smaller sizes of motor. Fig. 10 shows a three-lead starter, and the internal connections are shown in Fig. 11. A motor equipped with a three-lead starter may be reversed by interchanging any two of the three leads between the starter and the motor. A six-lead starter of the type used on larger motors is shown in Fig. 12. Reference to the diagram of connections for this starter, Fig. 13, will show the object of bringing all six of the motor leads to the starter.

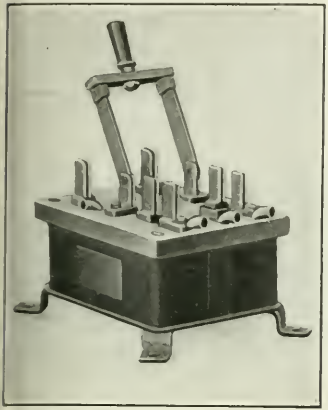


FIG. 10. THREE-LEAD STARTER

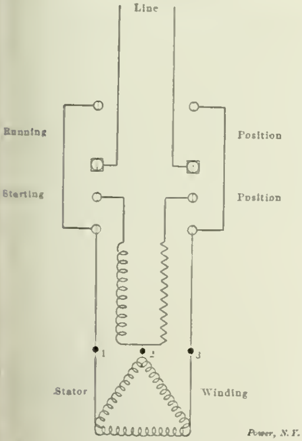
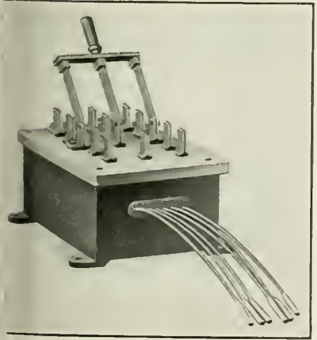


FIG. 11. CONNECTIONS OF THREE-LEAD STARTER


G. 12. SIX-LEAD STARTER USED ON LARGE MOTORS

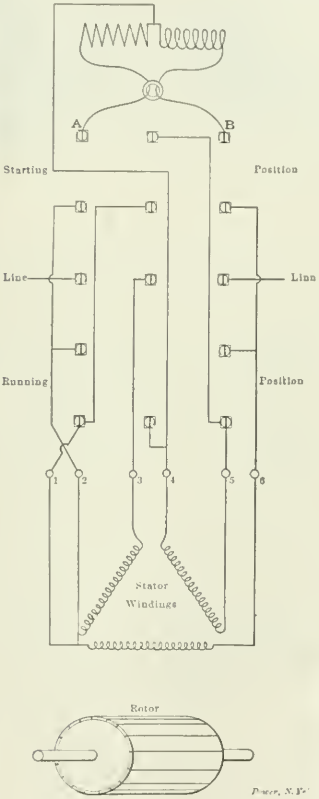


FIG. 13. CONNECTIONS OF SIX-LEAD STARTER

At starting the motor is star connected, thus reducing the voltage impressed on the windings and cutting down the starting current. When the starter is thrown to the running position the windings are connected in delta and the phase-splitting resistance and reactance cut out. The direction of rotation of motor equipped with six-lead starting boxes may be reversed by interchanging the leads *A* and *B*, Fig. 13, which extend through the switch base. As these motors cannot start with the starter in the running position.

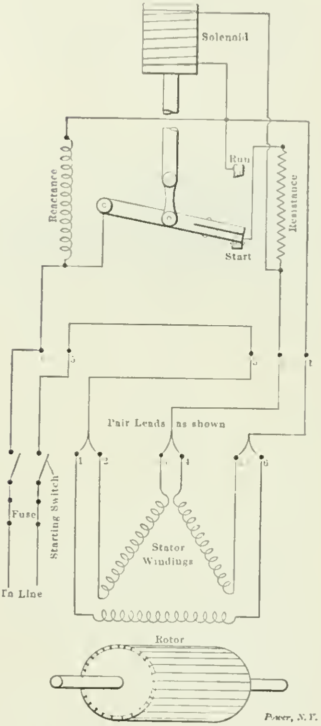


FIG. 14. CONNECTIONS OF SELF-STARTER FOR SIX-LEAD MOTOR

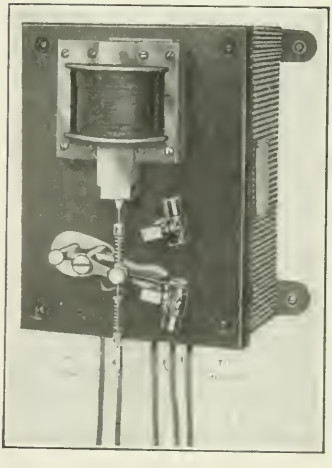


FIG. 15. EXTERNAL VIEW OF SELF-STARTER

the starter must be turned back to the "off" position if the power is temporarily cut off.

A type of self-starter adapted for use with this type of motor has recently been developed, and by substituting one of these for the hand starter, a motor will start and stop automatically simply by opening and closing a switch, which may be done at a distance. When a self-starter is to be used with a six lead motor, the leads must be joined in pairs, 1-2, 3-4, 5-6, as shown in Fig. 14. The external appearance of a self-starter of this type is shown in Fig. 15 and the type of clutch pulley used on the motors in Fig. 1.

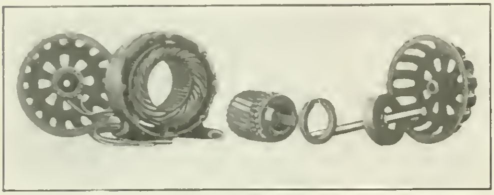


FIG. 16. NEW TYPE OF MOTOR

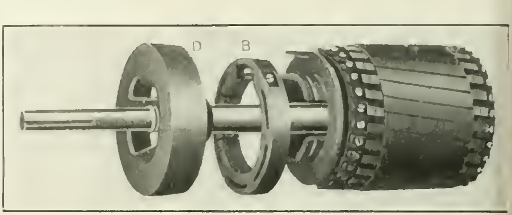


FIG. 17. SKEWED ARRANGEMENT OF ROTOR SLOTS

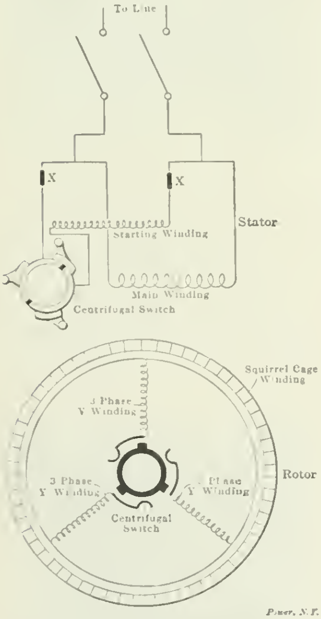


FIG. 18. INTERIOR CONNECTIONS OF NEW MOTOR

The motor shown in Fig. 16 has recently been placed on the market by the Westinghouse Electric & Manufacturing Company. The stator is equipped with two windings of unequal resistance. The winding having the higher resistance of the two is used only during the starting period and is automatically disconnected when the motor is up to speed. The low resistance winding is in circuit at all times and is the regular working winding of the motor.

The rotor slots of these motors are skewed as shown in Fig. 17, which represents the rotor used in the smaller sizes of motor. The rotors of the larger motors have a high resistance squirrel-cage winding to limit the starting current and also a low resistance three-phase winding star-connected. There is no current in this latter winding during the starting period, it being cut in by a centrifugal switch as soon as the motor comes up to speed. The skewed slots in the rotor of this motor materially reduce the noise during operation, and prevent poor starting torque in certain rotor positions.

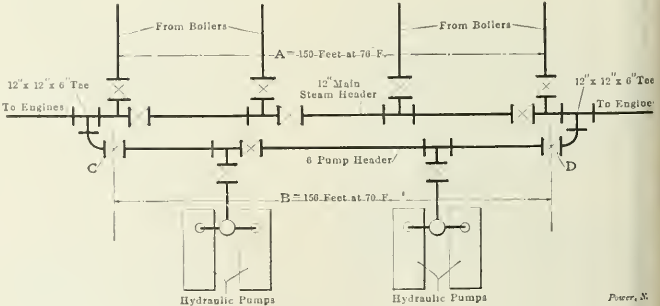
The driving pulley is keyed directly to the rotor shaft, the clutch feature being incorporated in the rotor itself. When the motor is started the rotor revolves freely on the shaft until about two-thirds of the full speed is reached, at which point the centrifugal clutch band *B* on the rotor, see Fig. 17, grips the drum *D* keyed to the shaft and gradually brings the load up to speed. The interior connections of this type of motor are illustrated in Fig. 18. The direction of rotation may be reversed by interchanging the leads to the starting winding at the connectors shown at *X*.

# Leaky Steam Pipe Joints and Wha Causes Them

By William F. Fischer

Leaky steam-pipe joints are a source o considerable annoyance around the power plant, not to mention the loss of time an the cost of repairing or repacking them

It is necessary in many cases to shut dow part of the steam line while making repairs or renewing gaskets, and this usuall throws one or more machines out of service while doing so. In some cases the engineer may repack a leaky joint, making it absolutely steam-tight, and in few days, or weeks, the joint is found t leak again as badly as before. In a cas of this kind the engineer should try t find the cause and remedy it if possibl before wasting any more time and mone in renewing gaskets and shutting dow for repairs



RIGID ARRANGEMENT OF PIPING

Excessive vibration in a steam line m in time cause the joints to leak by wor ing the pipe threads loose, or by loose ing the bolts on a flanged joint. Spaci hangers too far apart is another cau The weight of the pipe, fittings or valv impose a strain on the joints, putting t upper bolts in tension and straining t joint sufficiently to cause leakage.

Unequal expansion and contraction at the joints is another cause of leakage. A rill of water flowing along the bottom of the pipe is necessarily many degrees cooler than the steam flowing directly above it. This water (due both to the condensation of steam in the pipes and to priming or foaming at the boilers) is a poor conductor of heat and may at times be found comparatively cool even though the steam coming in contact with it is at a very high temperature. The water in coming in contact with the bottom of the pipe tends to lower its temperature at that point, causing a slight contraction of the lower fiber of the material. This contraction or shortening of the fiber may be in some cases sufficient to cause the water to leak through at the joints by causing them to open slightly. The water of condensation cools as it collects and in turn helps to condense other steam coming in contact with it. In all cases this water should be drained off as fast as it forms and the pipe should be pitched in the direction of the flow to prevent its accumulation in any quantity. It is known that water will leak through a steam-tight joint. This might be accounted for by the fact that when the water has been drained off, or swept past the joint, the hot steam coming in contact with the bottom of the pipe quickly raises its temperature and causes the metal to expand and close up the leak before the steam has much chance to escape. The fact that some joints leak water only, and that this leakage occurs only at times, would seem to prove that the joint does not leak until some water is present.

Probably nine-tenths of these leaky joints, however, are due to poor design of the piping system and to careless erection. One of the most difficult problems in the design of a system of steam piping is the proper provision for expansion and contraction due to changes in temperature. Where a plant is operated during the day and shut down at night, or *vice versa*, the piping system is alternately heated and cooled, thus setting up xpansion and contraction strains which end to cause leakage at the joints. Where he plant is operated continuously, as in he larger stations, there is less danger of he leakage from this source.

The sketch shows part of a system of team piping in a manufacturing plant. The 12-inch main steam header is fed rom four boiler leaders, steam being aken off from the header at each end to upply the engines. Running parallel to he main header is a 6-inch pump header, ed through the two 12x12x6-inch tees, wo 90-degree elbows and the two valves *C* and *D*. Note the short, rigid connection between the two headers.

The pump header is sometimes shut own entirely by closing valves *C* and *D* while the 12-inch main header is kept live to feed the engines, feed pumps, tc., in the plant. The joints in the 6-inch pump header were found to leak so badly as to require constant attention. What caused this leakage?

Referring again to the drawing, the piping measured 150 feet at *A* and *B* when installed, say, at 70 degrees Fahrenheit. Assume all the valves to be open and the whole system in operation. Take the temperature of the steam to be 470 degrees Fahrenheit, and the temperature of the surrounding air, 70 degrees Fahrenheit. This gives a rise in temperature of the pipe of 400 degrees. The coefficient of expansion of the metal in the pipe is 0.000007, or in other words, for every degree Fahrenheit rise in temperature above the initial temperature of the pipe, a piece of pipe 1 inch long will expand 0.000007 inch, or a length of 1 foot will expand,

$$12 \times 0.000007 = 0.000084 \text{ inch.}$$

Then for a rise in temperature of 400 degrees, 1 foot of the pipe will expand,

$$400 \times 0.000084 = 0.0336 \text{ inch,}$$

and 150 feet of the pipe will expand,

$$150 \times 0.00336 = 5.04 \text{ inches.}$$

Therefore dimensions *A* and *B* will be 150 feet at a temperature of 70 degrees Fahrenheit and 150 feet 5 inches long at a temperature of 470 degrees.

When the hydraulic pumps are out of service for the balance of the day and the pump header is shut down by closing valves *C* and *D* while steam is carried in the main header, the cause of leaky joints is readily apparent. The air surrounding the pump header gradually condenses the steam in the 6-inch pipe and lowers the temperature of the pipe to practically 70 degrees Fahrenheit. That portion of the pipe between valves *C* and *D* would then contract to its original length of 150 feet if free to do so. Steam is still on the main steam header, however, and the 6-inch pump header cannot resume its original length without bucking the main steam header.

Knowing the area of the metal in a cross-section of the 6-inch pipe the magnitude of the stress produced may be approximately determined as follows:

$$P = (T - t)\ A\ C\ E,$$

where

$P$ = Thrust, or force in pounds exerted by the pipe when expanding, or the pull when contracting or shrinking,

$T$ = Final temperature of the pipe, in degrees Fahrenheit when heated (in this case 470 degrees.)

$t$ = Initial temperature of pipe before heating (in this case 70 degrees),

$A$ = Area of metal square inches of a cross-section of the pipe,

$C$ = Coefficient of expansion of the metal in pipe (for this case 0.000007),

$E$ = Modulus of elasticity of material in pipe (for this case 30,000,000).

The area of metal in the cross-section of a 6-inch extra heavy pipe is usually given as 8.5 square inches. Substituting these valves in the formula,

$$P = (470 - 70) \times 8.5 \times 0.000007 \times 30{,}000{,}000 = 714{,}000$$

pounds tension in the 6-inch pump header. The stress per square inch of area, on the material in the pipe is,

$$\frac{P}{A} = \frac{714{,}000}{8.5} = 84{,}000$$

pounds per square inch. The stress per inch on the material at the threaded portion of the pipe would be even greater than the above as the area of the metal is reduced by threading.

These calculations give results close enough to form some idea of the cause of leakage in this and similar cases. The pump header should have been provided with a flexible expansion bend of long radius. The arrangement shown in the sketch should be avoided wherever possible, or else steam should be kept on both headers while the plant is in service.

The disastrous effects of expansion and contraction is frequently overlooked when designing the piping system, and if the engineer finds his pipe joints leaking excessively, the case might be found from some such condition as the above. Occasionally a boiler header is found running directly over the boiler nozzles and a short, stiff connection made between each nozzle and the header. This is a poor design inasmuch as when the header expands the boilers nearest the ends are pushed violently outward, thus straining the joints, loosening or cracking the boiler setting and causing air leaks which lower the furnace efficiency by cooling off the hot gases from the furnace. In a carefully designed system of piping, connections are always made between the boiler nozzles and main header through flexible bends of long radius, and very little if any of the above trouble is experienced.

After seeing the way some pipe jobs are put in, one often wonders how they ever hold together long enough to become old in service. They seem to do so, however, but usually at the expense of the engineer who is continually tinkering at the joints in order to keep them tight. In letting out a contract for the pipe work in a power plant, large or small, one should be careful to choose a contractor having experience with this class of work, and one who is reliable, as much of the piping may be installed without drawings to work from.

# Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think,
Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

## Engine Room Improvements

In a certain engine room the gravity system of oiling had been installed, with sight feeds and reserve cups over the bearings. Any engineer accustomed to the drip cups feels a certain uneasiness concerning this system, for he has been used to cast his eye over the engine and tell at a glance whether the oil cups were feeding properly. With the sight feed he is obliged to go around to the bearings and observe the feed at close range, and this he will do oftener than is really necessary. The engineer of this particular plant had been caught once, some foreign substance having clogged the feed to the eccentric, and that member had become uncomfortably warm. He confided to the writer that he much preferred the drip cups, as he felt more secure with them, and being more or less responsible for the introduction of the system in the plant, it was "up to me" to devise some means which would give the engineer confidence in the new system. He was obliged to do quite a little millwork at the bench in the engine room, and sometimes he would be absent an hour or more at a time.

The change in the oiling system finally adopted, and shown in Fig. 1, allows the engineer to see the cups from almost every corner of the engine room. There is no danger of the oil overflowing and creating a mess, as it often does when the oil flows into cups on the bearings. The system is now wired to give alarm in case of stoppage anywhere in the line, and the pipes are full of oil from the top cups to the sight feeds, so that in case of shortage after the alarm bell rings there is considerable reserve oil. Last, and not least, the new arrangement is quite an ornament to the engine room if well made and kept polished. A short description follows:

In Fig. 1 *A* indicates the old oil cups out of which the sight-feed needle valves and casings have been removed. The top covers are held by three small bolts placed in the form of an equilateral triangle. When the feed cocks *B* are turned on, the oil fills the pipes and eventually fills the cups *A* and the pipes above them. At *C* are the gage glasses on which are scribed a thin circumferential line, the purpose of which is to facilitate the regulation of the oil by the proper opening of the cocks *B*. A further means of accurate adjustment is obtained by the use of the overflow cocks *D*. Under no circumstances must the oil rise above the line on the gage glasses, so that the cocks *B* must be set when the bottom tanks of the oiling system have been pumped out. In one of the old oil cups *A* will be seen a small float, attached to a wooden stem which supports the light copper clippings *I*, made out of the fine leaves of an old copper collector ring brush. When the oil is out of the cups these clippings will complete the broken circuit between the opposite sides of the copper bars *F F*.

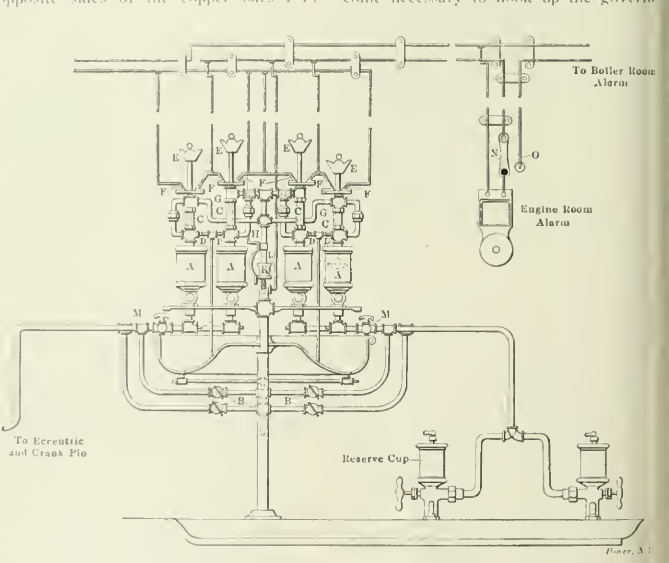


FIG. 1 NEW ARRANGEMENT OF OILING SYSTEM

Thus should the oil supply stop from any cause and the oil disappear from any one of the oil cups, an alarm is rung while there is still considerable reserve oil. Again should there be a blockage at the sight feeds on the engine bearings, then the oil will rise in the top oil cup of that particular bearing, fill the gage glass *C* and overflow through the pipes *G* which connect with the pipe *H* and lead to the cup *K*. This cup is held by a light spring of sufficient strength to support it when empty, but not when half full of oil. This cup then descends and completes the circuit between the wires *L* when any of the sight feeds on the engine bearings ar plugged up. If necessary, this whole sy tem may be cut out by closing the cock *M*. The tank pressure will then be d rectly on the sight feeds. The main ar outboard bearings are oiled by an ind pendent reservoir.

Recently, there was installed in the mi a large scouring machine which consum considerable power. Every time this ma chine is started, which is from three t six times an hour when it is in servic the engine, already well loaded, slov down to such an extent that it has b come necessary to hook up the govern to prevent a shutdown, and it also becai absolutely necessary to rig up some devi to stop the engine should the govern belt break. The device adopted is shov in Fig. 2 and consists of the usual idl riding the belt, and the ⅜-inch rod attached to cranks *E* near the steam lat hook of the valve gear. When the b breaks the idler will fall and the fork end *A* of the rod *B*, which is in one pie and pivoted at *C*, pulls the tripping r *D* toward the engine shaft. This caus the small castings *F* to get under t nose of the steam hooks, preventing th from catching the valve cranks and op ing the valves. A small wheel *G*, with a notch filed in it, and a pawl are used to overcome the tension of the spring *H* when the rod *D* is tripped by hand. It is proposed in the near future to rig an electric-tripping device to this rod, so that the engine can either be wholly stopped in case of emergency or run at any desired speed, and controlled from any part of the mill. The variable speed will be obtained by tripping the rod *D* by means of a solenoid. Thus, while the stopping switch is thrown in anywhere in the mill the valve cranks will not hook on. When the switch is pulled out, the spring *H* will cause the rod to assume its normal position, removing *F* from under the nose of the steam hooks, and the valves will open. By alternately throwing in and out any of the emergency switches any speed can be maintained. This arrangement should prove convenient when putting on heavy belts or taking off small belts which have wound round the shaft, as the speed can be controlled from where the work is being done.

R. O. Richards.

Framingham, Mass.

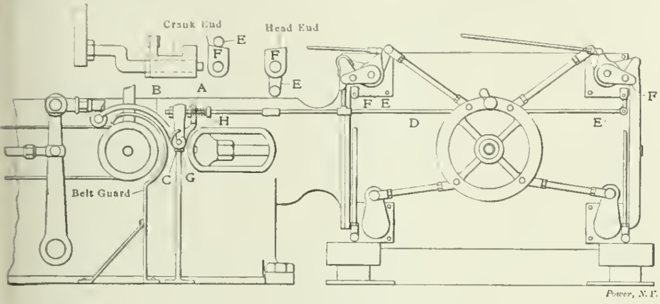


FIG. 2. SAFETY STOP ATTACHED TO ENGINE

## Maximum Bearing Pressure in Compound Engines

In response to the invitation in the editorial (June 29), "What is the Maximum Bearing Pressure in Compound Engines?" I offer the following as one way to reach the solution:

Let us assume a 12x24x30-inch tandem compound condensing engine; initial pressure in the high-pressure cylinder, 150 pounds per square inch, or 165 pounds absolute; receiver pressure, 20 pounds gage, or 35 pounds absolute per square inch, which will also be the back pressure acting on the high-pressure piston; the back pressure absolute in the low-pressure cylinder, 5 pounds per square inch.

The effective initial pressure per square inch in the high-pressure cylinder will be

$$165 - 35 = 130$$

pounds, this acting upon the area of the high-pressure piston, which is

$$12^2 \times 0.7854 = 113+$$

square inches, and this equals

$$113 \times 130 = 14,690$$

pounds. The back pressure in the low-pressure cylinder is 5 pounds absolute, so that

$$35 - 5 = 30$$

pounds, the effective initial pressure in that cylinder. The difference in piston areas is the effective low-pressure area, and is

$$24^2 \times 0.7854 - 113 = 339$$

square inches, and

$$339 \times 30 = 10,170$$

pounds, the total effective initial pressure acting upon the low-pressure piston. As 14,690 pounds was found for the high-pressure, then the sum of the two is the total initial pressure on the engine pistons, or,

$$14,690 + 10,170 = 24,860$$

pounds, the total initial pressure on the engine as a whole.

If a simple condensing engine were used, instead of the tandem compound, same range of expansion, same initial pressure per square inch, same 5 pounds absolute back pressure, and the cylinder were the same as that of the low-pressure, then there would be

$$165 - 5 = 160$$

pounds effective initial pressure per square inch. The area is, as before, 452 square inches, and

$$452 \times 160 = 72,320$$

pounds total initial pressure acting upon the piston. That for the tandem compound was found to be 24,860, so that a difference of

$$72,320 - 24,860 = 47,460$$

pounds exists, against the single-cylinder engine. This would mean bearings of greater extent for the single-cylinder engine, all else being equal, and as under the assumptions made.

Charles J. Mason.

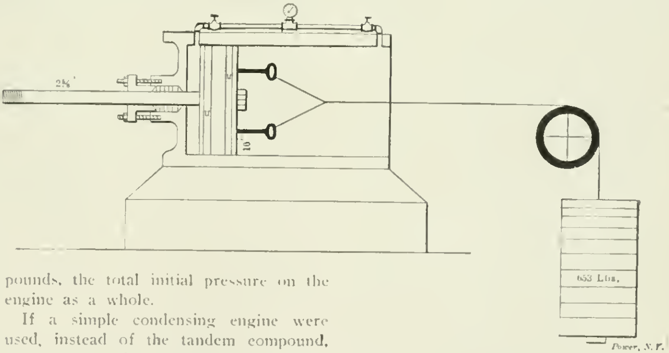
Scranton, Penn.

## Friction Due to Tight Stuffing Boxes

The friction due to tight stuffing boxes is illustrated in the drawing shown herewith.

The adhesive feature of modern fibrous packing, when compressed in stuffing boxes, is hardly realized by many. I did not myself until I experimented on an engine. I disconnected the piston from the crosshead as shown, and added weights to the cord attached to the piston. Without any compression of the packing the piston could be drawn in or out with one hand with ease, but by screwing up the gland to what might be called rather tight, but no tighter than found in many steam plants where, instead of renewing old packing the engineer will screw up the gland.

The retarding effect required that a weight of 653 pounds was required to move the piston rod through the gland. After taking off the weights and putting a low-pressure steam gage on the indicator pipe, as shown, it required $3\frac{1}{4}$ pounds of steam to move the piston at the rate of 6 feet per minute. This $3\frac{1}{4}$ pounds is mean effective pressure, because it is applied constantly. The piston has an area of 201 square inches, and $201 \times 3\frac{1}{4} = 653$ pounds, and a piston rod $2\frac{5}{8}$ inches in diameter.



FRICTION DUE TO TIGHT STUFFING BOXES

By this we learn that it is economy to renew packings rather than compress the gland too much.

A. C. Waldron.

Lynn, Mass.

## Firing Boilers

My opinion is that Mr. White understands handling slack coal, but each case has an individuality of its own.

It has been my experience that bituminous slack coal requires more skill to obtain the same results than lump coal does. Slack has a tendency to bake over, especially if the fires are heavy and the boilers working below their capacity. It will also be more difficult to hold steam up than with a hot, thin fire and good load; the draft will also have to be stronger than for a coarse coal.

When firing slack coal, sprinkle it very evenly and thin, and on one side at a time. In this way one side of the fire is always bright and the hydrocarbon driven off when the coal is first thrown on is ignited as it passes over the intense heat of the incandescent coal on the other half of the furnace.

If the boiler is heavily loaded and a charge of coal is thrown over the entire grate surface, the temperature of the fire is reduced, and the steam pressure will often drop 5 or 6 pounds before it starts to come up.

The slice bar or any other tool should not be used more often than is absolutely necessary, especially if the load is heavy and the boilers are crowded. When the bar is used, it should be worked back and forth on the grates and twisted up edgewise, just enough to break the fuel bed, and care must be taken to keep the fire from burning in holes.

It is very seldom that two different kinds of coal can be fired in exactly the same manner, and whenever the coal is changed it takes some time for the fireman to get the best results out of it. The length of time a fire will go without cleaning depends on whether the boilers are overloaded or run day and night. On a 24-hour run the fires should be cleaned about every eight hours, but if the load is off or very light at 6 and 12 o'clock, I should clean every six hours. I see no reason why two men cannot clean and re-coal 100 square feet of grate surface in 15 minutes.

In the June 8 number, W. Bowden intimates that he opens the fire door three times for each time he fires, and with his kind of a fire it is ten chances to one that the cold air will work through the back of the fire near the bridgewall, for, as he states, "the draft goes through the thinnest part of the fire." My idea is to put the coal where it is wanted, leave it alone, and fire each side alternately at intervals of a very few minutes, using only a very little coal at a time; then there will be no need of using the slice bar during the first two hours, if the slack is fairly good, and not oftener than once an hour after that, if it is used right.

J. C. HAWKINS.

Elyria, O.

## Boiler Efficiency

In reference to the inquiry of E. W. Jackson, regarding the difference in efficiency of his two boiler furnaces, as described in the July 20 issue, I believe the trouble with his No. 2 furnace is due to the lack of combustion space.

In order to burn the gases given off by the coal, it is necessary that they be supplied with a proper amount of air, and that there be ample space for this air and the gases to mix and completely burn before coming in contact with the comparatively cool boiler surface. In this furnace, if he carries a very heavy fire there will be very little space above the fuel bed for the proper mixing of the air and gases, and the gases being in such close contact with the cool boiler shell their temperature will be reduced sufficiently to prevent complete combustion. In the No. 1 furnace there is 12 inches more space, which makes a very appreciable difference in a combustion chamber.

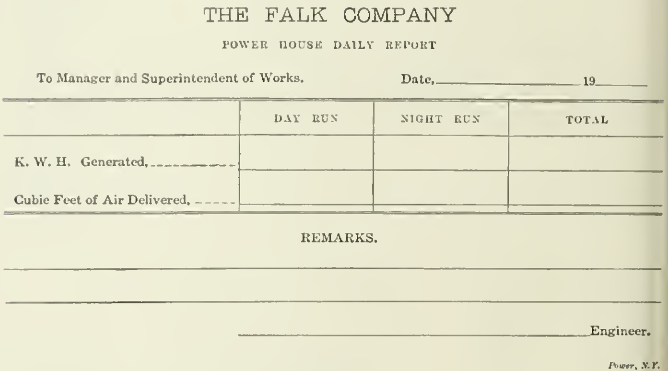
Being located in Illinois, he is probably burning Illinois coal, which is rich in gaseous matter, and with a gaseous coal the combustion takes place almost entirely above the fuel bed, and it can, therefore, be seen that lack of space will prevent complete ignition, and consequently the gases pass off unburned. Carrying a thin fire will no doubt considerably improve his conditions.

T. A. LEES.

Quincy, Mass.

## Keeping Power Plant Records

While visiting a steam plant recently, I was struck with the convenient, thorough and simple manner of keeping the recor for a plant of that size.



THE FALK COMPANY

POWER HOUSE DAILY REPORT

To Manager and Superintendent of Works. Date,______________ 19____

| | DAY RUN | NIGHT RUN | TOTAL |
|---|---|---|---|
| K. W. H. Generated,________ | | | |
| Cubic Feet of Air Delivered, _____ | | | |

REMARKS.

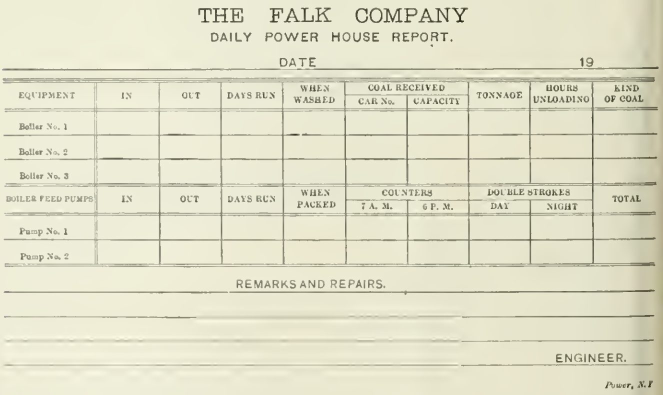
______________________________

______________________________

______________________Engineer.

Power, N. Y.

FIG. 1



THE FALK COMPANY

DAILY POWER HOUSE REPORT.

DATE 19____

| EQUIPMENT | IN | OUT | DAYS RUN | WHEN WASHED | COAL RECEIVED | | TONNAGE | HOURS UNLOADING | KIND OF COAL |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | CAR No. | CAPACITY | | | |
| Boiler No. 1 | | | | | | | | | |
| Boiler No. 2 | | | | | | | | | |
| Boiler No. 3 | | | | | | | | | |
| BOILER FEED PUMPS | IN | OUT | DAYS RUN | WHEN PACKED | COUNTERS | | DOUBLE STROKES | | TOTAL |
| | | | | | 7 A. M. | 6 P. M. | DAY | NIGHT | |
| Pump No. 1 | | | | | | | | | |
| Pump No. 2 | | | | | | | | | |

REMARKS AND REPAIRS.

______________________________

______________________________

______________________ENGINEER.

Power, N. Y.

FIG. 2

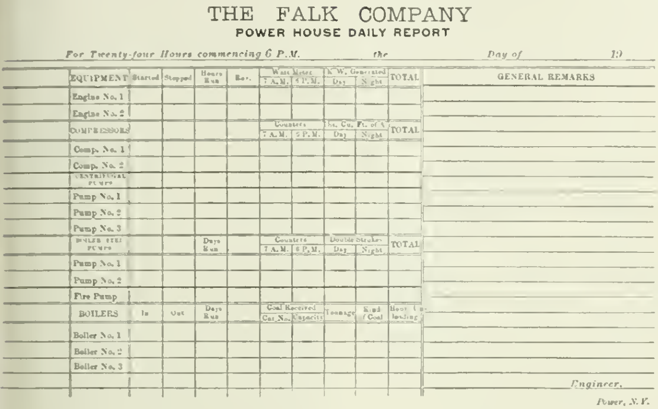
Fig. 1 shows the kilowatt-hours ge erated, and cubic feet of air delivered l the compressors for 24 hours. This ca is given to the superintendent each mor ing.

Fig. 2 is filled out by the fireman in t boiler room and is handed to the chi engineer each morning, from which t data are transferred by him to the she shown in Fig. 3, which also shows t total record of performance of each u for the 24 hours.

The report sheet, Fig. 4, is the total record of everything for the month and shows to a nicety what has happened, and is being done.

E. A. JEANSON.

Milwaukee, Wis.



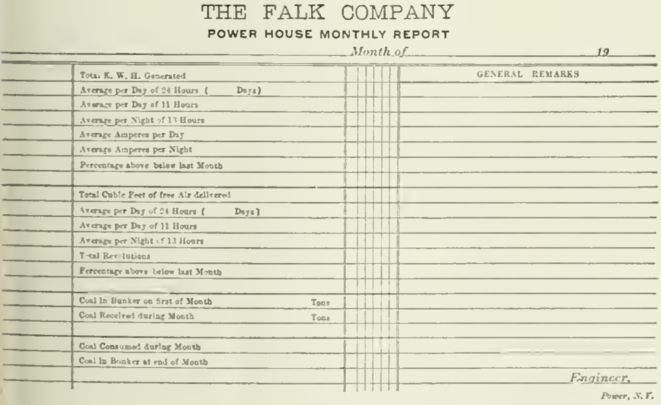
THE FALK COMPANY
POWER HOUSE DAILY REPORT

For Twenty-four Hours commencing 6 P.M. the Day of 19

| EQUIPMENT | Started | Stopped | Hours Run | Rev. | Watt Meter 7 A.M. | Watt Meter 6 P.M. | K.W. Generated Day | K.W. Generated Night | TOTAL | GENERAL REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|
| Engine No. 1 | | | | | | | | | | |
| Engine No. 2 | | | | | | | | | | |
| COMPRESSORS | | | | | Counters 7 A.M. | Counters 5 P.M. | Cu. Ft. of Air Day | Cu. Ft. of Air Night | TOTAL | |
| Comp. No. 1 | | | | | | | | | | |
| Comp. No. 2 | | | | | | | | | | |
| CENTRIFUGAL PUMPS | | | | | | | | | | |
| Pump No. 1 | | | | | | | | | | |
| Pump No. 2 | | | | | | | | | | |
| Pump No. 3 | | | | | | | | | | |
| BOILER FEED PUMPS | | | Days Run | | Counters 7 A.M. | Counters 6 P.M. | Double Strokes Day | Double Strokes Night | TOTAL | |
| Pump No. 1 | | | | | | | | | | |
| Pump No. 2 | | | | | | | | | | |
| Fire Pump | | | | | | | | | | |
| BOILERS | In | Out | Days Run | | Coal Received Car No. | Coal Received Capacity | Tonnage | Kind of Coal | Hour Unloading | |
| Boiler No. 1 | | | | | | | | | | |
| Boiler No. 2 | | | | | | | | | | |
| Boiler No. 3 | | | | | | | | | | |
| | | | | | | | | | | Engineer. |

Power, N.Y.

FIG. 3



THE FALK COMPANY
POWER HOUSE MONTHLY REPORT

Month of 19

| | | | | | | | GENERAL REMARKS |
|---|---|---|---|---|---|---|---|
| Total K. W. H. Generated | | | | | | | |
| Average per Day of 24 Hours ( Days) | | | | | | | |
| Average per Day of 11 Hours | | | | | | | |
| Average per Night of 13 Hours | | | | | | | |
| Average Amperes per Day | | | | | | | |
| Average Amperes per Night | | | | | | | |
| Percentage above below last Month | | | | | | | |
| | | | | | | | |
| Total Cubic Feet of free Air delivered | | | | | | | |
| Average per Day of 24 Hours ( Days) | | | | | | | |
| Average per Day of 11 Hours | | | | | | | |
| Average per Night of 13 Hours | | | | | | | |
| Total Revolutions | | | | | | | |
| Percentage above below last Month | | | | | | | |
| | | | | | | | |
| Coal in Bunker on first of Month Tons | | | | | | | |
| Coal Received during Month Tons | | | | | | | |
| | | | | | | | |
| Coal Consumed during Month | | | | | | | |
| Coal in Bunker at end of Month | | | | | | | |
| | | | | | | | Engineer. |

Power, N.Y.

FIG. 4

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## Transposing Formulas

George W. Richardson's article in the July 13 number of POWER AND THE ENGINEER is interesting and his method of ransposing formulas quite ingenious. He peaks of the liability of engineers to nake the error of using the number of evolutions instead of strokes for *N*. robably many of them are so occupied, vhen working on a problem, with the part hich they think is difficult, that they give ie simpler part little thought, and the umber of revolutions being given in the roblem, they naturally take the figures ito their operations just as given.

About the only way a person can avoid ich blunders is by working problems of the same kind until he becomes thoroughly familiar with them, asking himself at each operation if he has made any of those easily made mistakes, until it becomes a part of his method of solution to look out for such things.

Care in such matters is all that can be suggested in the working of the problems of what the arithmetics might call Case I, that is, to find the horsepower when *P*, *L*, *A* and *N* are given, using the formula,

$$H.P. = \frac{P\,L\,A\,N}{33{,}000}.$$

But if one is required to find the value of *P*, *L*, *A*, or *N*, it seems to me that confusion might arise from an attempt to transpose this formula, and for my part the solution of this equation for any of its unknown quantities is simpler without transposition than with it.

The equation merely means that the horsepower is equal to the product of the pressure, length of stroke, area of piston and number of strokes per minute, divided by 33,000. Then if any one of the numbers for *P*, *L*, *A* or *N* is required, having all the other numbers which are represented in the formula by letters, it is only necessary to multiply together the three given numbers of the second term of the equation and divide the product by 33,000. The quotient, if multiplied by the required number, is equal to the horsepower. Therefore, having the horsepower as the product of several factors, and the product of all these factors except one, we obtain the required factor by dividing the horsepower by the product of those given.

To illustrate: What must the mean effective pressure be for an engine of 24-inch stroke, 200 square inches piston area and making 150 revolutions per minute, to generate 291 horsepower?

Substituting the known values in the formula,

$$291 = \frac{P \times 2 \times 200 \times 300}{33{,}000};$$

$$291 = \frac{P \times 120{,}000}{33{,}000};$$

$$291 = P \times 3.63;$$

$$P = \frac{291}{3.63} = 80.$$

The value of any of the letters *P*, *L*, *A* or *N* can be determined in this way, and it is unnecessary to give an example here of each, the process being exactly the same for any of them. The same principle may be used and the operation simplified by clearing the equation of fractions, although this method has the slight disadvantage of giving larger numbers to work with. As an illustration, the above problem will be solved for *A*, all the other quantities being given.

$$291 = \frac{80 \times 2 \times A \times 300}{33{,}000}.$$

Multiplying both terms of the equation by 33,000 gives

$$9{,}603{,}000 = 48{,}000 \times A;$$

$$A = \frac{9{,}603{,}000}{48{,}000} = 200.$$

The disadvantage of larger numbers is offset when one number in each term ends in several ciphers, an equal number of which may be cancelled on each side.

My purpose in writing this letter is not to criticise Mr. Richardson, but to suggest the simplest possible way to solve the inverse problems relating to the horsepower of engines, yet I would like to call his attention to the fact that

$$\frac{P\,L\,A\,N}{H.P. \times 33{,}000}$$

cannot equal zero, which he states repeatedly, but must in all cases equal one, although I concede his right to use zero on the scales to show that the problem is solved and nothing is required of it, if he wishes to do so.

FRANK L. WALLIS.

Des Moines, Iowa.

[There have been a number of criticisms on this article and not all were inclined to be as tolerant of Mr. Richardson's analogy as the above letter. It is clearly evident to anyone at all familiar with mathematics that 5 ÷ 5 = 1; and that the expression

$$\frac{PLAN}{HP \times 33{,}000}$$

does not equal zero as given in the article, but should also equal one. It should be borne in mind, however, that Mr. Richardson explained the zero scale as his analogy and it was this analogy that used the term zero instead of one; for when a scale of the type illustrated is in balance, the weight on one side must equal that on the other, and there would be no deflection of the pointer. In other words, the pointer would be at the zero point of the scale. With this idea in view Mr. Richardson used the term zero instead of one, and while this is not mathematically correct, it was allowed to pass for the sake of the analogy.—EDITORS.]

## Return Tubular Boiler Setting

In reply to E. W. Jackson's letter, "Return Tubular Boiler Setting," in the June 29 number, page 1161, where he inquires why the furnace in his Fig. 1, the grates of which are 3 feet from the shell, burns coal with better results than can be obtained with the furnace shown in his Fig. 2, which has only 2 feet from the shell to the grates, the reason, I believe, is that there is more room in the first instance for the gases to mingle with the heated air and become ignited before they strike the cooler surface of the boiler. The bridgewall, being horizontal, is also a help to good combustion. The area on each side of the boiler will be large, and the flame will pass on each side, thereby keeping a higher temperature the full length of the boiler. With a shallow furnace, the flame impinges on the cooler shell and therefore impairs combustion, as the temperature of the boiler plate being much lower than the flame tends to retard the combustion of the inflammable gases which rise from the fuel; as a general thing a deep furnace is favorable for complete combustion.

The evaporative power of a boiler mainly depends upon the efficiency of its heating surface. The heat is communicated to the transmitting surface in two ways, by radiation and by contact, and from two or three different hot masses in the furnace, the solid incandescent fuel, the flame and the hot gases produced by combustion. The heat radiated from the solid bed of fuel is greater than from the flame and that from the flame greater than from contact of the flame on the boiler.

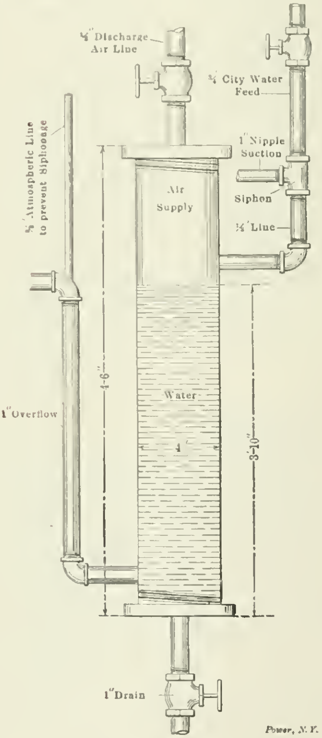
By careful firing, and admitting a sufficient quantity of air directly to the hydrocarbons, nearly any kind of soft coal can be burned without smoke, if there is from 25 to 30 inches of space above the bed of fuel and the bottom of the boiler shell. By admitting air through a few ½-inch holes drilled in the fire door, the air in going through will strike the red-hot lining, and become as hot as the gases in the furnaces, but care should be taken and not let in too much air.

JOHN COOK.

Springfield, Ill.

## Air Washing and Brazing Generator

This air washer and generator is constructed of common pipe and fittings. Take a piece of 4-inch pipe, 4 feet 6 inches long, and tap it in four places, for air and water feed combined, air discharge, water discharge and drain to clean out. The air supply is 8 inches long, and 4 inches internal diameter. The water storage is 3 feet 10 inches long and 4 inches internal diameter. The water discharge or overflow is of 1-inch pipe. The line to the atmosphere to prevent siphoning is ⅜-inch. The blowoff is of 1-inch pipe. The city water feed pipe is ¾ inch in diameter, and the suction for air is of 1-inch pipe.



AIR GENERATOR FOR BRAZING

The city water runs to a tapered nipple which is screwed past the center of the tee and discharges into a ½-inch nipple. Doing so forces the air out and the atmospheric pressure forces itself into the 1-inch suction pipe and mixes with the water. When it discharges into the storage tank, it separates itself from the water and leaves the impurities in the water, and the air is washed.

The air washer and generator is used for chemists' laboratory or for brazing.

E. H. MARZOLF.

Bellaire, Ohio.

## The Twelve Hour Shift

The editorial, "The Twelve Hour Shift," ought to touch the heart of every power-station engineer, and let us hope not a few of the owners. Engineers have to work too many hours for the good of their own health and the safety of the plants they handle.

Eight hours is long enough for any engineer to work, and the writer would like to see a national law passed that would prevent any engineer from working over eight hours, at least on the night run.

There seems to be an erroneous idea among many as to the work an engineer performs. They think that because he is not swinging a sledge hammer, or using the pick and shovel, he is having a "snap," while as a matter of fact eight hours in a power station will take more out of a man than twelve hours on the farm.

The average engineer will perform more work in eight hours than in ten, and when it comes to the question of safety, there is no comparison.

Then there is another question. The wages paid to engineers in charge of a watch is by far too small; and how about the assistant? Are they getting all that belongs to them? We intrust the care of lives and many thousands of dollars worth of property to them; they must be masters of several trades and we demand overtime of them, yet we are not willing to give them the pay of any other mechanic.

The brick mason and steamfitter get $4 a day, the carpenter $3.50, and no fault is found. Then the engineer comes in and has to make many of their poor jobs right, but it is like pulling teeth for him to get more than $3.

Here in the South it is difficult to get skilled men to take ten-hour watches at $2 a day. Some time ago we were hard pushed at this station for a man. For a month we had a locomotive engineer on the night watch, the writer sleeping in the station during this time. Upon the man getting through he said: "I have long been interested in this line of engineering, but on a locomotive I am not required to know one-tenth as much and receive three times the pay." With all due respect to the locomotive engineer did not this man speak a volume of truth?

M. F. JAMES.

St. Augustine, Fla.

## Cost of Keeping Boilers Clean

In reply to the editorial in the June 1 number as to the cost of cleaning boilers, I inclose an estimate of what it costs in my plant to remove and prevent scale.

The plant is a street railway power station, and there are five water-tube boilers, of the Aultman & Taylor make, each rated at 500 horsepower and having 252 four-inch tubes, 18 feet long, with a working pressure of 160 pounds gage.

The feed water is taken from a river, and is passed through two primary closed heaters, one auxiliary closed heater and a Green economizer to the boilers. Following is the result of an analysis made April 11, 1908, of one gallon of water:

| | |
|---|---|
| Calcium carbonate | 1.049 grains |
| Calcium sulphate | a trace |
| Magnesium carbonate | a trace |
| Total scale-forming solids | 1.049 grains |
| Organic and volatile matter | 0.326 grain |
| Sodium chloride | 0.500 grain |
| Total nonincrustating solids | 0.826 grain |
| Total solids | 1.875 grains |
| Free carbonic acid | 0.521 grain |

This water will form about 3/20 pound of scale for every 1000 gallons of water evaporated.

We blow down our boilers 1½ gages every night, and feed about 6½ pounds of soda ash each day, through a home made feeder, into the suction of the feed pumps, feeding continuously during the 24 hours. We also feed about 3½ quarts of kerosene oil each day, feeding continuously into the feed-water line just before it enters the economizer.

During three months of the summer, and some of the time in winter, we use the five boilers, but the rest of the time only four boilers.

We scale the tubes of boilers once each year, during the slack time, generally in the fall, and do it with our regular help. We use a turbine tube cleaner and a water pressure of 180 pounds.

We use three men when scraping tubes and some of the time four, while cleaning caps, headers and drums; the men work nine hours per day. It usually takes about six days to do the work after the boiler is cold.

About a gallon of kerosene oil is put in each drum after cleaning and it loosens the old scale. The manhole gaskets are used over as long as they will hold tight, but we use new handhole gaskets each time.

The cost of labor for scaling tubes and cleaning the boiler is approximately $41; handhole gaskets (4), $1.50; manhole gasket (1), $1.50; emery cloth, bolts, nuts and repairs to turbine scraper, $2.50; kerosene oil per year to each boiler, $6.15; soda ash per year to each boiler, $21.35; cost per boiler per year, $74.

Our economizer contains 768 four-inch tubes, 9 feet long. We scale that with the turbine scraper once a year. It is usually out of service two weeks, as we clean out the soot and look after the scrapers at the same time. The labor for scaling and putting on caps and manifold plates would be about $71.50, the material used, such as packing and a few new bolts, $15, or about $86.50 for the job. This would make a total for the five boilers and economizer per year of $456.50.

That is a much lower figure than was quoted by two different agents selling boiler compound. One representative said we would need to blow down the boilers three times a day and open them and wash each tube with a hose once or twice a year. I told him we would scrape them a while longer.

We do not get any oil in the boilers and have only lost one tube by its being burned in the past three years. I have not included that in the cost. The thickness of scale in the boiler tubes after a year of service is less than 1/32 inch; in the drums where circulation is not so rapid it is more. The economizer tubes scale worse than the boilers, but it is a soft scale and a good deal of it seems to be iron rust, as the warm water is hard on the cast iron.

The temperature of gases in the uptake between the boilers and economizer is 390 degrees Fahrenheit; of the gases leaving the economizer, 295 degrees Fahrenheit; of the water entering the economizer, 175 degrees Fahrenheit; of the water leaving the economizer, 222.5 degrees Fahrenheit. This reading was taken eight months after scaling the boilers and economizer; all air leaks in the boiler settings were stopped as well as possible.

During the past year we burned 14,680 tons of West Virginia coal of about the same quality as New River coal. We have no water meter so I cannot say what the evaporation per pound of coal is for the plant.

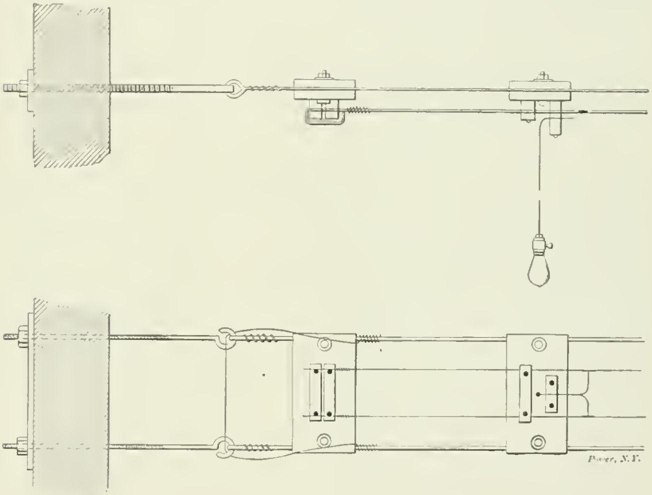
C. B. Smith

So. Framingham, Mass.

## A Useful Method of Wiring

A very useful method of wiring for shops and factories is herewith described. The writer has used this system and for economy and appearance has found it to have many advantages over others. Where the roof is high, shorter drops may be used than if the wires were carried along the ceiling, and where concrete construction is met with, none of the difficulties of attaching to the ceiling will be experienced.

The materials required are No. 10 steel wire, several pieces of soft wood, about 4x8x⅝ inches, drilled for stove bolts about ½ inch from each end; some 1¼-inch stove bolts and washers, and for each line four rods, ½x24 inches, hooked at one end and threaded for about 1 foot at the other.



A USEFUL METHOD OF WIRING

In each building and along line where lights are required, and about 16 feet above the floor line, drill two holes on the walls about 7 inches apart, put screwed rods through, and either a plate or large washers on the outside with a nut. As it is difficult to drill such a hole through a brick wall without dislodging some brick, it is better to use a plate, as the space behind may be neatly filled in with cement. Then run the No. 10 steel wire between the hooks and screw up from both ends until the wires are quite tight.

Take two of the wood pieces and bolt them together with 1¼-inch stove bolts; attach two pairs of two-wire cleats for the end boards, and for the others one pair of two wire cleats and one pair of single wire for the drop cord, as shown in the sketch. At each end of the line the boards should be fastened to the rod hooks by a piece of steel wire to prevent them from slipping when the copper wire is stretched on the cleats. The boards can then be placed anywhere along the line as desired and No. 10 or No. 12 rubber-covered copper wire stretched between the cleats, using, of course, two pairs at each end for securing the wires. Afterward drop cords can be attached where needed and, if necessary, the boards slipped along to a new place if a change is desired.

F. H. Stacey.

Montreal, Can.

## Safety of Pipe Fittings

I. A. Tenger, in a quite recent issue, asks: "When the steam pressure and the screwing-down pressure are equal, are we to suppose there is no strain on the screws?"

Putting the case in a different way for convenience, let the two pieces *C C*, Fig. 1, be joined together by the bolt *D*. Assume the nut to be screwed down, producing a tension of 1500 pounds in the bolt. Then with a weight *E* of 1000 pounds suspended from the lower piece *C*, as shown, what is the total tension in pounds on the bolt? The joint in this case is made up metal to metal without a gasket.

Fig. 2 is the same as Fig. 1, with the exception that a spring *G* is placed between the two pieces *C C*. The nut in this case is also screwed down until the bolt is under an initial tension of 1500 pounds. In screwing down the nut the spring *G* is then compressed, or shortened an amount sufficient to produce this tension in the bolt; then, when the weight *E* of 1000 pounds is suspended from the lower piece *C* as before, what is the total tension in pounds on the bolt?

For simplicity, substitute the weight *E* for the pressure within the cylinder or valve, as the case might be, and the conditions are not altered as far as the strain on the bolt is concerned.

In Fig. 1, by tightening up the nut, the bolt is stretched, or elongated to some slight extent, as shown by the arrows *F F* and their direction. This draws the faces of the two pieces *C C* together, as shown by the arrows *A A*, with a force of 1500 pounds.

The weight *E* suspended from the lower piece *C* tends to pull the two pieces apart with a force of 1000 pounds, as shown by the arrows *B B*.

In this case we have an excess pressure of

$$1500 - 1000 = 500$$

pounds holding the two pieces *C C* together at the joint, or, in other words, as the initial tension of 1500 pounds in the bolt holding the two faces together is greater than the weight *F* which tends to separate them, it does not seem reasonable that 1000 pounds (*E*) should be added to the bolt, as mentioned by Mr. Tenger. Therefore, if the weight *E* is less than the initial tension, the total load on the bolt is the initial tension only.

If the weight *E* is greater than the initial tension, the total tension on the bolt will be that due to the weight *E* alone, and not *E* plus the initial tension, for the following reasons:

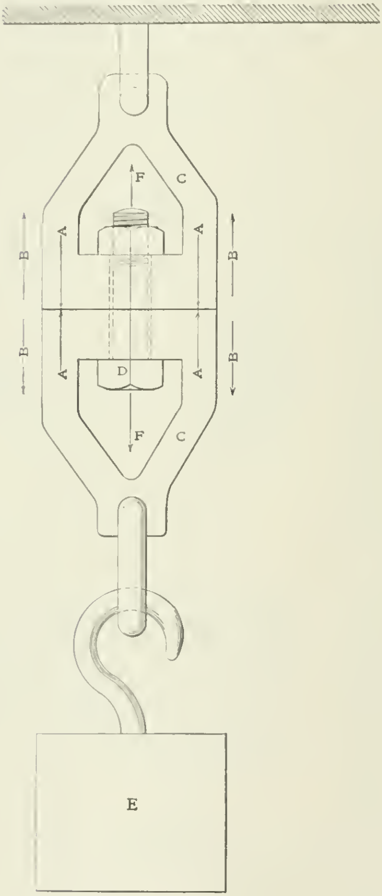
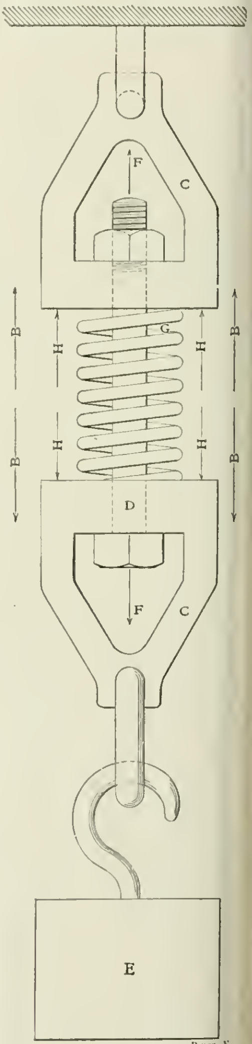


FIG. 1

When screwing up, if the bolt is elongated or stretched an amount sufficient to produce in it a tension of 1500 pounds, it seems reasonable to assume that a weight *E*, if greater than 1500 pounds, would stretch the bolt a corresponding amount over and above that due to the initial tension and the joint would open slightly, assuming the metal in the pieces *C C* as practically incompressible under the pressure against the face of the joint.

There would then be no question that the weight *E* in this case would represent the total tension in the bolt, and not *E* plus the initial tension. This result may not actually be obtained by experiment, however, unless the weight *E* is greatly in excess of the initial tension.

If this reasoning is correct for a joint made similar to that in Fig. 1, metal to metal and using no gasket, it is readily seen that the total tension produced in each bolt is either the initial tension due to screwing up, or the tension produc by the internal fluid pressure, accordi as the former or the latter is greater.



Power, N.

FIG. 2

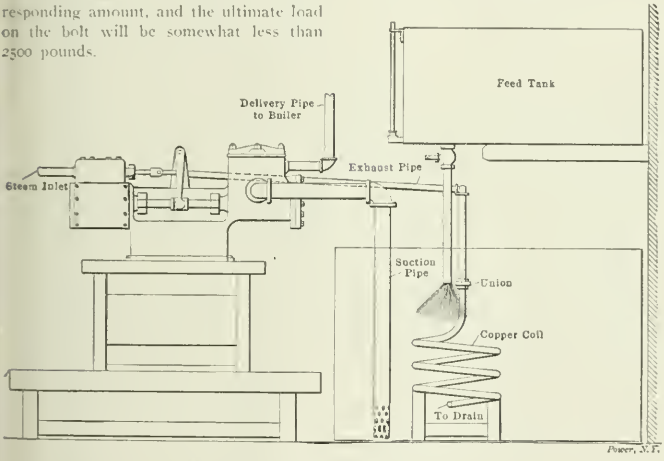
In Fig. 2 the spring *G* being compress or shortened exerts an outward thr against the two pieces *C C* (in this ca 1500 pounds), as shown by the arro *H H*.

The initial tension in the bolt due

screwing up is then 1500 pounds and the elongation, or extension, of the bolt under this load is the same as in Fig. 1, as the initial tension is the same in each case.

Any farther extension of the bolt under the load *E* as shown by the arrows *B B* may not affect the initial tension in the bolt to any great extent, as the extension of the bolt may be small compared with the compression of the springs. Therefore, the weight *E*, suspended as shown, should in this case add to the initial tension, and the total tension or ultimate load on the bolt would then be somewhere in the neighborhood of 2500 pounds, or the initial tension of 1500 pounds plus the weight *E* of 1000 pounds, as both forces act in the same direction.

If, however, this additional extension, or elongation, of the bolt under the load *E* is sufficient to relieve part of the compression in the spring, the initial tension in the bolt, due to the outward thrust of the spring, is decreased by a corresponding amount, and the ultimate load on the bolt will be somewhat less than 2500 pounds.



APPARATUS FOR HEATING FEED WATER

This, of course, could not be determined without knowing the exact elongation of the bolt, and the compression of the spring. To determine this accurately, the relative rigidity of the bolts and the flanges, or parts they connect, must be known, also the elasticity of the gasket where one is used to make up the joint.

In the case cited, the spring is substituted for a gasket for the purpose of illustration; as, like the spring, an elastic gasket exerts an outward thrust against the faces of the connected pieces when compressed, and the action is similar.

If the foregoing is correct, then Mr. Perkins' statements are true only where the joint is made up metal to metal without a gasket, as in Fig. 1, or similar, and Mr Tenger's statement is true only where the joint is made up with an elastic gasket, or as in Fig. 2.

WILLIAM F. FISCHER.

New York City.

## Heating Feed Water

At the plant of which I have charge the feed water is supplied by a 3x1½x3-inch direct-acting pump. The suction pipe runs to a tank, which in turn is supplied from another tank, taking its supply from the town water mains, as per the sketch.

The exhaust pipe from the steam end of the pump was long and contained many bends which caused a good deal of back pressure on the pump and considerable leakage of condensed steam when first starting up. It was, therefore, decided to condense the exhaust and heat up the feed water at the same time. A coil of ⅞-inch copper tube, with six turns, and 10 inches in diameter, was obtained. The exhaust pipe was taken down, turned horizontally, and fitted with a union to suit the one on the copper tube.

A hole was cut in the side of the feed tank near the bottom, and the lower end of the copper spiral passed through, with a nut and soft-lead washer on either side of the tank body; the outside end was fitted with a short length of tube leading to a drain close by. The exhaust pipe was then connected by the union joint to the upper end of the spiral, the feed tank filled with water and the pump started. It was found to work much more smoothly than before and the feed-water temperature rose from 55 degrees Fahrenheit to from 175 to 200 degrees Fahrenheit, according to the work being done by the boilers. This rise in the temperature of the feed water was greatly appreciated by the fireman, who found it easier to keep the steam pressure constant, even when the boiler was hard pressed.

Another advantage which arose from this alteration was the facility afforded for measuring the steam consumption of the noncondensing engines. By disconnecting the lower end of the spiral from the drain and catching the condensed exhaust steam from the pump and measuring it, and also measuring the total water supplied to the boiler and then subtracting the former from the latter, the amount of steam consumed by the engine or engines running was obtained, including, of course, any leakage there might be on the steam line. With care there should be no leaks, and, therefore, the actual steam consumption would be obtained.

E. J. SHELDRICK.

Cambridge, Eng.

## The Three-phase System

In the July 6 number, James M. Sherman, of Columbia, Mo., has an article headed "Three-Phase Alternating Current," in which he, for argument's sake, condemns absolutely the use of the three-phase system for furnishing electricity for universal use, on the ground that it is impossible to give entire satisfaction to each particular class of customer at all times with this system.

I wish to take exception to Mr. Sherman's statement. In those small towns where it is only possible to run one set of circuits for both power and light, absolute satisfaction is not obtained; but so far as I know, absolute satisfaction is not obtained in any system in any small town, even where different machines are used to furnish different individuals with the power they may require. The three-phase system, if installed with an idea to meet the needs of the individual customers, is perfectly satisfactory. This is obtained through the use of a three-phase power circuit for power consumers, and a separate three-phase circuit for the lighting, each of the lighting circuits having a potential regulator at the station switchboard, and if necessary additional regulators at the central distributing points, although this latter is seldom needed. The arc lighting may be done through the use of mercury arc rectifiers and tub transformers, or with alternating-current lamps, no difficulty being experienced in the regulation of the lighting circuits, even though taken direct from the power-circuit busbars. If direct current is desired at any point, there is no trouble in obtaining it either by mercury arc rectifiers or rotary converters.

The standard frequency of 60 cycles has been perfectly satisfactory, with the exception of where more than 600 volts is desired on the direct-current side of the converters. It is probable that 40 cycles would give better results for all kinds of work, but apparently 60 cycles has been and is perfectly satisfactory for the general distribution of electricity in any community large enough to require excellent [illegible] not [illegible] to pay the corresponding [illegible] place.

Henry D. [illegible]

B[illegible]

## Transfer of Heat and Cold

After [illegible] the [illegible] article on [illegible] of July 6 [illegible] conversation [illegible] expert, I am still unable to understand [illegible] where he quotes that part of the article [illegible].

In the first place, what difference does it make whether the Fahrenheit or the Centigrade scale is used? The ratio of the temperature differences will be the same in either case. To be specific, if we take the temperature of the hot liquid as 212 degrees Fahrenheit, and the temperature of the room as 32 degrees Fahrenheit, the temperature difference is 180 degrees. If we assume the temperature of the cold liquid to be 32 degrees Fahrenheit, and the temperature of the room in warm weather to be 80 degrees Fahrenheit, the difference is 48 degrees. Now all the latest investigations seem to show that heat transmission from one fluid to another through metal varies directly as the difference in temperature, other things being equal. Therefore it should take three times as long for the cold liquid to heat up 10 degrees as for the hot liquid to cool down 10 degrees, assuming that they are equal quantities and have the same specific heat. This would seem to confirm the claim made by the vacuum-bottle people that a bottle will keep cold three times as long as it will keep hot.

It may be objected that this comparison is based on two different temperatures for the room, that is, 32 degrees Fahrenheit in one case and 80 degrees Fahrenheit in the other. But suppose we assume the room temperature to be 60 degrees Fahrenheit in both instances, and further take into consideration the fact that a liquid feels hot at 150 degrees Fahrenheit, which is said to be about as hot as the hand can bear. Then we have 60 degrees Fahrenheit from 150 degrees Fahrenheit equals 90 degrees Fahrenheit and 32 degrees Fahrenheit from 60 degrees Fahrenheit equals 28 degrees Fahrenheit, so that the temperature difference is about three times as great as that for the cold bottle, as in the first case.

Doubtless the statements of the vacuum-bottle people were based upon practical experience, which is always hard to controvert even though a man's ideas about the relative rates at which heat and cold travel may be quite ridiculous.

Frank J. McMahon.

New York City.

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The first time I read the advertisement "Keeps Liquids Hot for One Day and Cold for Three Days," I did a little mental calculation about like this: Temperature of cold liquid, say 32 degrees Fahrenheit, temperature of outside air, 72 degrees, difference, 40 degrees, time for heat transfer with this temperature difference, three days. If the time of transfer is one day for hot liquids, as the rate of heat transfer per degree difference in temperature must be the same, then the temperature difference must be three times as great for hot liquids and would be

$$3 \times 40 = 120$$

degrees. That is, the hot liquid would be at

$$72 + 120 = 192$$

degrees when placed in the bottle.

To figure this more correctly we should take the mean temperature difference during the time of heat transfer.

Assume that one pound of water at 35 degrees Fahrenheit increases to 45 degrees in three days in a room, the temperature of which is 72 degrees, then we have a mean temperature difference of 32 degrees, or a transfer of

$$\frac{10}{3 \times 32} = \frac{5}{48}$$

B.t.u. per degree, per day.

If we assume the same loss of heat for hot liquid to take place in one-third the time, then the mean temperature difference would necessarily be three times as great or

$$3 \times 32 = 96$$

degrees. The mean temperature of the hot liquid would be

$$96 + 72 = 168$$

degrees. As the change in temperature is 10 degrees, there being a loss of 10 B.t.u. from the bottle, the initial temperature would be

$$168 + 5 = 173$$

degrees and the final

$$168 - 5 = 163$$

degrees. The heat transfer in this case is also $\frac{5}{48}$ B.t.u. per day, per degree difference in temperature.

In this explanation I have made no allowance for the slight difference in the specific heat of hot and cold water.

E. P. Haines.

Philadelphia, Penn.

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In reference to C. M. Ripley's article on "The Problem of the Vacuum Bottle," in the July 6 number, I will say that according to my theory, the matter is governed by the law that the greater the difference in temperature of two bodies the quicker the transmission of heat or cold will be. Suppose we have ice water in the bottle, say at a temperature of 35 degrees Fahrenheit, with the outside air at a temperature of about 70 degrees Fahrenheit, the difference in temperature would be 35 degrees. Then a hot liquid, say at a temperature of about 160 degrees Fahrenheit, is put into one of these bottles, and if the usual temperature in winter is 20 degrees above zero, the bottle would naturally be used to keep a liquid warm and at that rate we have a difference of 140 degrees. I think this difference would account for the hot liquid not maintaining its heat as long as the cold liquid would remain cold. Now in order for the hot liquid to get to its normal temperature the air on the outside would have to travel through the wall of the outside bottle, then through vacuum and thence through the shell of the bottle proper; or the heat that is stored up in the hot liquid would have to radiate outwardly through the same course. Then the air on the outside, which is 140 degrees lower than the liquid in the bottle, will cool it off much quicker than the 35 degrees higher temperature of the outside air would tend to bring the cold liquid to its normal temperature. I am not very well versed in the minute details of a vacuum bottle, but I should think that the heat or cold would have the same resistance to contend with on going outwardly from the bottle as it would have going inwardly.

Arthur P. Schmitt.

Chicago, Ill.

## Kerosene Oil in Boilers

In the July 6 number, Charles Cryster states that kerosene oil is worthless as a remover of scale or other deposit in steam boilers.

Where sulphur water and oil from open feed-water heaters are to be contended with, the proper use of kerosene is all that can be desired. I have used it for years under these conditions, and find it to be safe and not injurious to the boilers. In water-tube boilers place about 5 pints in the mud drum before filling with water, so it will be deposited on the tubes and drum shell.

When filling a boiler, the kerosene oil is deposited upon the scale or cylinder oil and penetrates to the metal. Then heat is applied to the boiler and it is transmitted to the water. The temperature will gradually rise from the point before the application of heat to the point of vaporization. Just at this point the vibrations of the molecules of the oil, which have become more and more rapid as the temperature has risen, have become rapid enough to overcome the force of cohesion which tends to keep them together. The oil begins to change to a gaseous form, or vapor.

The expanding of the molecules at such rapidity tends to loosen the scale. My theory why this condition does not continue until the flash point of the oil is reached is because there is insufficient oxygen present.

I have found deposits of kerosene oil 100 feet from the boilers in the steam line.

William P. Bruce.

Pittsburg, Penn.

## Patching a Cracked Cylinder

I was called upon to patch a fractured xhaust steam chamber on a 20x80-inch orliss engine cylinder. The fracture be- g on the bottom and a short way up ie side compelled me to strip it of all nnecting parts and turn it upside down I ascertain the nature of the fracture. saw that I would have to recover the ire bottom and make a patch of inch boiler steel, as shown in Fig. 2.

After sending a sketch of the patch the shop to have it flanged, I looked er the pipe line and discovered the cause of the accident. The exhaust line had several ells in it before passing through a hot-water heater to the atmosphere. The heater would retard the exhaust steam and condensation would fill up the exhaust pipe, as the bleeder pipe was too small and caused excessive pressure in the exhaust vacuum chamber.

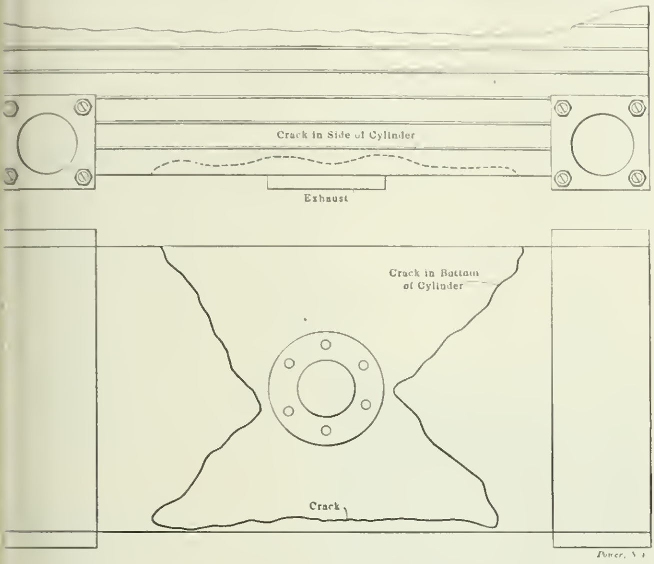


FIG. 1. BOTTOM VIEW OF CYLINDER

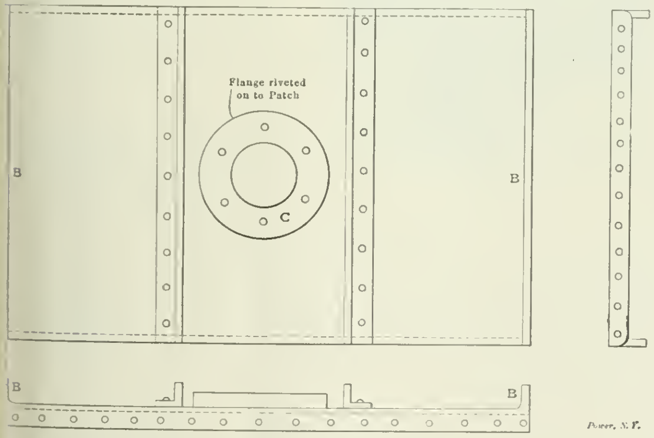


FIG. 2. PATCH TO FIT OVER CRACK

I put through the exhaust chamber eight 1-inch staybolts, to brace the sides. The patch also had angle-iron braces, as shown in Fig. 2, riveted to it to keep down breathing. The flanges on the patch *B*, Fig. 2, were turned up on the ends, and down on the sides, drilled and countersunk for ¾-inch patch bolts. The exhaust pipe flange at *C* was riveted on.

After bolting the patch to the cylinder and calking it tightly, I changed the exhaust line and bleeder pipe, cut out the heater and made a free passage to the atmosphere, placing a tee on the exhaust pipe, for connecting to a condenser the company expected to install later.

I tested the cylinder and calked the leaks, making it tight, and thus saved the company the price of a new cylinder.

John S. Van Pelt.

Augusta, Ga.

## Firing Buckwheat Coal

Having read different discussions on firing, I should like to state my views on firing No. 1 buckwheat coal.

On getting ready to bank the fire at night, the coal on top of the ash should be pushed back against the bridgewall, and enough coal added to this to permit of cleaning the following morning.

In the morning, after noting the water level, etc., the fireman should pull out the ash which is in front of the banked coal, then pull down the live coal very gently onto the grates, and draw it to the front. Then with a hoe rake as much of the remaining ash through the bars as possible, and jump the balance over the good coal and draw it out. An experienced fireman can jump the back part over the coal in front with an extremely small amount of waste.

Next spread the fire evenly over the grates, and then green coal over the live bed, using about 8 or 10 shovelfuls. In about 10 minutes the fire will be burning brightly and at this time it should be leveled by the use of the shovel only, putting coal in the low places, filling the corners, etc. The fire, when properly cleaned and coaled over, should be about 2 inches thick.

When the fire shows the first tinge of grayness, it should be coaled over, using about 8 or 10 shovelfuls of coal for a grate surface of from 30 to 34 square feet. Fires worked in this way will not clinker. By occasionally glancing through the draft hole in the door, an experienced fireman can tell whether the fire is getting sufficient air. In some cases it is necessary to leave the furnace door open a crack to accomplish this.

The proper way to clean the fire while running, so as to avoid loss of steam pressure, is to have the boiler filled to about three gages of water, and coal over on one side only, letting the other side burn out, or nearly so, depending on the load on the boiler. Next, stop the feed pump, rake out the ashes, spread the good coal over the grates, and add new coal. When conditions are right, clean the other side in the same manner. It should take a fireman 4 or 5 mintues to haul out and clean the half fire.

I have had about six years' experience using No. 1 buckwheat coal, and in this time have never had occasion to use a slice bar. To become a good buckwheat-coal fireman, the first lesson should be, "Lose the slice bar."

CHARLES T. MELLEN.

New York City.

## Denver Boiler Explosion

I have read your account of the explosion of a Wicks boiler in an electric-generator plant at Denver, Colo., and it would appear, according to the account, that the steam pressure in the boiler in question was some 25 pounds higher than the pressure in the header at the time the boiler was cut in. Such being the case, I think it more probable that the accident was caused by water hammer.

In this connection I would call attention to experiments described in the *Transactions* of the American Society of Mechanical Engineers, Volume 24, page 312, which shows that a reduction of pressure in a boiler is followed by the movement of the mass of water therein, caused by the rapidity of the generation of steam brought about by the reduction of pressure in the boiler.

A. BEMENT.

Chicago, Ill.

## Power-plant Records—Gumption

The editorials in the June 1 and 15 numbers, on "Power plant Records" and "Gumption," are, on general principles, very good, but I believe the conclusions have been drawn too much from ideal surroundings.

Why a good many engineers do not know what it costs to run their departments is not so hard to find out if you know under what conditions they have to operate. There are plants of from 500 to 1000 horsepower where the engineer does not know what his oil, packing, coal and other supplies cost; has no facilities for weighing his coal daily and sees none of the supplymen or agents. Under these conditions who is to blame, the operating engineer or the man who pays the bills?

There are some engineers who have "gumption" enough, but cannot use it. If all engineers could come in contact with and talk matters over with the man who pays the bills, there would no doubt be some valuable improvements in some power plants, and some money in the pockets of the owners, but "gumption" sometimes gets "nipped in the bud," especially where it has to go through the petty jealousy of a general manager, superintendent or master mechanic, who probably knows little or nothing about steam engineering.

IRVIN A. RESH.

Phillipsburg, N. J.

## Why Won't the Engine Carry the Load?

Replying to J. W. Blake's letter, and assuming that Fig. 1 is the low-pressure and Fig. 2 the high-pressure diagram, the low-pressure piston valve should be moved on its rod toward the crank end (as it takes steam at center) enough to even up the diagram.

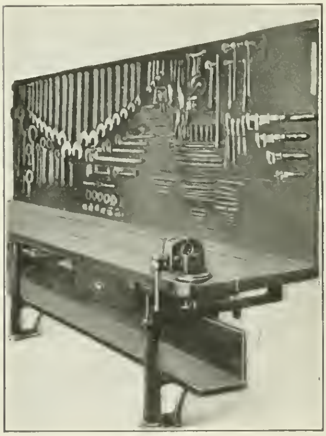
The high-pressure diagram is bad, as it gets steam too early. Therefore, the eccentric on the shaft should be turned in a direction opposite to the way the engine runs and, if I am not mistaken, the loop in Fig. 2 will disappear.

L. JOHNSON.

Exeter, N. H.

## A Toolboard

The toolboard described by Mr. Barnes, in a recent issue, I do not consider the proper board for the average engine room. It is too difficult to make unless there is a jigsaw handy. Another objection is that if we break or lose a tool, which often happens, we should have to get an exact duplicate or remodel the recess in the board, which would be quite a task, especially if made up of two 10-inch boards set at right angles. Again, additional machinery in a plant means additional tools for the board, and it would be a difficult matter to add them to his type of board.



A TOOLBOARD

The average engine room has more or less dust in circulation and that type of board would prove a good collector, especially if hanging on an incline as suggested, and the recesses could not be cleaned properly.

The accompanying illustration shows a toolboard that is easy to put up, easy to replace lost or broken tools in, or to add additional tools to, and easy t keep clean. There is nothin elaborat about it, but it makes a goo appearance. One can readily detect i a tool is missing; and the backgrounds ar not painted white either, to becom marked every time a tool is reached fo

Once an engineer becomes accustome to a toolboard, he would not be withou one and it saves trouble looking for tool when wanted.

H. J. MISTELE.

Milwaukee, Wis.

## Removing Scaly Boiler Tubes

Stephen C. Cafiero's way of gettin scaled tubes out of boilers, as stated o page 1112 of the June 22 number, do not seem to be a plan that should b recommended. A better way would be t take out a few tubes, even though the don't leak, so as to make a way to pa others out of the manhole or handhole.

Stretching such large holes in a tu sheet might crack the metal between t holes, and if not, the holes would not b round after stretching, and it would b difficult to make a good job.

W. F. CLAY.

Stamford, Tex.

There is a much easier way than M Cafiero's, which is to use a tube-drawin device that will remove a tube in fro 20 to 50 minutes.

I have been using one for about tw years, besides loaning it to other engineer and we have never found a tube that r quired more than 50 minutes to get out.

GEORGE STANTON.

Pittsburg, Penn.

## Alternator not Damaged When th Belt Came Off

I was running two 150-kilowatt N tional alternators in parallel from tw separate water wheels, when one of th penstocks began to leak, throwing wat over the belts of one alternator and o exciter, causing both to run off the pulle

I was always under the impression th if one exciter went out while running parallel with another, the coils in t dead machine would short-circuit and bu out, but to my surprise the machine ke running as though nothing had happen (running as a motor). As the belt wou up on the driving pulley and was goi to do a lot of damage, I shut down th water wheel before I pulled the switc After the machine stopped I looked over and found it was not damaged. Th alternators were two-phase 2200-volt m chines.

WILLIAM F. KINGSLEY.

Boise, Idaho.

# Some Useful Lessons of Limewater

## The Entrance to the Fascinating Subject of General Analysis; Importance of the Chlorine Compounds; Secrets of Explosives

### BY CHARLES S. PALMER

We are almost ready to take up the ascinating subject of general analysis, but rst we must give a few moments to the ubject of hydrochloric acid and chlorine; ecause certain questions will unavoidably come up in analysis which can be readily understood by knowing a little more about the relations of the chlorine compounds. The accompanying table gives list of these compounds.

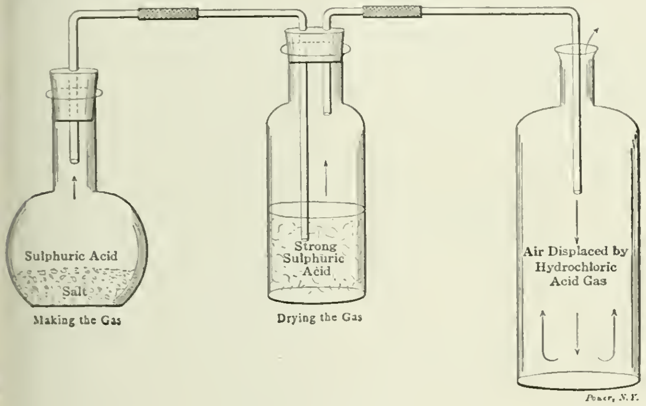


FIG. I

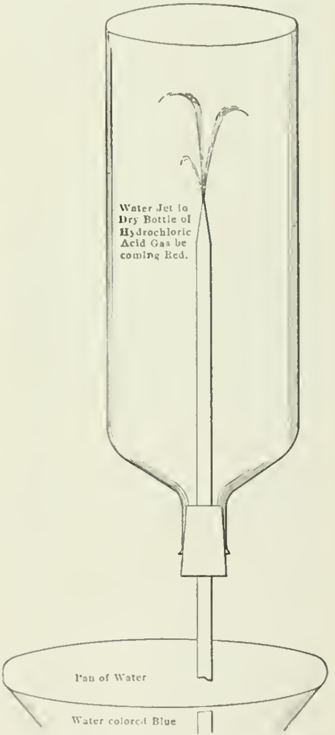

Water Jet to Dry Bottle of Hydrochloric Acid Gas be coming Red.
Pan of Water
Water colored Blue
Power, N.Y.

FIG. 2

OXIDATION TABLE OF CHLORINE.

| Reduced End. | Intermediate Compounds. | | | | Oxidized End. |
|---|---|---|---|---|---|
| HCl<br>Hydrochloric Acid. | $Cl_2$<br>Chlorine. | $Cl_2O$<br>Hypochlorous Anhydride. | $Cl_2O_3$<br>Chlorous Anhydride. | $Cl_2O_5$<br>Chloric Anhydride. | $Cl_2O_7$<br>Perchloric Anhydride. |
| NaCl<br>mmon Salt; Sodium Chloride. | | HClO<br>Hypochlorous Acid. | $HClO_2$<br>Chlorous Acid. | $HClO_3$<br>Chloric Acid. | $HClO_4$<br>Perchloric Acid. |
| $NH_4Cl$<br>Sal ammoniac. | | NaClO<br>Sodium Hypochlorite. | | $KClO_3$<br>Potassium Chlorate. | $KClO_4$<br>Potassium Perchlorate. |
| | | $Ca\left\{\begin{matrix}Cl\\OCl\end{matrix}\right.$<br>Calcium Chloride and Hypochlorite: Bleaching Powder. | | | |

It is not necessary to memorize all this, hough it is wise to stop and take in something of the relative grouping of the various compounds. At the left and the reduced extreme come hydrochloric acid and its salts, the chlorides. Then comes chlorine itself; and then the oxygen acids of chlorine. It would take several weeks to master all of these oxygen compounds of chlorine; but we will pick out one or two of the most important. Note the bleaching-powder salt, commony and popularly called "chloride of lime," though it is not really pure calcium chloride. Bleaching powder acts as though t were a mixture of calcium chloride, $CaCl_2$, and calcium hypochlorite, $Ca(OCl)_2$, in the same molecule; and so the simpler formula, $Ca\left\{\begin{matrix}Cl\\OCl\end{matrix}\right.$ is given it. Also, there is potassium chlorate, $KClO_3$, the common throat gargle, and the salt used to make oxygen; you will remember that you have used it, mixed with black oxide of manganese. These three compounds, with chlorine itself, will cover most of the practical forms of this wonderful substance.

### Hydrochloric Acid

Hydrochloric acid is worth making, although you have used it in many ways, and have made some of the most important tests for it. A couple of hundred years ago, hydrochloric acid was called "spirit of salt," a name which should be emphasized and explained, because it carries the gist of the chemistry and physics of this important acid. As you have used this acid, it is a clear watery liquid, with a sharp odor very much in evidence; but really, that is only a strong solution in water of the real acid, which is a colorless gas; just as common water of ammonia is merely a strong solution of the gas ammonia, $NH_3$. So we will make some of the real gas, hydrochloric acid, HCl, and collect it in much the same way as that used in the experiments with ammonia. You will make the acid by heating a tablespoonful of common salt, covering it with strong sulphuric acid, $H_2SO_4$, as shown in Fig. 1. The gas comes off according to the following equation:

| $H_2SO_4$ | + | 2 NaCl | = | $Na_2SO_4$ | + | 2 HCl |
|---|---|---|---|---|---|---|
| Sulphuric Acid. | | Common Salt. | | Sodium Sulphate, Glauber's Salt. | | Hydrochloric Acid Gas. |

The gas can be dried by passing through strong sulphuric acid, as also shown in Fig. 1; and then it is led to a clean and perfectly dry bottle, with the same care which you used in making the gas ammonia, [illegible] litmus paper at the neck will tell when it is full. But, in this case, as the hydrochloric-acid gas, HCl, is a trifle heavier than air, you will fill the clean and dry bottle with its mouth upwards. Also you will prepare for the absorption experiment with the same glass [illegible] [illegible] that the same fountain effect which you practised in the case of ammonia. But in this case, as shown in Fig. 2, the water in the tub, pail, or pan, and which is to be sucked up into the bottle (after it is filled with the hydrochloric-acid gas), may be colored with blue litmus, which is changed to a bright red by the natural acid action as the water passes up and into the bottle. You will also collect some of the solution of the gas by holding the delivery tube over and just above the surface of some water in a bottle, cup, or tumbler. Do not put the delivery tube down or into the water, lest the backlash from the rapid absorption of the gas by the water might draw the water back into the drying apparatus, and even into the generating flask.

Another very impressive experiment, and one well worth bothering over, is to prepare two large tumblers or, better, wide-mouthed fruit jars, with their mouths ground flat and smooth (which you can easily do by rubbing them down with fine sand or emery on a flat stone or iron plate). Then fill these dry and clean jars, the one with dry ammonia and the other with dry hydrochloric-acid gas and, with both covered with glass plates as shown in Fig. 3, quickly draw out the glass plates, and let the contents of the jars mix, which they will do instantaneously, with the making of a dense cloud of sal ammonaic, $NH_4Cl$. The following is the reaction:

| | | | | |
|---|---|---|---|---|
| $HCl$ | + | $NH_3$ | = | $NH_4Cl$ |
| Hydrochloric Acid, Colorless Gas. | + | Ammonia Colorless Gas. | = | Sal Ammoniac, White Solid. |

This will explain better than any amount of reading can do why your bottles of ammonia and muriatic acid always fume when they are brought next to each other.

Now if you take the solution of hydrochloric acid which you made and attack the common metals, you will find that most of the metals will be cut to solution by this acid, excepting lead, mercury and silver; and this golden fact you want to tuck away in your best memory box, for it is part of the analytical scheme which we are about to take up. The chlorides of lead, silver and mercury (mercurous chloride, not mercuric) are insoluble in water; though that of lead is easily soluble in boiling water.

### Making Chlorine

But to finish this subject of chlorine: Get ready to make some chlorine; but —note this—do not make the chlorine till you have everything ready to make the tests for chlorine, and have read the tests over once or twice so that you can make them without delay. Chlorine gas is about the meanest chemical to handle, and you will not stop to talk speculative philosophy or even baseball while you are working with it. To begin with, chlorine is made by the action of hydrochloric acid on black oxide of manganese; it is a heavy greenish-yellow gas, which, for choking, can give the hangman aces and spades and then beat him at his own game. This gas is also active; and you will not have to wait for the tests if you have them all ready. They are much as fol-

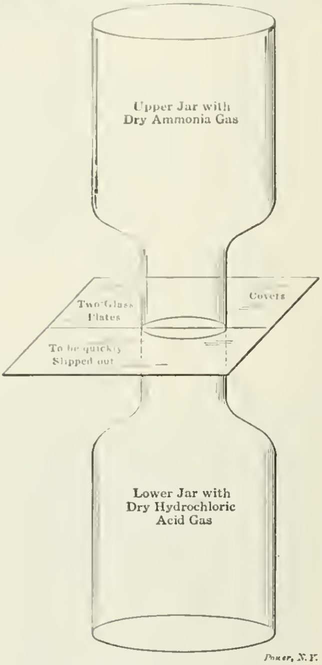

Upper Jar with Dry Ammonia Gas
Two Glass Plates
Covers
To be quickly Slipped out
Lower Jar with Dry Hydrochloric Acid Gas
Power, N.Y.

FIG. 3

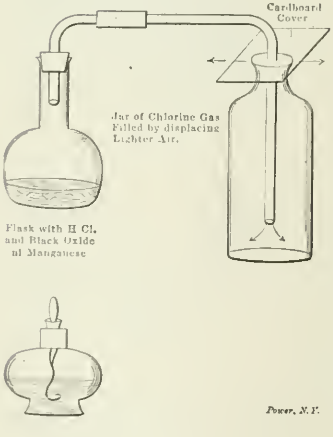

Cardboard Cover
Jar of Chlorine Gas Filled by displacing Lighter Air.
Flask with H Cl. and Black Oxide of Manganese
Power, N.Y.

FIG. 4

lows. Take a pinch of common star
and cook it to a nice creamy thin past
mix with this a crystal or two of pot
sium iodide, KI. The two will be smear
on white filter paper, and this mixture
the potassium-iodide starch mixture whi
will be instantly turned dark by t
chlorine, but if you leave it in the g
for about a minute or two it will be turn
light colored again. The reason is th
chlorine gas is a terrible oxidizer in t
presence of water; and the hydriodic ac
which is first made, is changed to fr
iodine which makes a dark purple or bl
compound with the cooked starch. Ne
this free iodine is oxidized by more of t
chlorine to colorless iodites and iodat
and the like. Another test is to ha
several calico strips, of various brig
colors, and have them moist; and you w
see the chlorine bleach them before yo
eyes—all but the calicos which are print
with mineral colors: it is the organ
vegetable, animal and coal-tar dyes whi
are mostly bleached by the chlorine. Al
in this and most of the chlorine exper
ments note the white fumes which a
only so many indications of the hydr
chloric-acid gas, which is made by the r
action of chlorine on water; it is th
gaseous hydrochloric acid which is
thirsty that it catches some water out
the air at hand and makes a little fog f
itself; for that is what the fuming of plai
hydrochloric acid in air means: the co
densation of water out of the air.

Another experiment is to drop som
finely powdered antimony (the met
which is used in babbitt) into a jar
chlorine; when you will see that there
a flash with every pinch of the antimon
powder, as the two unite.

Another experiment is to have a bit
common white cotton cloth, saturate
with common turpentine, not the too com
mon imitation or substitute for turpentin
which is only so much gasolene or benzin
flavored with a little turpentine; but th
real thing which leaves that sticky resi
due all over the bottle. When a clot
previously saturated with turpentine, i
lowered into a jar of chlorine, there is
rather quick action; there are white fume
of hydrochloric acid formed from th
action of chlorine on the turpentine, an
soon, if it works, the turpentine is light
by spontaneous combustion, burning wit
a thick, smoky flame. But, if you ca
just stop short of this flame, you will not
that the cloth is hot as you take it ou
of the jar; and the cloth is charred so tha
it is rotten enough to be torn by th
slightest ripping. Of course, you wil
lower the cloth into the jar of chlorin
by making a small flag of it on a small
stick.

### Four Important Tests

That makes four tests: the staining of the potassium iodide-starch paper; the bleaching of the damp cotton; the ignition of the powdered antimony; the charring of the turpentine; and the gist of the whole chemistry of chlorine is in these four tests. That means that you will have to have four jars of chlorine ready. When you are ready, mix the black oxide of manganese and the hydrochloric acid, and heat the mixture gently; then the gas will be led over by the delivery tube to four clean and dry jars in turn, as indicated in Fig. 4. As soon as one jar is fairly full of this gas, change the delivery tube to the next jar, covering the last jar filled, mouth upward, with thick cardboard. You had better do all this in a good draft for obvious reasons; after you have finished the tests, you will realize that actual work with chlorine is far different from merely reading about the experiments.

You have now laid the basis for the work on bleaching powder. You will read in the books about the making of bleach; but you may as well take the commercial "chloride of lime" and start with that. If you pour some strong acid, such as sulphuric or hydrochloric, over the bleach, you will get off some vapors which in their way are just as active and as unsavory as chlorine. You can try the same tests with this mixture of bleach and hydrochloric acid that you did with chlorine; only do not try to collect any of the gas in this case, but do the experiments in the open, over a saucer of the stuff. You will find that you have much the same kind of active gas, but not quite so active as in the case of chlorine. Now if you heat some of this dry bleach in a test tube you will get the simple tests for oxygen, such as the ignition of a spark into a flame, showing the close relation between the action of chlorine and that of oxygen. In fact the chemistry of chlorine is tied right up with the following reaction, as shown in the bleaching of cotton:

$$Cl_2 \quad + \quad H_2O \quad = \quad 2\,HCl \quad + \quad O$$

$$\left.\begin{matrix}\text{Chlorine}\\ \text{Gas}\end{matrix}\right\} + \text{Water} = \left\{\begin{matrix}\text{Hydrochloric}\\ \text{Acid}\end{matrix}\right\} + \left\{\begin{matrix}\text{Nascent}\\ \text{Oxygen}\end{matrix}\right.$$

So it is not the chlorine directly which does the bleaching, but the oxygen released from the water by the chlorine as it makes hydrochloric acid with the hydrogen of the water; this really does the bleaching. And here we have another case of the very common operation of moist combustion, as the coloring matter in the cotton is really burned up by the "nascent" oxygen from the water, released by the chlorine acting on the water. This term, "nascent," refers to the oxygen which comes off from the water as plain atomic O, not $O_2$, and before it has had time to unite with another atom of oxygen to make the molecule, $O_2$. This nascent oxygen is, for the millionth part of an instant, so to speak, "in the air," and the colors of the cotton catch it "on the fly." As you go on with your chemical work you will come across hundreds of similar cases; in every case, "nascent" means that the element so described has left one molecular family, and has not yet united with another.

As to potassium chlorate, we will not dwell long on that compound, it is much like saltpeter in its general oxidizing nature, and it is so active that I will not run the risk of being called an anarchist by giving away many of the secrets of explosives. Perhaps you might try this one, if you will promise not to go into the business of making bombs. Mix a pinch of plain brimstone with a pinch of powdered potassium chlorate, lay the mixture on an anvil, and strike it with a hammer, protecting your hand with a good glove. You will get a snappy explosion, and that will tell you that potassium chlorate is like a doubly-active saltpeter. Your imagination can easily expand this experiment into a dozen more; but be careful that you use more care than you do imagination; or your subsequent personal history may serve to make a short paragraph in the daily list of accidents.

And now, having got some of the ground fairly well cleared away, we will go on to tackle the principles of analysis, and in this way we will get hold of some of the main facts of the metals, and incidentally of that old friend lime, with whom we started on this slow but sure search for the leading facts of analysis.

## A Gala Field Day in Rhode Island

The fourteenth annual outing and field day of Rhode Island Association No. 2, N. A. S. E., of Pawtucket, took place on Sunday, July 25, at Palace Gardens, near Providence.

In the morning there was an informal reception at the Narragansett hotel, where the members of the local organization were joined by the visitors from nearby cities, including many National and State officials.

At half-past ten the assemblage, numbering more than three hundred, boarded special trolley cars, and were conveyed to the grounds, where a tempting lunch awaited them. After full justice had been bestowed upon the good things to eat and to drink the company repaired to the ball field to witness the baseball game between the members of the Pawtucket Association and the "Bunch" of New York. For the first time in seven years, and after a most exciting contest, the "Bunch" were victorious by the score of 19 to 12. The umpire, William McCauley, was congratulated for his fairness, and Capt. Frank Martin felt justly proud of his team's victory.

At the conclusion of the game, there was a summons to the dining hall, where an old-fashioned shore dinner was served, and met with the hearty approbation of everybody present.

After dinner the "Bunch" gave an enjoyable entertainment in the dance hall, each number being generously applauded.

While the outing of Rhode Island No. 2 is ostensibly a local event, yet it always flavors of the National occasion, as among the distinguished guests present were Past National Presidents Herbert E. Stone, P. H. Hogan, T. N. Kelsey, Joseph F. Carney and National Vice-President W. J. Reynolds. State Deputy Edward H. Kearney, of Boston, State Deputy Edward Wilkens, of Rhode Island; State Secretary Frank Henderson, of Dedham, Mass.; State Treasurer Walter Damon and National Trustee William J. McLean were also present.

The enjoyable occasion was under the superintendence of the following committee: Riley Daniels, chairman; James M. O'Brien, Thomas P. Burke, Albert H. Keene, W. R. McCauley, W. H. Keene, James J. Chandley, Alexander Van Vredenburg, Fred B. Beck, E. M. Kennedy, Henry Porter, Benjamin Scholes, John Ryan, Harry Dunlap.

A very handsome combination menu and program was donated by the Burke Engineering Company, of Providence.

## Small Things That Count

Apparently insignificant things around a power plant may sometimes produce serious trouble. In a gas-power plant equipped with suction producers, the threeway cock at the entrance to the purge pipe of one of the producers was unintentionally left so that the purge pipe communicated with the gas main through a very slight crack. The consequence was the suction of air into the system, causing an explosive mixture to be formed in the pipe leading to the scrubber. It is not known how the mixture became ignited, but it did. No one was hurt, fortunately, but the producer was put out of commission for several hours.

Moral: Don't use a threeway valve that is capable of connecting more than two of the outlets in any position, even by the merest crack or leakage space.

Again: Don't allow the use of connections at the engine which make it possible for the gas-supply pipe to connect with the air-supply pipe at any time other than during the suction stroke of the engine.

Once more: If you are using illuminating gas or gasolene in an engine with high compression by diluting the mixture to prevent premature ignition, arrange the mixing valve so that the attendant cannot increase the proportion of gas or gasolene, accidentally, intentionally or otherwise, without taking the mixing chamber apart. If necessary, rivet a chunk of cast iron in the path of the lever that controls the gas proportion so it cannot be moved any farther toward increasing the richness of the mixture.

POWER
AND THE ENGINEER

DEVOTED TO THE GENERATION AND
TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

John A. Hill, Pres. and Treas. Robert McKean, Sec'y.

505 Pearl Street, New York.
355 Dearborn Street, Chicago.
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of Power solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "Powpub," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During 1908 we printed and circulated 1,836,000 copies of* Power.

*Our circulation for July, 1909, was (weekly and monthly)* 141,000.

*August* 3.............. 42,000
*August* 10............. 33,000

*This paper reaches 42,000 separate readers each month and 33,000 each week*

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation*

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## Cylinder Lubrication

A man whose every utterance upon steam-engine practice would be listened to with respectful interest writes: "I suggest that you start a discussion on the lubrication of engine cylinders. I believe that ninety per cent. of the cylinder troubles throughout the country are due to poor lubrication. Superheated and wet steam both introduce complications that are little understood. A thorough ventilation of the subject would be profitable to all concerned."

We commend the subject to our correspondents as an interesting and fruitful one. Inquiries among engineers and owners of steam plants indicate an astonishing discrepancy in the amount of cylinder oil used in engines running under apparently similar conditions. How much oil do you use? What is the size and speed of your engine; what pressure do you carry, and is the steam wet or dry, and if superheated how much? What kind of oil do you use, and, if it is a fair question, what do you pay for it? Have you had any cylinder troubles due to lack of lubrication; how did they manifest themselves and how did you get rid of them?

Water in the steam increases the difficulty of lubrication and naturally so. Apply a drop of hot oil to a well-wetted metallic surface, and see whether it will stick and spread. If a separator were of no other use it might "earn its keep" in the possible saving of oil and cylinder wear.

Notwithstanding the explanation of some manufacturers of sight-feed oil cups that the oil is "vaporized and carried with the steam to every part," we cannot imagine that oil in the form of vapor is of much use as a lubricant. Perhaps they mean "atomized." Perhaps if the oil is really vaporized—evaporated—by the hot steam it is recondensed against the cooler metallic surface and becomes efficient as a lubricant. This, together with the fact that the boiling point is much higher under pressure, explains the possibility of lubricating cylinders using highly superheated steam with oil having, at the atmospheric pressure, a temperature of vaporization considerably below that of the steam. The metallic surfaces, be it remembered, assume a temperature considerably below that of the steam as it comes from the boiler or superheater, being exposed to this temperature only up to the point of cutoff, to a gradually decreasing temperature during expansion and to the comparatively low temperature of the exhaust during the return stroke.

What we want most is practical information upon the subject, something which will enable our readers to avoid and cure the cylinder troubles which they have, or to get along with less expense than they are now incurring for avoiding them.

## Bluffers

There is a remarkable type of man in this country who, for lack of a more accurately defining term, may be classified as a "bluffer." He exists in every class of activity, from the clergy down to the coal passer, and seems to care as little about the contempt of decent people as he does about the quality of his work In a few—a very few—instances he has flourished, by supreme impudence skilfully veiled and a plausible, genial manner that makes others doubt their judgment of him in the face of damning evidence The great majority of these time-serving parasites, however, don't last long in one place or vocation; they must be constantly shifting to new fields where they are not so well known. In engineering, the bluffer formerly flourished riotously, but as engineering in the United States approaches more and more closely to a solid scientific plane, the bluffer's chances of success in any of its branches grow beautifully less When we reach the state of accuracy which characterizes European engineering the engineer bluffer will have to work for his living or go into wildcat-mine promotion.

We saw a bluffer wreck a fine four valve engine many years ago by starting it up cold with the cylinder-drain cocks closed; the cylinder head went out with fragments of the barrel, the connecting rod pulled loose at the crosshead end and wrapped around the crank pin like a watch spring, causing the shaft to lift out o the main bearings, after which it rolled on the two belt wheels, out through the side of the house.

More recently we saw a set of bluffer "test" a direct-connected engine-generato set with the calorimeter in the steam main sixty-five feet away from the throttle and the wires from the alternating-current gen erator extending more than two hundred feet to a water rheostat and hanging from three to seven feet apart; no wattmete was used, the output being measured with a voltmeter and an ammeter and the power factor of the generator and con necting wires being "estimated." The speed regulation was measured by a decrepit tachometer belted so loosely tha it did not show a change of speed unti the engine had made a dozen revolutions or so.

More recently still we had submitted to us a report of a gas producer and engine "test" in which the efficiency of the dyna mo driven by the engine was estimated the power taken by a pump belt-driven by the engine was "calculated" from the mechanical piston displacement and the vertical distance through which the water was moved, and the coal consumption was "determined" by counting the number of barrow loads, one load having been weighed in instalments on a small pair of scales.

We could go on citing these nauseating examples through several pages of space. It is an international reproach that so much sloppiness and bluffing is practised in this country, but there is cause for congratulation in the fact that conditions are steadily improving.

The particular point we wish to make, however, is that bluffing does not pay in the long run. There is a lot of difference between the man who has the courage to tackle problems that he never met before, and the one who undertakes responsibilities with only a bare smattering of knowledge of the principles involved and the practical application of them. Don't be afraid of new and difficult work, if you understand the fundamental principles involved, but don't pretend to know things that you don't know at all, and don't do anything in a sloppy fashion—don't be a bluffer.

## Think It Over First

If you have suddenly conceived the idea that the cylinder ratio of your compound engine is wrong and that you can improve it, don't go right off and have patterns made for bushing one of the cylinders and making a new piston—think it over awhile and see if you can convince yourself that your few years of engine running have made you more competent to design a compound engine than a man who has probably spent most of his life doing that kind of work.

When you have an inspiration as to the kind of grate bar your mechanical stoker really ought to have, stop a moment and remember that that grate bar is not the result of a rough calculation made on the back of an envelope in one and a quarter minutes. Perhaps it is not precisely what your conditions require, but did you ever work a fire on a grate of your own design?

"Peradventure," as the old-fashioned story writers used to say, peradventure you feel a yearning to rewind the armature of a motor or dynamo to suit your own advanced ideas, or maybe it is the commutator design that needs your expert correction. Before you start in to spend any actual money on "improving" the apparatus, pause and reflect that that armature or commutator is not the first one its designer ever built; he probably laid awake a few nights and wasted a lot of money on experiments before your machine was turned out.

Now we are not arguing that the gentle manufacturer or his engineer is perfect either in learning or in the application of it—not for a moment. He can and does make mistakes, and it's entirely possible you have one of them in your plant. *But*, before you start in to reform his engineering practice as reflected in your machinery, stop and convince yourself that you are better able to do it than he is. In one case out of a hundred thousand or so you may be; but in the other ninety-nine thousand or so, some money and humiliation will be saved by making the builder do his own correcting or revising, if any is needed.

## The Indicator

Not many years ago the average engineer knew very little about the steam-engine indicator. Such an apparatus was considered a most intricate affair, and to operate it and read the diagrams with some degree of precision was altogether beyond the intelligence of an ordinary engineer. It was then the practice to call in an expert versed in this line of work, and during each visit, which happened about once a year, he was supposed to point out all defects in the adjustment of the engine and leave it in such condition that it would at least turn over for the succeeding twelve months. This was the custom adhered to by the management of many plants, and little or no thought was given to the fact that the money spent for each visit of the expert would buy an indicator.

The practice has changed now, and the indicator is no longer a mysterious device to be used only by a few experts. Its usefulness has been gradually impressed upon the minds of engine owners, and most of them have begun to realize that the time to adjust an engine is when it needs it, and not several weeks or months afterward. Even now, however, there are many plant owners and engineers entirely innocent of the ownership of an indicator, and not a few fail to realize, apparently, that it is not merely a convenience or an optional refinement, but a real necessity if the engine equipment is to be kept in proper condition.

To obtain the highest efficiency from an engine it is absolutely necessary to know all operating details, and the use of an indicator makes this possible. No other means will enable one to ascertain quickly and accurately the points of cut-off and release, the amount of compression, the mean effective pressure, the leakiness of a piston or a valve, the relation between the work done in the head end and that done in the crank end of a cylinder, or, in a compound engine, the relation between the work of the low-pressure and high-pressure cylinders, and so on.

It takes time, of course, to learn all the necessary details about the operation of the indicator and to be able to read the diagrams with intelligence. It is a matter of a little study and practice, but any engineer who has ambition for a better place, or wishes to make the best possible showing in his own plant, must of necessity own or have the use of an indicator and know how to use it.

## That Rhode Island Coal Again

Intermittently for some time past there have appeared in the daily and weekly newspapers of the eastern section of the country, notices and editorials on the coal mines of New England. Especially mentioned in each were the workings at Portsmouth, R. I., which, after several periods of alternate activity and depression, extending over half a century or more, were finally abandoned in 1870. Analysis of the coal from the Portsmouth mine shows it to be very high in fixed carbon and low in volatile matter, even more so than Pennsylvania anthracite, and therefore exceedingly difficult of ignition. It was successfully used in smelting by the Taunton (Mass.) Copper Company, until the tariff placed on imported copper ore drove the company out of business, when the mine was abandoned.

Requiring a high temperature to ignite and not being adapted to slow burning, the coal is unsatisfactory for domestic use. It may, however, find a market for industrial purposes such as smelting and steam making, where strong draft and fierce fires are requisite. Its exceedingly small content of volatile matter renders it less suitable for use in producer-gas manufacture than the Pennsylvania anthracites and the lignites of Dakota.

There are paragraphs in the press notices of the Portsmouth coal which tend to create suspicion in the minds of the well-informed that this coal has little commercial value as a fuel. One statement, from an alleged coal expert, is to the effect that certain "treatment" is necessary to make the coal satisfactory in all cases. "The treatment," he says, "results in making a coal, which in its natural state is practically incombustible, burn in a particularly satisfactory manner." We understand that the "treatment" referred to consists in applying a solution of nitrate of sodium, or, better still, a solution of chloride of sodium, either of which is said to have the remarkable property of setting free gases which make the coal kindle readily and burn freely. This method of treating the coal has been designated, by those interested, the "Bloss process," but most of our readers will recognize under the chemical names "sodium nitrate" and "sodium chloride" old acquaintances commonly known as saltpeter and salt; and they naturally will not understand how these substances can set free gases that have no existence in the coal.

Then, the statement made in the press notices that the stock of the R. I. C. Company will probably be listed on the New York curb, perhaps states as plainly as any words can the true value of the mine as a fuel producer.

# Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

## The Bliss Turbine

One of the very compact forms in which the steam turbine is built for relatively small output is that of the machine made by the E. W. Bliss Company, Brooklyn, N. Y. It is of the impulse class, identical in principle of operation with the Pelton water wheel, but is compounded or made multistage after the manner of the Reidler-Stumpf design. The steam is expanded completely in the nozzles, and after impinging on the buckets is exhausted into the reversing chamber, where it is redirected upon the buckets. The reversing chamber is common for all reversals, so that the steam runs on a film of steam instead of on metal, which greatly reduces the frictional losses. The number of times which the steam is used on the wheel depends upon the steam pressure and the speed of the buckets, and in this nozzle the steam continues to strike the wheel as long as there is any energy in it, but still keeps the peripheral speed of the bucket wheel low enough to permit the practical direct-connection of electric generators, centrifugal pumps, blowers and other machinery to the turbine shaft.

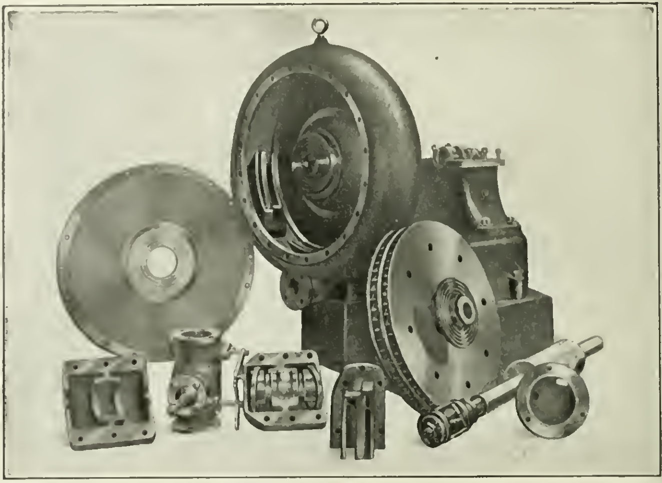


FIG. 1. BLISS TURBINE DISASSEMBLED

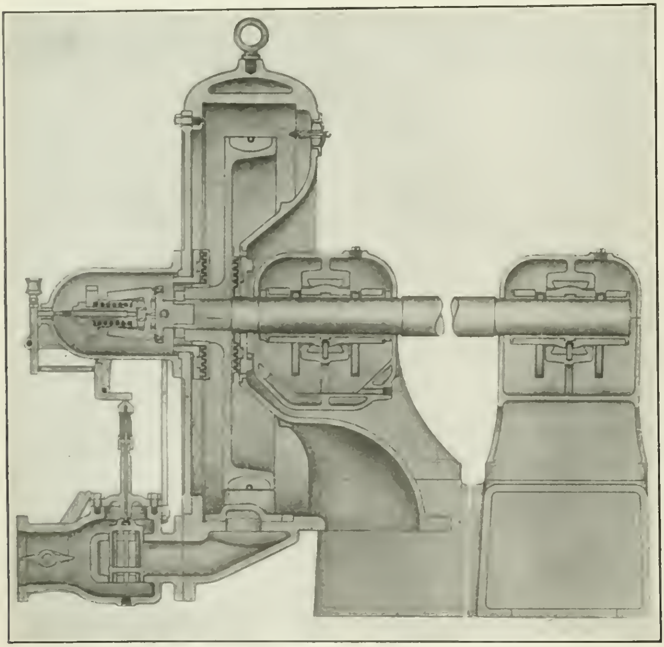


FIG. 2. SECTIONAL VIEW OF BLISS TURBINE

In mechanical construction the machine is simple, each detail being reduced to the lowest possible condition of simplicity consistent with good machine building and economy of operation. From an examination of the view of the disassembled machine (Fig. 1) it will be evident that the casing is a casting having a continuous steam chest concentric with the shaft; it is an iron casting. Bolted to the inside of the casing are the nozzles and also steam reversing chambers.

The rotor is one piece of open-hearth steel, with the buckets milled from the solid; the buckets are separated by sheets of special anti-corrosive metal held in place by steel bands shrunk on the periphery of the wheel, giving a smooth unbroken surface. The running clearance between the rotor and the ends of the nozzle and faces of the reversing chamber is 1/16 inch.

Complete expansion of steam takes place in the nozzles, all of its expansive force being changed to kinetic energy, and it is claimed that there is no difference of pressure between the steam in the buckets and that in the reversing chambers, and, consequently, little if any leakage.

Attached to the end of the shaft is the governor, of the flyball type, consisting of two weights supported on hardened-steel knife-edge fulcrums; through the action of suitable connections the governor controls a balanced throttling valve, while a separate emergency governor operates a speed-limit valve. This latter valve may be set for any predetermined number of revolutions above the normal and any over-speeding of the turbine will at once close the valve and stop the machine.

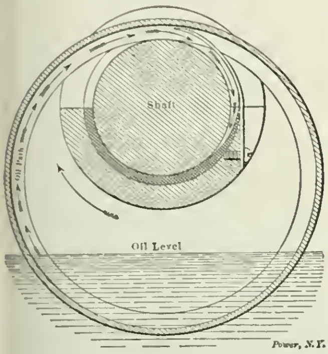


FIG. 3. SECTIONAL VIEW OF SHAFT BEARING

Steam leakage from the interior of the casing to the atmosphere is provided against by the use of a frictionless labyrinth packing in which there is no contact between the rotating and stationary rings. The construction and relative proportions of this packing, as applied to this turbine, are indicated in Figs. 1 and 2; the concentric rings on the side of the rotor, on the casing cover and in the inside of the casing constitute the packing.

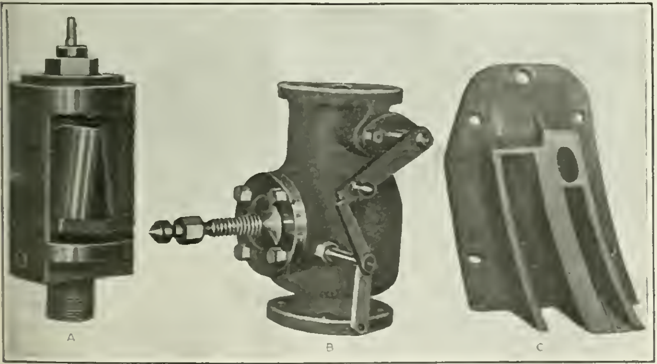


FIG. 4. CENTRIFUGAL GOVERNOR, BALANCED GOVERNOR VALVE, EMERGENCY STOP VALVE, AND THEIR CONNECTIONS

A ring oiling device with special features is used on the main bearings. This is shown in the sectional view of the shaft bearing, Fig. 3. Oil is held on the inside of the channel ring until it reaches a point directly over the shaft where it is diverted from the ring to the bearing by the action of the scoop which projects into the interior of the ring between the sides.

Fig. 2 is a section of the turbine with the steam inlet at the bottom, showing also the construction of the governor, the balanced governor valve, the emergency stop valve and their connections.

In Fig. 4 are shown the centrifugal governor, the balanced throttle and emergency stop valves and the nozzle casting. Fig. 5 shows a 200-horsepower turbine directly connected to a Robinson fan designed to deliver 100,000 cubic feet of air per minute against a static head of four inches of water.

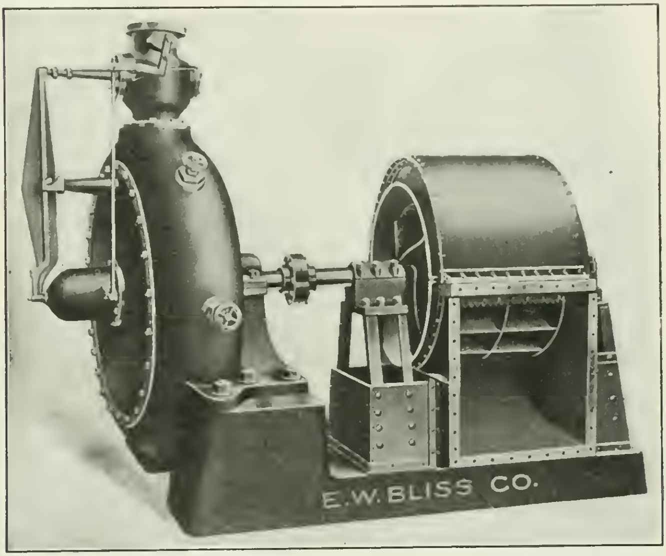


FIG. 5. 200-HORSEPOWER BLISS TURBINE DIRECT-CONNECTED TO ROBINSON FAN; CAPACITY, 100,000 CUBIC FEET AT 4-INCH STATIC PRESSURE

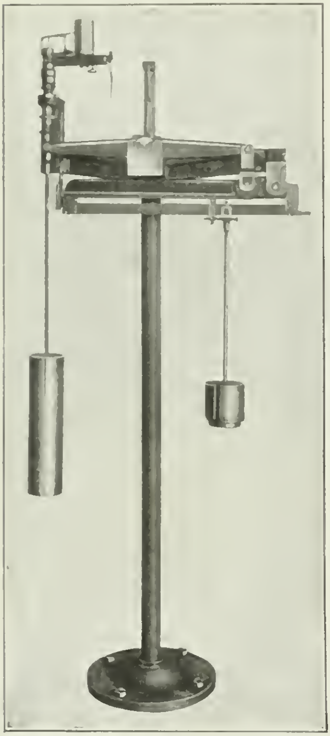
## Instrument for Calibration of Indicator Springs

Experience in the calibration of indicator springs has proved that dead weight applied directly to the spring itself in the cylinder of the indicator gives more satisfactory results than those obtained by the use of mercury columns or steam pressure. In the illustration is shown an apparatus that has been designed and patented by A. B. Calkins with a view to facilitate the accurate calibration of indicator springs by means of pressure exerted by weight. The machine is a scale, which by means of a sliding weight measures the tension put upon the spring by the weight in any position on the beam. At the top of the standard an equal-armed lever is hung upon knife-edged pivots. At one end hangs a weight which balances the graduated scale or weight beam along which the actuating weight slides, by its position on the beam determining the pressure which compresses the spring.

The action of the scale beam is that of a compound lever, and the effectiveness of the single calibrating weight is proportioned to its distance from the fulcrum. On the upper side of the left-hand end of the primary lever is a small countersink into which one end of an extension screw is fitted. This extension screw is composed of an upper and lower member, one of which screws over the other. This extension screw, which passes upward through the socket which supports the indicator to be tested, has two nurlededged flanges by which it may be extended or shortened.

To the top of the standard is fixed a small post bearing a zero mark and a pointer bracket on which the pointer is pivoted. The upper end of the pointer sweeps past the zero mark and the lower end connects with the primary lever in such manner as to give a multiplication of the movements of the primary lever and allow of an exact observation of the movements of this lever.

In the calibration of an indicator spring, the instrument is secured to its support, with paper on the drum. The sliding weight is set at the zero mark on the lower scale beam and the upper end of the extension screw is brought in contact with the under side of the indicator piston. The sliding weight is then moved to any desired position on the graduated beam. This causes the pointer to move to the left of the zero mark. The extension screw is then unscrewed, compressing the indicator spring and bringing the pointer back toward the zero mark.



NEW INSTRUMENT FOR THE CALIBRATION OF INDICATOR SPRINGS

When this point is reached, the pressure on the spring is equal to the product of the weight by its distance from the fulcrum, and a mark may be drawn on the paper showing the hight of the pencil point at this pressure.

Suppose a 50-pound spring is to be tested. The area of the piston of the indicator is one-half square inch. The area being but one-half square inch, but one-half the dead weight will be necessary to show an equivalent of full pressure on the piston. A graduated-scale strip suitable for a 50 spring is inserted in the secondary lever and will have 10 divisions marked thereon. A 50-pound spring will stand a pressure of 100 pounds per square inch above the atmosphere and this pressure will move the pencil point two inches or 100/50. The weight to be used on the weight beam will be 5 pounds avoirdupois. It is placed on the first line from the zero mark on the scale strip. This causes the pointer attached to the stationary post to move to the left of the zero line. The true line of equilibrium is established by holding the upper member of the extension screw and unscrewing the lower member until the pointer comes back to zero.

A line is now drawn on the paper. The weight is then moved to the next division, and another line drawn, and so on, until 10 lines have been drawn, bringing the pointer back to the zero mark for each line.

It will be seen by this description that the 5-pound weight has performed the duty of a 50-pound weight. The pencil has been raised consecutively through 10 divisions on the scale, and 10 lines drawn above the atmospheric line. By taking the scale of the spring, which is 50 divisions to the inch, and measuring the lines on the paper, the amount of error, if any, can be ascertained. If accurately drawn the lines will be 10/50 of an inch apart Any amount plus or minus this distance would show the error in the spring.

In like manner, springs of any othe scale are calibrated. Scale strips and weights for metric calculation are furnished with the apparatus if desired.

The apparatus is easily adapted to the calibration of pressure gages of all makes It is being put on the market by John S. Bushnell & Company, 227 Fulton street New York City, sole agents for the manufacturers, A. R. Calkins & Son, 232 Fulton street.

The machine from which the illustration was made was built for the Russian government for use in the naval department.

## The "Strong" Engine Stop

The new "Strong" engine stop, just go out by the Strong, Carlisle & Hammond Company, 336 to 344 Frankfort avenue N. W., Cleveland, O., is of novel design The device is shown attached to a steam engine in Fig. 1, set to operate. It consists of a cold-rolled steel band *A*, Fig. 2 and spring-steel band *B*, secured to the engine shaft by the clamps *E*, the weight *H* being free to move more or less from the center of the shaft as the speed of the engine varies the side clamps *C*, which can be moved toward or from the weight as the speed of the engine demands These clamps are set for the desired speed before leaving the factory. There is also a stand *F*, at the top of which is a lever *D* With the engine running at normal speed

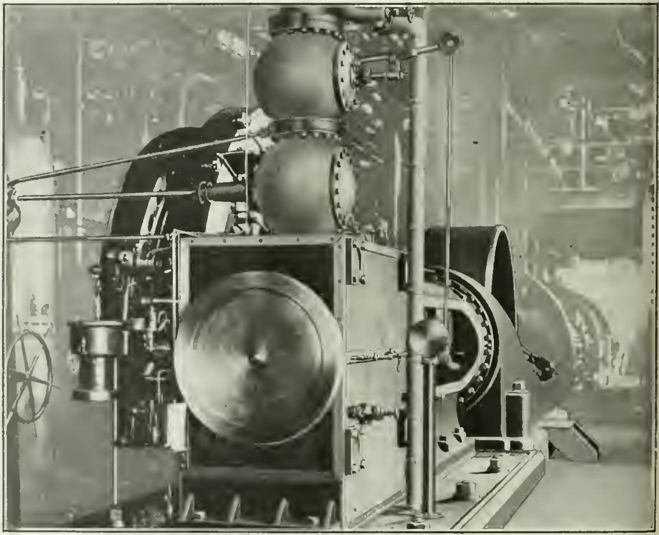


FIG. 1. "STRONG" STOP ATTACHED TO ENGINE

*F* can be adjusted in hight until *D* is just out of striking distance of the hardened point *P*. The slightest increase of the speed of the shaft will throw the point *P* a slightly greater distance from the center and striking the lever *D*, bring it in contact with the arm of the stand *F*, which closes the circuit.

Current instantly passing through the magnet coils in the engine stop draws the magnet bar down, and with it lever *M*, Fig. 3. This releases the hammer *H*, which drops and knocks the rod *L* from its support and closes the quick-closing valve. The latch *O*, Fig. 4, locks the hammer in place so that the rod *L*, Fig. 3, cannot be placed on its support until the hammer *H* is returned to its normal position. The lever *D* can then be returned to its vertical position.

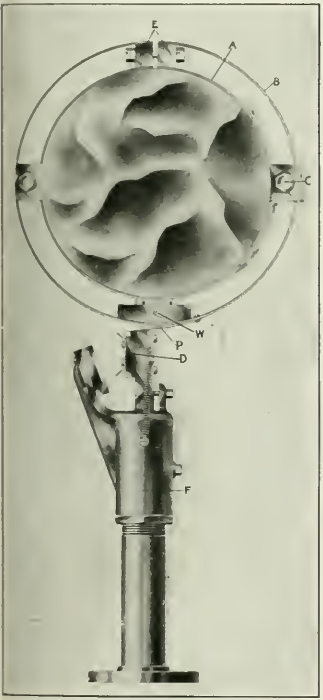


FIG. 2. SHOWING ELECTRIC CONTACT

This engine stop can be operated by pressing a push button located anywhere in the plant. It operates in connection with a quick-closing valve located just above the throttle of the engine, thus making it wholly independent from the engine throttle.

An engine equipped with a "Strong" engine stop cannot be started without first setting the stop. It will readily be seen that opening the throttle will not permit the steam to enter the engine, as the quick-closing valve will be closed, and it cannot be held open unless the stop is set. The only thing which could be neglected by the engineer and thus make the stop inoperative is lack of attention to the storage batteries. A duplicate set of batteries is furnished with each installation and also a voltmeter. The duplicate set of batteries permits one battery to be charged while the other is in service. The voltmeter not only checks the condition of the battery for the benefit of the engineer, but shows the superintendent or manager at a glance, as he passes through the engine room, that the apparatus is being taken care of. The stop can be tested at any time by pushing the button, an attendant standing at the stop and catching the lever as it is thrown from its position. If the stop is at once reset, the speed of the engine need not be affected.

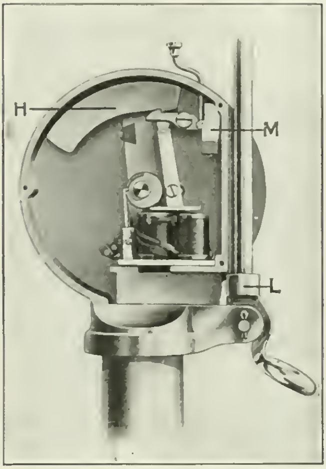


FIG. 3. POSITION WHEN ENGINE IS RUNNING

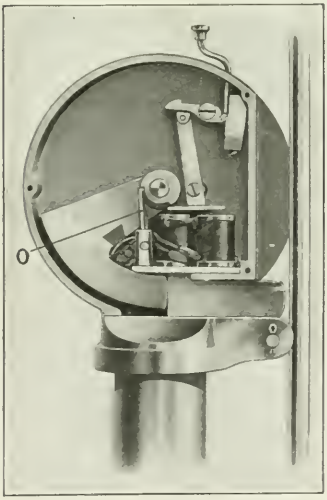


FIG. 4. POSITION OF STOP AFTER SHUTTING DOWN ENGINE

The speed limit connected with this engine stop is independent of all belts, chain drives, etc., and being bolted in place on the engine shaft cannot easily be thrown out of service.

## Vacuum Tube Cleaner

A new design of vacuum tube cleaner is illustrated and described in the following: The cleaner is connected with a live-steam pipe, and properly relieved of all condensation prior to entering the tubes of the boiler. In the head of the cleaner are small counterbored apertures, which aid in relieving condensation and also in causing an agitation of soot in the tubes as the cleaner is placed in them.

The tube cleaner is admitted into the tube for about 6 inches, until it strikes a shield which acts as a valve and drives the steam to the rear end of the tube, causing considerable agitation for its full length. By gently pulling out, the vacuum that is formed cleans the tube of soot and accumulation.

CLEANING THE TUBES

It is claimed that the steam is superheated and that it is utterly impossible to cause contraction, due to cold air entering the tubes or parts of the combustion chamber of the boiler. This is due to the fact that if the fires are in the proper condition, the heat from the furnace will follow the head of the cleaner as it is withdrawn from the tube, due to the strong vacuum that is created. It is said that the cleaner will work in a very satisfactory manner with a steam pressure of from 10 to 15 pounds. This cleaner is handled by the Corbett Supply Company, Trenton, N. J.

## James Watt Association Outing

James Watt Association No. 7, National Association of Stationary Engineers, of New York, held its annual outing at Schmidt's grove, Glendale, L. I., on Sunday, August 1. The hospitality of No. 7 is well known, and the usual good time was had. There were a baseball game and several other outdoor sports, which awakened great interest. At the conclusion of the games, the gong was sounded, and the company repaired to the dining hall where fully one hundred partook of a tempting repast. The committee in charge of this merry occasion were Andrew Howard, John Ronnie and George Bush.

## Business Items

Charles Webber, who is well known to the engineers about Greater New York, is now representing Sanderson & Wright, of New York.

The Hoppes Manufacturing Company, Springfield, Ohio, reports 13 recent sales of Hoppes live-steam feed-water purifiers, ranging in capacity from 200 to 30,000 horsepower; also a number of recent sales of large steam separators, oil eliminators and exhaust heads.

The Parker Boiler Company has received an order for three 267-horsepower boilers from the King Philip Copper Company, Winona, Mich., making the second order from this company. Also, an order for a 300-horsepower boiler from the Winona Copper Company, which is the third order from that company.

The A. S. Cameron Steam Pump Works, foot of East Twenty-third street, New York, has issued a new catalog illustrating and describing the Cameron condensing apparatus. This company now makes all types of condenser for every service and a copy of this new catalog will be gladly sent to any engineer upon application.

The Torrington (Conn.) Electric Light Company is adding a 50-kilowatt Westinghouse turbine generator set to its power-station equipment, which has hitherto comprised a 300-kilowatt General Electric Curtis turbine set and a 500-horsepower Harris engine direct connected to a Stanley generator. The station supplies a lighting and power service with 60-cycle three-phase current at 2300 volts.

Among recent sales of heavy electrical machinery made by the Allis-Chalmers Company is a contract covering two three-phase, 25-cycle, 6600-volt alternating-current generators, with a combined capacity of 8000 kilowatts, to be direct coupled to gas engines in the power plant of the Carnegie Steel Company's Carrie furnaces at Rankin, Penn. These are the largest machines ever built for service of this character.

"Piping and Chimneys" is the title of a very attractive catalog just issued by the M. W. Kellogg Company, 50 Church street, New York. The information about this company's radial brick chimneys is concise and of value to the engineer, as is also the information about its welded pipe, which is so necessary in power-plant practice of the present day. The catalog also illustrates and describes the Kellogg barometric condenser. A copy will be gladly sent any engineer on application.

For additional power on its railway lines and for lighting several adjoining towns, including Narragansett pier and Wickford, R. I., the Sea View Railroad Company has installed in its Hamilton, R. I., power station two 400-kilowatt Westinghouse turbines driving Westinghouse three-phase, 60-cycle, 360-volt alternators. This equipment is additional to a set of horizontal, cross-compound reciprocating engines driving Westinghouse generators already installed. The plant is supplied with Westinghouse LeBlanc condensers which preserve a vacuum of 28 inches.

## New Equipment

C. Ham will build a brewery at Silver Creek, Wis.

The citizens of Peru, Neb., will vote on issuing $15,000 bonds for water works.

The Kings County Cold Storage Company, Brooklyn, N. Y., is building a new ice plant.

Water works to cost about $50,000 will be constructed at South Paris, Me. E. N. Haskell, village clerk.

The village trustees of Rankin, Ill., are said to have under consideration the question of constructing water works.

The citizens of Jellico, Tenn., voted to issue $90,000 bonds for water works and sewers. S. B. Snyder, mayor.

The citizens of Central City, Neb., voted to issue $18,000 bonds for constructing a lighting plant. C. F. Neumeyer, city clerk.

Bids will be received until Aug. 16 by water commissioner, Niagara Falls, N. Y., for nine pumps, piping and valves for water works.

Plans are being drawn for enlargement of the power plant of the Bar Harbor and Union River Power Company, at Ellsworth, Me.

G. H. Jay, of Great Falls, Mont., is reported to have been granted a franchise for an electric-light and water-power plant in St. Maries, Idaho.

The Canadian Fish and Cold Storage Company will build a plant at Prince Rupert, B. C., to include a public cold-storage buidling and fertilizing plant. This will cost $300,000.

The Delaware Ice Company has been incorporated with $250,000 capital to manufacture ice. Incorporators are J. H. Scott, W. F. Kohlbecker, J. R. O'Donnell, of Wilmington.

The Philadelphia (Penn.) Warehousing and Cold Storage Company has let contract for the erection of an eight-story warehouse and two-story engine building to cost about $300,000.

It is reported that the Lexington & Interurban Railway Company will soon begin construction of power house at Valley View, Ky., to cost about $250,000. Geo. McLeod, Lexington, Ky., is chief engineer.

The South Bend Vacuum Ice Company, South Bend, Ind., has been incorporated with $75,000 for the purpose of manufacturing ice. S. A. Knoblock, C. M. Kreighbaum, P. E. Bondurant, and others, directors.

Proposals will be received at the office of constructing quartermaster, Fort Slocum, N. Y., until 10 a.m., August 18, for installing heating systems in barracks Nos. 35, 38 and 40 and officers' quarters Nos. 8 and 9.

The Peoples Plate Ice and Cold Storage Company, Bayonne, N. J., has been incorporated to manufacture ice, etc. Capital, $150,000. Incorporators, Edward Rosedon-Foote, Horace Windsor Bodine. Henry F. Kisker.

## New Catalogs

The Curtis & Curtis Company, Bridgeport, Conn. Catalog. Pipe cutting and threading machinery. Illustrated, 36 pages, 7½x10 inches.

Jacobson Machine Manufacturing Company, Warren, Penn. Bulletin No. 27. Gas and gasolene engines. Illustrated, 24 pages, 6x9 inches.

American Huhn Metallic Packing Company, 1876 Broadway, New York. Booklet. Huhn metallic packing. Illustrated, 16 pages, 4x8 inches.

The Gardner Governor Company, Quincy, Ill. Bulletin No. 143. Gardner-Rix vertical high-speed air compressor. Illustrated, 8 pages, 6x9 inches.

Wickes Bros., Cedar and West streets, New York. Bulletin No. 2. New model gas and gasolene engine No. 2. Illustrated, 4 pages, 6x9 inches.

Dodge Manufacturing Company, Mishawaka, Ind. Booklet. "From Log to Line-shaft." Construction of Dodge wood split pulley. Illustrated, 16 pages, 6x9 inches.

The Bristol Company, Waterbury, Conn. Bulletin No. 104. Preliminary bulletin of recording gauges, pressure and vacuum. Illustrated, 40 pages, 8x10½ inches.

Chapman Engineering Company, 917 Land Title building, Philadelphia, Penn. Catalog No. 9. New Chapman case-hardened corrugated copper flange gasket. Illustrated, 24 pages, 6x9 inches.

Henry R. Worthington, 115 Broadway, New York. Bulletin W 165. Volute centrifugal pumps. Illustrated, 16 pages, 6x9 inches. Bulletin W 166. Triplex house tank pumps. Illustrated, 4 pages, 6x9 inches. Bulletin W 169. Boiler feed pumps. Illustrated, 4 pages, 6x9 inches.

## Help Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," Power.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

AGENTS WANTED to sell Burgmann celebrated engine packings in territories not yet covered. See our advertisement on page 85.

WANTED—First-class designer and draftsman on steam and power pumping machinery. Good experience essential. Advise age, experience, education and compensation desired. Box 85, Power.

WANTED—An assistant chief engineer, man experienced as chief engineer or assistant chief engineer, for power plant operating gas engines and steam engines. Give full information as to your experience. Address "C-33-85" Trude Bldg., Chicago, Ill.

WANTED—Engineer for power plant of smelter, five miles from Chihuahua. Alternating day and night shift. Wages, seven pesos (about $3.50 U. S. Cy.) per day. State experience, age, references, married or single. American Smelting & Refining Co., Apartado No. 63, Chihuahua, Mexico.

## Situations Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

POSITION WANTED as master mechanic or chief engineer. Thorough experience in electrical and mechanical steam engineering; familiar with all kinds of printing machinery. Very best references. Address Box 86, Power.

## Miscellaneous

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A PRACTICAL MAN wants to buy or lease an electric light plant. Box 84, Power.

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# Belted Electric Elevators

## Wherein They Differ from the "Self-Contained" Types; Description of Principal Methods of Operation and Some Features of Construction

BY WILLIAM BAXTER, JR.

An electric elevator, properly speaking, is a combination machine, consisting of some type of hoisting apparatus and an electric motor, usually mounted on the same bed, and connected with each other through suitable gearing, so that the motor may operate the hoisting machine. In the early days of the electric motor, before complete combination machines were manufactured, it was not uncommon to belt the electric motor to a countershaft, and belt that to the hoisting machine, and the installation was called an electric elevator. This sort of arrangement is still used for small outfits and intermittent service, and to distinguish it from the self-contained machine it is called a "belted" electric elevator.

Belted elevators are used principally for freight service, although they are also employed to operate passenger cars in buildings a few stories high, where a speed of more than 75 feet per minute is not required. For higher speeds they are not suited, for reasons that will be fully explained hereafter. As the mechanical details of these machines are not materially different from those of the hoisting-machine part of the self-contained electric elevator, I will give only such description of them as may be necessary to point out the difference between the two types, and to give a general idea of their operation.

### Belted Elevators

Belted elevator machines may be divided into two classes, the double-belt and the single-belt types. In the double-belt type, the driving motor is belted to a shaft, and from this shaft two belts are run to pulleys on the hoisting machine, one belt being straight and the other crossed; one of these drives the car upward and the other one drives it downward. The belts are put into and out of action by the use of clutches or tight and loose pulleys, which are arranged in many different ways, just as in any other type of apparatus where opposite motions are obtained by the use of open and crossed belts. In the single-belt type of machine, the motor is belted directly to the hoisting machine, and the reversal of the direction of car travel is obtained by reversing the motor. For both types of machine the same kind of motor is used, as no special construction is required to make the motor reversible when modern carbon brushes and holders are employed. While there is no difference between the motor used for double-belt and single-belt machines, there are considerable differences in the switches used to stop and start the motor, which will be made clear later.

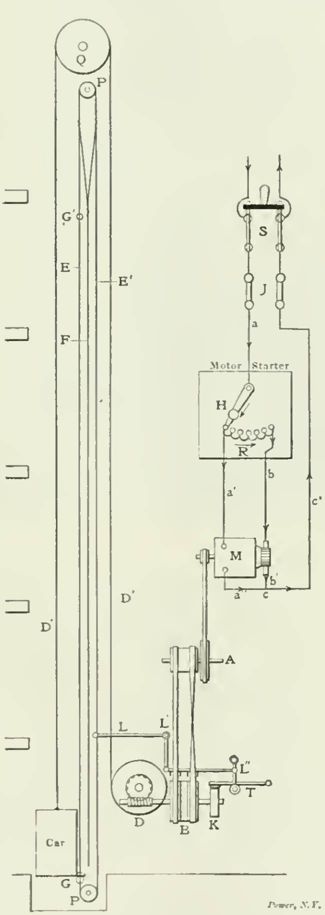


FIG. 1

The switches used to start a motor constitute what is called a controller. When they are arranged to run the motor in one direction only, they are called nonreversing controllers; for operating the motor in either direction they are called reversing controllers.

The simplest way in which a double-belted elevator machine can be installed is shown in the diagram, Fig. 1. In this arrangement the controller is a plain motor starter, of the design used for starting stationary motors to drive any kind of machinery. The motor *M* is belted to a shaft *A*, from which two belts run to the pulleys of the hoisting machine *B*. One of the belts is crossed and the other one is open. The driving shaft of the elevator machine has a screw mounted on one end, and that meshes with a worm wheel on the side of the hoisting drum *D*. When the shaft is turned the drum is rotated and through the lifting ropes *D'* the car is moved, being raised or lowered according to which of the belts does the driving. On the worm shaft is also fastened a brake wheel, and a brake shoe controlled by the lever *L"* acts to prevent the shaft from turning when the belts are both on the loose pulleys. To operate the elevator, the motor is first set in motion, which causes the shaft *A* to revolve, and the hand rope *E* or *E'* is pulled. If the rope *E* is pulled down, the rope *E'* will be pulled upward and lift the lever *L*, which swings around the pivot *L'*; this will draw the belt shifter to the left, and the crossed belt will be carried over on the tight pulley and at the same time the brake shoe will be raised by the action of the lever *L"* on the lever *T*. Assuming suitable construction, the car will be drawn up by the drum *D*. To stop the car at any floor, the operator merely grasps the hand rope *E* and holds it. As the car moves upward the rope also moves upward, and in that way the lever *L* is returned to the position in which it is shown, the belt shifter drawing the crossed belt back to its loose pulley; at the same time the lever *L"* releases the brake shoe, which comes down on the brake wheel and stops the elevator machine.

One objection to this arrangement is that the motor is kept running as long as the elevator is likely to be needed, even when the elevator is stopped, and the motor is using current driving itself and the shaft *A*; but as the power required to do this work is small, the current consumption is also small. If the motor is shut off whenever the elevator is stopped, this results in the disadvantage that the motor must be started up again in order to start the elevator together. In places where the elevator is in constant use and where the stops at the floors are short, the waste of current caused by keeping the motor running all the time is not as great as might at first appear, owing to the fact that every time the car is started, the additional current required to set it in motion is not as great as in cases where the motor and the elevator car start at the same time.

The motor starter used in an installation arranged as in Fig. 1 should be provided with an automatic release to cut off the motor in case the supply current fails.

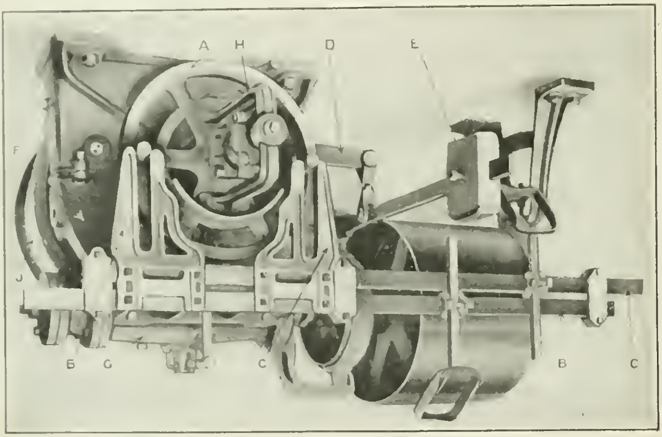


FIG. 2

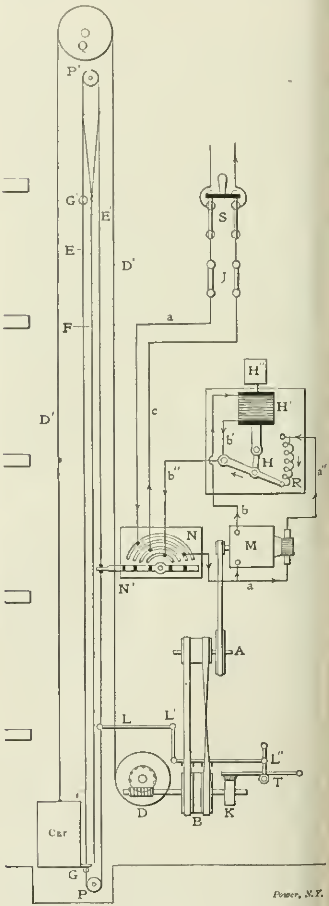
The general appearance of a high-grade double-belt hoisting machine is shown in Fig. 2; this is made by the Westbrook Elevator Company, of Danville, Va. In this machine the sheave wheel *A* takes the place of the starting lever *L* of Fig. 1, and the slotted arms *B* and *C*, together with the bars *B* and *C*, constitute the belt-shifting device. With this construction only one belt is shifted at a time, so that the loose pulleys do not have to be as wide as they would be in a construction like that of Fig. 1, in which both belts are shifted, one to the tight center pulley and the other away from it. The hand-rope sheave *A* has strong pins on the sides and these, sliding down in the slots in the arms *B* and *C*, cause the belt to be carried over on the tight pulley. On the sheave *A* there is a cam which lifts the lever *D* when the wheel is turned in either direction and thereby releases the brake by lifting the weight *E*. A composition worm gear is mounted on the drum shaft within the casing *F*, and is driven by a steel worm on the under side, within the cylindrical casing *G*. The device at *H* is an automatic stop, to stop the machine whenever the car reaches either the upper or the lower limit of travel.

The lifting ropes by means of which the car is raised and lowered are wound upon the drum *J*.

If the car were to become wedged in the hatchway when running down, and the machine were not stopped, the lifting ropes would slack up and a serious accident might follow. To prevent such a mishap a device is provided that acts to stop the machine by throwing the belt off the tight pulley as soon as the ropes begin to slack up. Such devices, which are used on all electric elevators, are called slack-cable stops. The general principle of operation of slack-cable stops, top and bottom stop-motion mechanisms and the brakes are substantially the same in all elevator machines.

When an elevator is installed in the way shown in Fig. 1, the operator in starting the motor takes hold of the handle of the switch lever *H* and slowly moves it over to the right, until it cuts out all the resistance. Now if it is desired that the motor and the car may be started together, it is evident that the man who starts the car cannot also start the motor by actually taking hold of the handle of the motor-starter lever; therefore, some means must be provided for moving the lever of the motor starter without actually taking hold of it, and this means must also be made so that it will move the lever at the proper velocity that the starting resistance may not be cut out too rapidly or be allowed to remain in the circuit longer than is necessary.

A device that can be operated from a more or less distant point to cut out the starting resistance is called an automatic motor starter; such devices are made in many forms, but the general principle of operation can be understood from the diagram, Fig. 3. In this diagram an automatic starter is shown in which the switch lever *H* is drawn up over the resistance contacts by the pull of a solenoid magnet *H'*. This magnet, if acting without any hindrance, would pull the lever up to the top position almost instantly, and as it is necessary for it to move up slowly to cut out the resistance gradually, a retarding dashpot *H''* is placed above the magnet and a stem projecting up from the solenoid plunger carries at its upper end the dashpot piston. By properly adjusting the dashpot, the lever *H* can be caused to move upward at any speed desired.



Power, N.Y.

FIG. 3

In addition to the automatic starte there is a controlling or master switch *N* provided with a lever *N'* connected wit the hand rope *E'*. When the hand rope i moved it closes the switch *N*, and als moves the lever *L* to shift the proper bel onto the tight pulley and to lift the brak shoe. When the switch lever *N'* is move either upward or downward, the circui between the motor and the line is closed and then the current will flow throug the motor and controller circuits in the direction indicated by the arrow heads. Following the arrow heads it will be seen that the main current will pass through the armature by the wires *a* and *a''* to the top of the resistance contacts and thence through the resistance to the lever *H*, and through the wire *b''* back to the switch *N* and thence to the line wire *c*. The current that is shunted from the wire *a* through the field coils of the motor will pass by the wire *b* to the upper end of the solenoid magnet *H'* and through this to the wire *b* and the wire *b''* and back to the main switch and the line wire *c*. Thus as soon as the switch *N* closes the circuit, the magnet *H'* becomes energized and begins to lift the switch lever *H*, which slowly cuts out the starting resistance *R*, all of this resistance being cut out when the lever *H* reaches its uppermost position.

In the simple diagram, Fig. 1, it will be noticed that the field winding and the armature of the motor are connected with each other so as to form a closed circuit or loop. This connection is always made this way if possible, because it prevents serious sparking at the switch contacts when the circuit is opened to stop the motor, and in addition protects the insulation of the field coils from possible damage by a high voltage, self-induced when the field circuit is suddenly opened while fully energized. With the connections as in Fig. 1 this is avoided because the field circuit is never opened in ordinary operation.

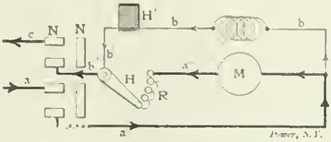


FIG. 4

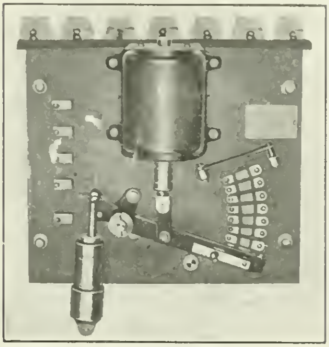


FIG. 5

The closed circuit connection of Fig. 1 is preserved in Fig. 3, although it may not be as readily seen from casual examination. The actual connections are as shown in the simplified diagram, Fig. 4, in which the construction of the main-line switch *N* is modified so as to simplify the run of the wiring. In this diagram it will be noticed that the field winding and the solenoid of the automatic starter are connected in series with each other. This construction is not generally followed, because in order to do so it is necessary to wind the solenoid with a special size of wire for each size of motor, so that it may be properly magnetized by the current required for the motor field. The advantage of the arrangement shown, is that if the field circuit should be broken in any way the solenoid magnet would be de-energized and the switch lever *H* would drop and put the starting resistance back in the armature circuit and prevent serious damage. In most cases the solenoid *H'* is connected in parallel with the field winding, this being done because then it is not necessary to proportion the solenoid winding and the field winding of the motor to correspond with each other.

The appearance of an actual automatic starter of the type shown in Fig. 3, is shown by Fig. 5. This apparatus is made by the Cutler-Hammer Company, of Milwaukee, Wis. The most noticeable difference between this device and the one indicated in Fig. 3, is the position of the

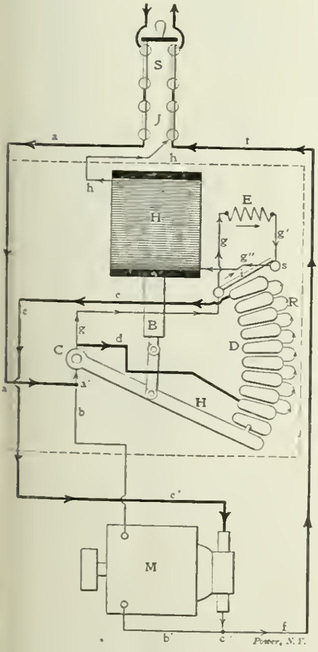


FIG. 6

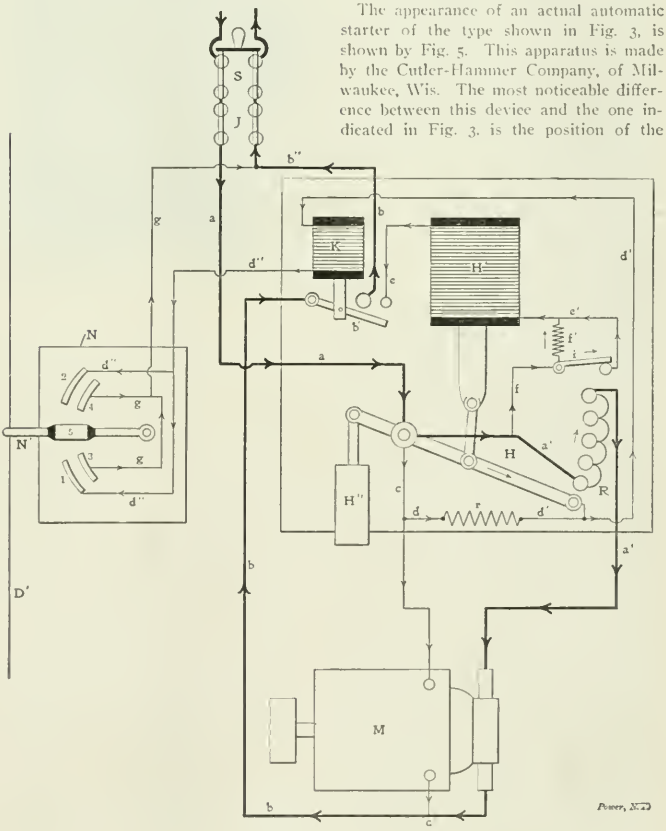


FIG. 7

dashpot, but there are other features that can be more easily understood from the wiring diagram, Fig. 6. In this diagram the main line switch $N$ is left off for the sake of simplicity. The paths of the currents can be easily traced by following the arrow heads. The current for the solenoid $H$ is drawn from $C$, and following the wire $g$ reaches a small switch lever $i$ and from that passes to the contact $s$, whence it passes through the solenoid $H'$ to the wire $h$ and to the line. When the switch lever $H$ is raised to the highest position, the projection on its upper edge lifts the switch lever $i$ and forces the current to pass from the wire $g$ through a resistance $E$ to the wire $g'$ and thus reach the contact $s$ and the wire $g''$. The object of this arrangement is to reduce the current in the solenoid winding; this is practicable because the current required to hold the lever $H$ up in the highest position is very much less than that required to lift it from the lowest position. This arrangement cannot be used if the solenoid and the motor field windings are connected in series; hence, connecting the solenoid in a circuit by itself has an advantage in this particular.

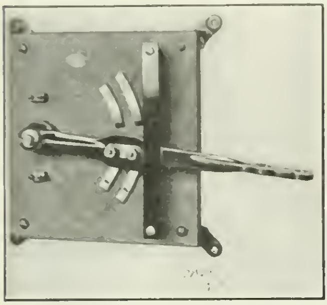


FIG. 8

Another point that will be noticed in Fig. 6 is that when the lever $H$ is in the lower position it does not rest on a contact connected with the starting resistance $R$, but rests on dead contacts and must move up past a second dead contact before it begins to cut out the resistance. This construction is used so that, in starting, the motor may get a chance to speed up a little before the lever $H$ begins to cut out the resistance.

The type of the main-line switch $N$ shown in Fig. 3 is not used for elevators that require a motor larger than 5 horsepower, because switches of this construction do not wear well when subjected to the sparking produced when they handle currents as large as those taken by motors larger than 5 horsepower. For large-sized motors it is common practice to provide an electromagnetic main-line switch, and then the switch $N$ of Fig. 3 is displaced by a smaller switch which controls the current that actuates the magnetic main switch. An electromagnetic switch, it may be well to explain, is one in which the switch is operated by an electromagnet. The diagram, Fig. 7, shows the way in which the controller wiring is arranged when an electromagnetic line switch is used. The small controlling switch $N$ is shown in Fig. 8 and the automatic starter with the magnetic line switch in the upper left-hand corner is shown in Fig. 9.

Referring to Fig. 7, when the lever $N''$ of the small switch is moved upward by the hand rope $D'$, the connector 5 connects the segments 2 and 4, and if $N''$ is moved downward, the segments 1 and 3 are connected. Either movement, it will be noticed, closes the circuit of the main switch magnet $K$, and if this switch closes, the motor circuit will be closed and the elevator will start up. Unless, however, the lever $H$ is in the lowest position, as shown in the diagram, the magnet $K$ will not be able to pull up the switch lever $b'$ because the resistance $r$ will be in the circuit and the current passing through will be too weak. If $H$ is in the position in which it is shown here, the current from the wire $a$ can pass through the lever $H$ to the wire $d'$ without having to pass through the resistance $r$, and in that case it will be strong enough to enable the magnet $K$ to pull up the lever $b'$ and close the main line by closing the circuit between the wires $b$ and $b''$. At the same time the lever $b'$ will connect with the wire $c$ and close the circuit through the magnet $H'$ of the rheostat, by which the resistance will be gradually cut out. When the lever $H$ reaches the uppermost position the small switch $i$ will be opened, just as in Fig. 6, and the strength of the current passing through $H'$ will be reduced.

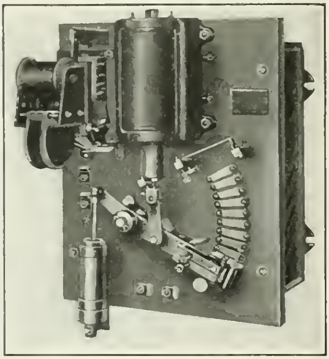


FIG. 9

The resistance $r$ and the wires connecting with it form a safety feature which makes it impossible to start the motor unless all the starting resistance is in the armature circuit; for if the lever $H$ is not in the lowest position, the current that enthrough the resistance $r$, and it will be so weak that the magnet will not be able to pull up the lever $b'$; hence, the main line will not be closed.

Double-belt elevator machines arranged to stop and start with the motor are sometimes provided with two hand ropes, one ergizes the magnet $K$ will have to pass to set the motor in motion and the other to start the car. To equip the apparatus in Fig. 3 this way, it would be necessary only to connect the lever $N'$ of the starting switch $N$ to the extra hand rope. The object of such an arrangement is to keep down the strength of the current required to start the elevator, the current necessary to start the motor and elevator together from standstill being much greater than that required to start the elevator when the motor is already running at full speed. This arrangement is not often used because it is so easy for anyone using the elevator to forget to stop the motor after stopping the car.

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## Pointers on the Compression System of Refrigeration

By James G. Sheridan

In various branches of industry a knowledge of refrigeration is an absolute necessity, and the operating engineer who wishes to keep ahead must become conversant not only with refrigeration and ice making, but also its theory. Fig. 1 is an actual working drawing of the compression system as now employed in modern refrigerating plants.

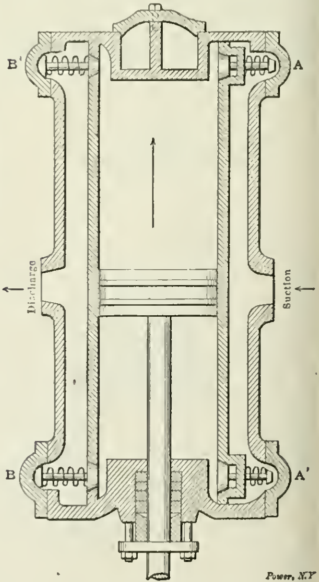

FIG. 2. VERTICAL SECTION THROUGH COMPRESSOR CYLINDER

### Operation of the Compressor

Fig. 2 is a sectional view of the compressor showing the induction and eduction valves arranged in such a manner as to require the least possible amount of labor to inspect, remove or repair. Referring again to Fig. 2, the induction valves are shown at *A* and *A′* and the eduction valves at *B* and *B′*. Assume the compressor piston is moving in the direction of the arrow, then the ammonia, or whatever refrigerant is employed, is sucked in through valve *A′* and whatever ammonia was above the piston is driven or forced out through valve *B′*. The piston will now have reached the end of its stroke and is ready to travel in the opposite direction, thus forcing the ammonia out through the eduction valve *B*. During this downward stroke of the piston ammonia is drawn into the cylinder through valve *A*, and when the piston has forced out all, or nearly all, of the ammonia through valve *B*, the direction of motion is again reversed and the piston proceeds to compress the ammonia in the opposite direction.

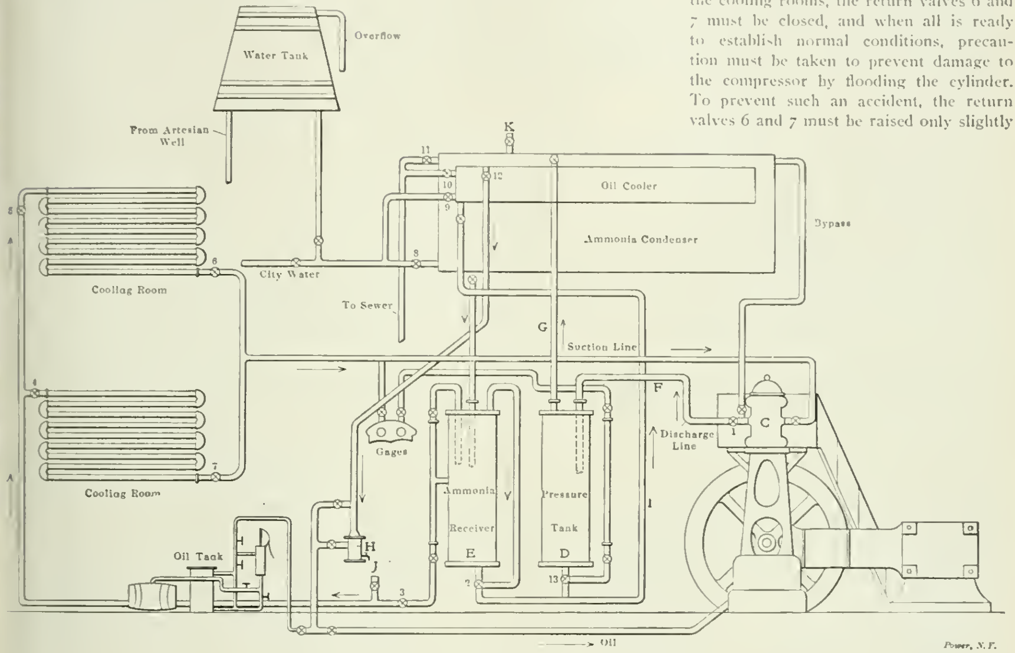

FIG. 1. OUTLINE OF THE COMPRESSION SYSTEM

## Path of the Ammonia

Referring to the working drawing, Fig. 1, the compressor is shown at *C*, the pressure tank at *D* and *E* is the ammonia receiver. From *D* the ammonia is discharged into the condenser, where it is cooled, and thence passed on to the ammonia receiver *E* and conducted to the various expansion valves. Two cooling rooms are shown, and by tracing out the piping one complete cycle of the refrigerating medium can be followed. The ammonia is discharged from the compressor through valve 1 and along the line *F* into the pressure tank *D*. From *D* the hot gas rises through the pipe *G* and into the condenser, where liquefaction occurs, and the liquefied medium finds its way into the liquid receiver *E*. From the receiver the ammonia is led to the freezing coils through the valves 3, 4 and 5 and sucked back from those coils by means of the return or suction line as indicated.

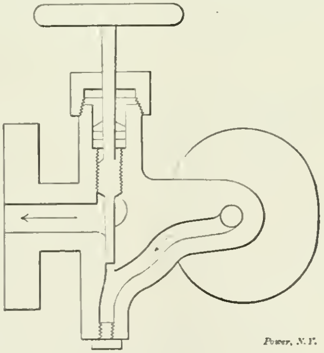

FIG. 3. EXPANSION VALVE

## Expansion Valve

Fig. 3 is a sectional view of the type of expansion valves which are located in the cooling rooms at 4 and 5. These valves separate the high- from the low-pressure side of the system, and in operation should be opened just a trifle from their seats. The exact amount can be best judged by holding the ear near the valve.

## Making Repairs on System

If for any reason, such as repairs, the ammonia is to be pumped in the coils in the cooling rooms, the return valves 6 and 7 must be closed, and when all is ready to establish normal conditions, precaution must be taken to prevent damage to the compressor by flooding the cylinder. To prevent such an accident, the return valves 6 and 7 must be raised only slightly off their seats, preferably one at a time until each coil is empty. The bypass shown between the compressor and condenser is used to store the ammonia in the condenser coils if repairs are to be made on other parts of the system.

After the system has been opened for repairs, the air must be excluded by starting up the compressor, first closing the main liquor valve 3, and pumping the system down to zero. Have a hose or pipe attached at *K* on the condenser leading to a pail of water to act as a water seal. Bubbles will come to the surface of the water until the air has been all removed. A strong odor of ammonia is also a sign that there is no more air in the system.

To charge the system, a cylinder of anhydrous ammonia is attached to the connection at *J* and valve 3 is closed. When the system has been pumped down so that the vacuum gage reads from 5 to 10, the contents of the cylinder can be discharged into the system. As an indication of the cylinder being empty, frost will appear on the bottom at the outlet end. The other end must be blocked up 3 or 4 inches from the floor.

### WATER SUPPLY AND OILING SYSTEM

In the illustration is also shown a water tank located on the roof to supply the condenser, which is of the double-tube type. The water is pumped to the tank from an artesian well and flows from the tank to the condenser by gravity. The cooling water enters the condenser and oil cooler through valves 8 and 9, and is discharged through valves 10 and 11 to the sewer.

From the oil cooler the oil passes through the valve 12 and down through the oil trap *H* to a small pump at the compressor. This pump receives its motion from an attachment to the crosshead of the refrigerating machine, and the oil is sprayed into the compressor under pressure, as this is the high-pressure side of the system. The oil and ammonia together are forced from the compressor *C* through the discharge line *F* to the pressure tank *D* and, the oil being heavier than the ammonia gas is forced out at the bottom through valve 13 and up the line *I* from which it again enters the oil cooler. If enough oil is not maintained in the system, frost will appear on the oil line to the compressor. To supply the deficiency, oil can be either pumped direct to the oil cooler with the hand pump or through the line going to the compressor. Valve 2 beneath the ammonia receiver should be opened as occasion warrants to clear away the oil that collects in the bottom from time to time. The gage glass will show the amount of oil and indicate when the valve should be opened.

Only pure mineral oil should be used for lubricating the compressor. If animal or vegetable oil is used, either forms a soapy substance from which endless trouble will arise. The oil does not reduce the capacity of the machine, as it is injected only after the compressor has been charged with ammonia gas and compression has begun. Hence it takes up some of the heat development in the gas during compression and thereby adds to the economy. It also helps to seal the valves and stuffing box and prevent leakage, besides lubricating the moving parts.

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## Primer of Electricity

### ELECTRICAL UNITS AND TERMS

The principal units of measurement in electrical work are the volt, the ampere, the ohm and the watt.

The volt (pronounced "vohlt") is the unit of pressure or electromotive force; it was named in honor of the Italian physicist Alessandro Volta.

The ampere (pronounced "ompair") is the unit of current "strength," and was named in honor of the French scientist, Marie André Ampère.

The ohm (pronounced as spelled) is the unit of electrical resistance. It was named for the German mathematician, Georg Simon Ohm, who discovered the law of current flow in an electrical circuit.

The watt is the unit of electrical power, and was named for James Watt, of steam engine fame. Volts multiplied by amperes = watts, if the volts and amperes are practically steady.

An electrical circuit is a continuous conductor, or a number of conductors linked together, forming a closed path through which an electric current may flow.

An electrical conductor is any material through or along which electricity will pass at practical pressures.

A nonconductor is a substance which offers such a high resistance to the passage of electricity that an enormous pressure is required to force even the smallest current through it.

### OHM'S LAW

Ohm's law is the foundation of electrical theory. It was formulated by Georg Simon Ohm, hence its name. The law is as follows:

*The current flowing in an electrical circuit is proportional to the pressure applied to the terminals of the circuit, and inversely proportional to the resistance of the circuit.*

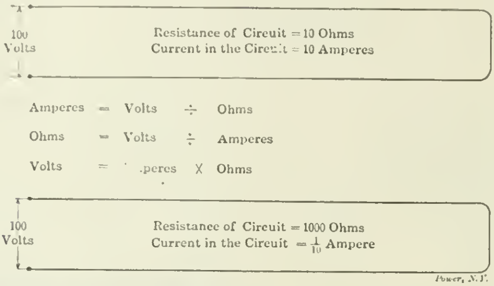
For example, if a circuit having a resistance of 10 ohms is subjected to a pressure of 100 volts, the current flowing in the circuit will be

$$\frac{100}{10} = 10 \text{ amperes.}$$

Again, if the circuit had a resistance of 1000 ohms and the pressure applied to it were 100 volts, the current in the circuit would be

$$\frac{100}{1000} = 0.1 \text{ ampere.}$$

These two examples are illustrated by the diagrams in Fig. 1, where Ohm's law is also stated in the modern form and in transposed forms. These transposed forms are useful when the current is known but either the electromotive force (pressure) or the resistance is unknown.


100 Volts
Resistance of Circuit = 10 Ohms
Current in the Circuit = 10 Amperes
Amperes = Volts ÷ Ohms
Ohms = Volts ÷ Amperes
Volts = Amperes X Ohms
100 Volts
Resistance of Circuit = 1000 Ohms
Current in the Circuit = 1/10 Ampere

Power, N.Y.

FIG. 1

TABLE 1. RESISTANCES OF CONDUCTOR MATERIALS COMMONLY USED.

| Cross-Section. | Resistance of One Foot, in Ohms, at 32° F. | |
|---|---|---|
| | One Mil. Diameter. | One Inch Square. |
| Aluminum wire and sheet | 15.50 | 0.00001217 |
| Copper wire, ordinary | 9.59 | 0.00000753 |
| Copper wire, hard drawn | 9.78 | 0.00000768 |
| Rolled copper. . . . . . . . | . . . . . . | 0.0000076 |
| Cast copper. . . . . . . . . . . . | . . . . . . | 0.00002 |
| Cast iron, gray . . . . . . . | . . . . . . | 0.000054 |
| Iron wire, galvanized. . . . | 57.20 | . . . . . |
| Iron, wrought. . . . . . | | 0.000006 |
| Lead, compressed . . . . . . | 120.00 | 0.000095 |
| Mercury . . . . | . | 0.000445 |
| Nickel . . . | 74.00 | 0.000058 |
| Steel wire, galvanized . . . | 78.90 | . . . . . . |

TABLE 2. PROPERTIES OF COPPER WIRES USED FOR ELECTRIC LIGHT AND POWER CONDUCTORS.

DRAWN TO BROWN & SHARPE GAGE.

| Gage Number. | Diameter, Mils. | Cross-section. | | Feet per Pound. | Ohms per 1000 Feet. | | |
|---|---|---|---|---|---|---|---|
| | | Circ. Mils. | Sq.In. | | At 60° Fahr. | At 75° Fahr. | At 90° Fahr. |
| 0000 | 460 | 211,600 | 0.16619 | 1.561 | 0.048 | 0.0497 | 0.0513 |
| 000 | 409.64 | 167,800 | 0.131794 | 1.969 | 0.061 | 0.063 | 0.065 |
| 00 | 364.80 | 133,079 | 0.10452 | 2.482 | 0.076 | 0.079 | 0.082 |
| 0 | 324.95 | 105,560 | 0.082932 | 3.130 | 0.096 | 0.100 | 0.103 |
| 1 | 289.30 | 83,694 | 0.065733 | 3.947 | 0.122 | 0.126 | 0.130 |
| 2 | 257.63 | 66,370 | 0.052129 | 4.977 | 0.153 | 0.158 | 0.163 |
| 3 | 229.42 | 52,630 | 0.041338 | 6.276 | 0.194 | 0.200 | 0.206 |
| 4 | 204.31 | 41,743 | 0.032784 | 7.914 | 0.245 | 0.252 | 0.260 |
| 5 | 181.94 | 33,102 | 0.025998 | 9.980 | 0.308 | 0.318 | 0.328 |
| 6 | 162.02 | 26,250 | 0.020618 | 12.58 | 0.388 | 0.401 | 0.413 |
| 8 | 128.49 | 16,510 | 0.012967 | 20.01 | 0.622 | 0.636 | 0.657 |
| 10 | 101.89 | 10,382 | 0.008154 | 31.82 | 0.979 | 1.012 | 1.044 |
| 12 | 80.81 | 6,530 | 0.005129 | 50.59 | 1.55 | 1.605 | 1.66 |
| 14 | 64.08 | 4,107 | 0.003225 | 80.44 | 2.49 | 2.56 | 2.61 |
| 16 | 50.82 | 2,583 | 0.002028 | 127.9 | 3.92 | 4.05 | 4.18 |

### CONDUCTORS

The resistance of a conductor depends upon the material of which it is made, its cross-sectional area and its length. The larger the cross-section, the smaller will be the resistance; the longer the conductor, the greater will be its resistance.

For example, a wire ¼ inch in diameter and 10 feet long will have a certain resistance; another wire of the same material and length but ⅛ inch in diameter will have four times the resistance of the first one because its cross-section is one-fourth as great.

Again, if two wires are equal in diameter and quality, and one is 10 feet long while the other one is 100 feet long, the latter will have ten times the resistance of the former because its length is ten times as great.

For transmitting electricity from one point to another, round wire is generally used. Such wires are made of iron or steel when the current is small, as in the case of telephone, telegraph and other signaling systems. For carrying heavier currents, such as those used for electric lighting and power, copper wires are mostly used because copper has a much smaller resistance than any other conducting material of reasonable value.

Table 1 gives the resistances of the different materials commonly used for electrical conductors. In one column is given the resistance of a round conductor one mil in diameter and one foot long. (One mil is one-thousandth of an inch.) In the other column is given the resistance of a conductor one inch square and one foot long.

TABLE 3. PROPERTIES OF GALVANIZED IRON AND STEEL WIRES OF USUAL COMMERCIAL SIZES.

DRAWN TO ROEBLING GAGE.

| Gage Number | Diam. Mils. | Feet per Pound. | Ohms per 1000 Feet at 70° | |
|---|---|---|---|---|
| | | | Best Iron. | Steel. |
| 4 | 225 | 7.48 | 1.22 | 1.69 |
| 6 | 192 | 10.28 | 1.65 | 2.78 |
| 8 | 162 | 14.41 | 2.31 | 3.74 |
| 9 | 148 | 17.30 | 2.78 | 4.35 |
| 10 | 135 | 20.79 | 3.42 | 4.73 |
| 11 | 120 | 26.31 | 4.16 | 5.75 |
| 12 | 105 | 34.37 | 5.39 | 7.46 |
| 14 | 80 | 59.2 | 9.27 | 12.82 |

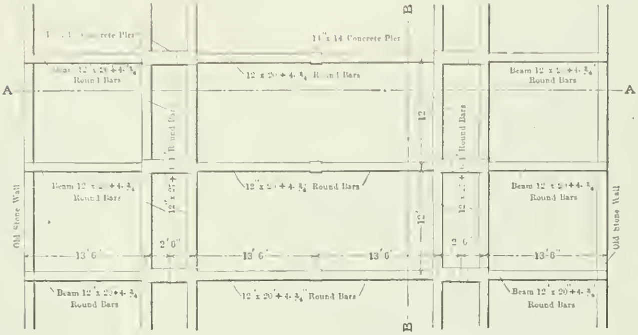
The resistances given in the table are those at the temperature of melting ice (32 degrees Fahrenheit). Increasing the temperature of a solid conductor increases its resistance, in nearly all cases. Carbon is an exception to this rule; increasing its temperature *decreases* its resistance very rapidly.

The effect of temperature upon the resistance of commercial copper wire is clearly shown by the figures in Table 2, which gives the sizes, cross-sections, weights and resistances of copper wires drawn to the Brown & Sharpe gage. The table includes only those wires ordinarily used for electric light and power circuits.

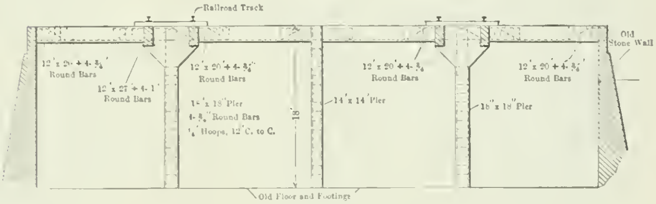
Table 3 gives the sizes, weights and average resistances of galvanized iron and steel wires used for telegraph and telephone circuits. When such circuits extend over very long distances—several hundred miles or so—hard-drawn copper wires are sometimes used because of their much lower resistances.

# A Reinforced-concrete Coal Trestle

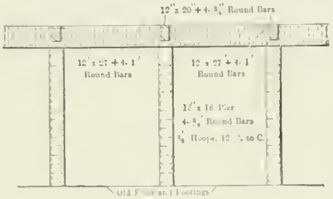
By W. B. Snow


A
A
B
B
14"x 14 Concrete Pier
Beam 12"x 20+4-¾" Round Bars
12 x 20 + 4-¾ Round Bars
12" x 20 + 4-¾" Round Bars
12" x 20"+4-¾" Round Bars
Beam 12"x 20+4-¾ Round Bars
Beam 12"x 20"+4-¾ Round Bars
12"x 27+4-1" Round Bars
Old Stone Wall
Old Stone Wall
12'
12'
2'0"
2'0"
13'6"
13'6"
13'6"
13'6"

Plan Typical Bays



Section A-A



Section B-B

Power, N.Y.

REINFORCED-CONCRETE COAL TRESTLE

The reinforced-concrete coal trestle recently erected by the Aberthaw Construction Company, of Boston, for the Jackson Manufacturing Company, Nashua, N. H., presents some interesting features which are illustrated by the accompanying engravings. Wood, with the exception of the sleepers to which the rails are spiked, is eliminated altogether and concrete suitably reinforced is utilized for the entire trestle, which is built between and partly supported by the old stone walls of the pocket measuring 64 feet in width and 18 feet in depth. The two tracks are parallel, 32 feet apart to centers, and the rails and entire construction are amply heavy to accommodate the largest coal cars.

The main supports consist of a single row of 18x18-inch piers with Y tops under each track. These piers are spaced longitudinally 12 feet between centers. The tops have sufficient spread to embrace the two 12x27-inch beams, one under each rail. To make the entire structure rigid, transverse tie beams, 12x20 inches section and 12 feet between centers, connect with the large piers under each track and extend to and rest on the stone side walls to which they are bonded. These tie beams are supported midway between the two tracks by 14x14-inch piers.

The 18x18-inch piers are reinforced by four ¾-inch steel bars in the corners, stiffened by ¼-inch hoops, 12 inches apart between centers. The 14x14-inch piers are similarly reinforced. The 12x27-inch beams have steel reinforcement consisting of four 1-inch bars in each beam near the bottom, turned up near the supports to take care of the shearing stresses.

# Modern Machines for Pipe Threading

## Early Methods of Threading. Development of the Die, Its Adaptability and Taper. Typical Examples of Modern Pipe-threading Machines

BY J. F. SPRINGER

We are living in an age of steel. The iron age has been slowly but surely passing. Wrought iron used to be considered just the material for railway rails and the forms used in bridge construction, but now, all is changed. The use of steel in railway trackage is well nigh universal, and about the same thing may be said relative to bridge construction. It was inevitable, then, that steel should find its way into the manufacture of steam pipes, but here there has been pronounced resistance to its introduction. Slowly and surely, however, it has been gaining ground, until today its foothold is a firm one.

### Chasing Tools

The National Tube Company was, perhaps, the first pioneer in introducing steel tubing to the steam-fitting trade to any considerable extent. At first, there was much difficulty experienced in cutting the threads on steel pipe. The chasing tool used for wrought iron was found to be inadequate. Mr. Speller has given the form of the chaser used for wrought iron and also two forms found successful with steel. Fig. 1 is a view of a chasing tool the face of whose cutting edge is perpendicular to the bottom of the groove. That is to say—if the face of the cutting edge be prolonged it will pass through the center of rotation of the pipe. This form was found successful with wrought iron, but with steel it failed. It is thought that success was due to the want of uniformity in the wrought iron—in fact, to the intermixture of iron and cinder. The stronger and more uniform steel resisted the action of a tool having so blunt an edge as 90 degrees. It was found, however, that, if the cutting angle were reduced about 15 degrees, making an edge of about 75 degrees, a good thread might readily be cut upon steel pipe. In Fig. 2 are shown two forms of cutting tools. In both the principle is maintained of providing a cutting edge that slopes about 15 degrees back from the radius drawn through the point where the cut is being made. With proper attention to clearance and lubrication, chasing tools formed and set to provide the cutting edge described have been found to handle with facility the threading of steel pipe. Further, these tools are also effective with iron. In practice, it is quite probable that the angle of 75 degrees may be considerably varied with the different varieties of pipe material and tool steel. Nominally there may be but two kinds of pipe—wrought-iron and mild-steel. Actually, however, there are intermediate varieties, and, of course, with the chasing tools, there is the endless variation of the ordinary tool steels and of the various alloys.

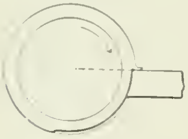


FIG. 1

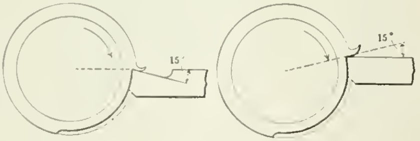


FIG. 2

Power, N. Y.

### Development of the Die

If we go back to the period of the seventies and early eighties in the last century, we shall find that there were on the market but few special machines for the threading of pipe. The general practice for pipe of any size seems to have been confined to the turning lathe. The cutting of a straight thread by this means is an old process. But, as L. B. Curtis points out in a letter to the writer, it was impossible to taper the thread—but few compound rests being in use—except in accordance with the judgment of the workman in withdrawing the cutting tool. Of course, for cutting the thread on small pipe, a solid nut would suggest itself, see Fig. 3. But such a device is inoperative as no provision is made for the disposal of the material. If iron and steel were as compressible as wood, some success might attend this procedure, for it is an invariable law of nature that material moved from one spot must be put into another. However, by cutting longitudinal grooves across the threads of the nut, material squeezed out would have opportunity of escape, see Fig. 4. Several strips of threads are thus obtained, but there is one thing further needed, and that is, so to form the forward edges of these strips that they will be effective as cutting tools.

If wrought iron is to be dealt with,

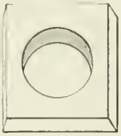


FIG. 3

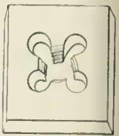


FIG. 5

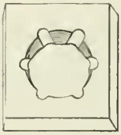


FIG. 4

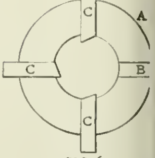
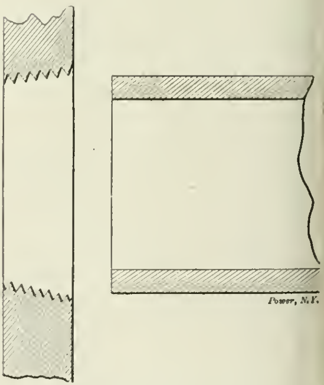


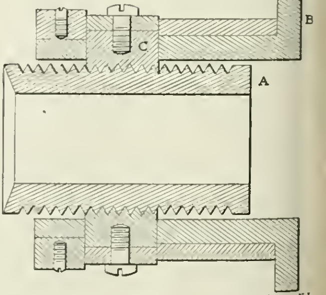
FIG. 6

Power, N.Y.



Power, N.Y.

FIG. 7. TAPER ON THE DIE



Power, N.Y.

FIG. 8. EARLY METHOD OF THREADING PIP

hese edges may be directed to the central axis. But if steel, then the principle of he 75-degrees slope must be adhered to. A solid nut or die of this description is hown in Fig. 5. It will be observed that his die is flared on the side towards the eader. This funnel-shaped opening is lead the work. Now such dies as this are well adapted to the work of threadng small pipe. By suitably tapering the hread in the die, the Briggs thread may be cut on the pipe, but when it comes to utting the thread on the larger sizes of ipe, such a tool would be of excessive ize. There would be a great waste of l steel and great difficulty in harden-. The only parts that need be of tool l and need to be hardened are the rtions which perform the actual cutting. d so it has come about that only these rtions are made of the expensive tool l. But it is expected that all the arate tool-steel pieces will agree with ch other in such a way that if the material were put in the intervals between them and the threads continued, the whole ould form a perfect nut. In practice, owever, the requirement is not so severe s this. If the cutting edges of all the parate dies properly correspond, then ovision can be made back of each edge f clearance. In other words, as the thread is cut, every cutting edge must be down in the bottoms of the grooves, but it is unnecessary that the whole of each short thread of the die should be thus down in the groove. This is of great importance, for it enables the cost of the dies to be much reduced.

### Adaptability to Different Sizes

In looking over the specifications for the Briggs threads, it will be seen that all sizes from 1 to 2 inches inclusive have the same number of threads per inch, that is 11½. And further, all sizes above 2 inches have 8 threads per inch. Advantage is taken of these facts, for matters can be so arranged that the very same set of dies may be used for various sizes of pipe, if the number of threads per inch is the same. This will be better understood by referring to Fig. 6, which consists of a frame *A* in which a number of radial grooves are arranged. One of these at *B* is shown unoccupied; the remainder have the dies *C* in them. In order to use these dies for a larger size, it is only necessary to withdraw each die precisely the same distance from the center. As only the extreme cutting edges count in matching the dies all around to form the thread, it is only necessary to see that the correspondence is perfect for a single size. For any other size having the same number of threads per inch, simple expansion or contraction is sufficient. The clearance, however, will vary, becoming less and less as the size increases.

Now the method of simultaneously expanding and contracting the assemblage of dies is usually, if not universally, by means of cams. A good example of this may be seen in Fig. 15 where one of Crane Company's machines is shown with the apron lowered and the die holder and cam ring exposed. Five of the six dies are seen in position. There are two rings, one surrounding the other. The inner one is the die holder and is not permitted to rotate. The outer ring contains the cams and is rotatable about the die holder. The cam ridges cooperate with grooves on the rear edges of the dies. The die lying on the apron shows this groove. By rotating the cam ring the dies are simultaneously forced in or out.

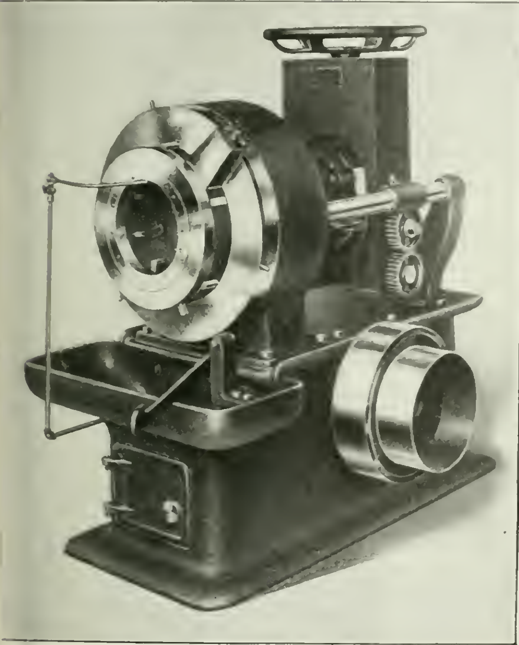


FIG. 9. LOEW BELT-DRIVEN MACHINE

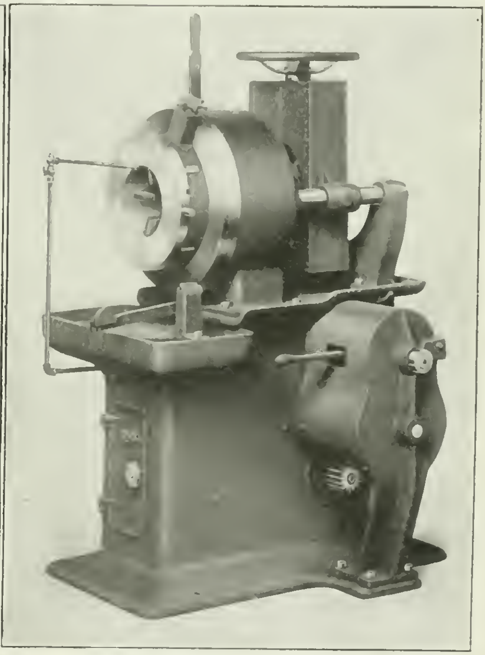


FIG. 10. LOEW MOTOR-DRIVEN TYPE

### Taper

The adaptability of the same set of dies for a variety of sizes is a wonderful advantage. Its possibility, as already pointed out, depends upon the fact that the number of threads per inch is kept the same for a range of sizes. There is still another thing which operates to permit this flexibility of use. The taper of the Briggs thread is uniform throughout all the sizes, and is 1 in 32 (relatively to the axis) whether the pipe be the smallest size or the large 20-inch size. This taper is arranged on the die as seen in Fig. 7.

In consequence of the adoption of the Briggs standard in the United States, not only does the pipe-threading apparatus have to provide for the cutting of variable material, but it must cut the threads following the taper just given. This standard was more or less in use before, but was formally and effectively adopted by engineers and manufacturers about a quarter of a century ago. To form the threads, two radically different procedures are followed. The one most generally employed is to use a die holder containing broad chasers set around the inner circumference. The taper is arranged for in the chasers themselves. This die head is then held in a fixed position and the pipe rotated, or the pipe is held and the die head rotated.

An entirely distinct process is that employed in the Toledo pipe threading apparatus. In this the chasing tools are quite narrow, cutting but a thread or two at a time. To secure the taper as the thread is cut further and further back upon the pipe, the chasing tools are forced to recede from the axis of rotation as the work goes on. This is taken care of automatically and precisely in accordance with the standard requirement. But, in general with the other machines, the dies or chasers remain fixed relatively to the die head

## Typical Examples of Pipe-threading Machinery

Special machines for the cutting of pipe threads have been on the market a quarter of a century or more. Thus in or about 1882 pipe-threading machines were built by the Eaton Cole and Burnham Company (now Crane Company), of Bridgeport, Conn.; D. Saunders & Sons, of Yonkers, N. Y., and the Bigelow-Keeler Company, of St Louis. In all of these the pipe was rotated and the die head restrained from rotary motion. In the late eighties, one of these firms (D. Saunders & Sons) put on the market a radically different machine. The die head was rotated about the pipe. The mode of operation of this ancient—and now apparently obsolete—apparatus may be understood from Fig. 8. The dies are held in the head *B*, which is so arranged as to be rotatable, but not free to shift longitudinally. A series of lead screw blocks *C* are arranged in slots around the sleeve which is integral with *B*. The tube *A* is non-rotatable, but is free longitudinally. Its outer surface is threaded and co-operates with the lead blocks *C*. It will now be seen that a rotary motion of *B* carrying the lead blocks with it will operate to cause the tube *A* to advance in precise correspondence with the thread on its outer surface. Now *A* is in fact the work holder. It is easy to see, then, that the pipe would be threaded by the rotation of the head about it. If the head is fitted with broad tools, then there must be correspondence between the pitch of their threads and that of the thread on *A*. It will be observed that as the cutting proceeds the work is drawn forward. This is very similar to procedure adopted with the modern machine built by the Loew Company.

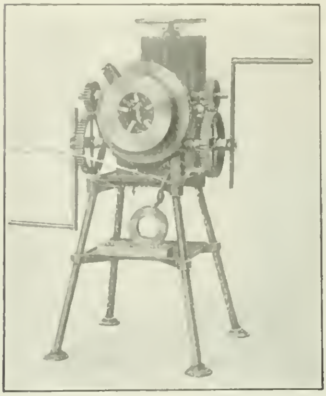


FIG. 11. LOEW HAND MACHINE

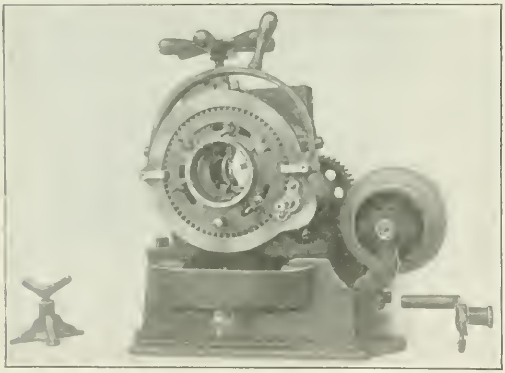


FIG. 12. CURTIS & CURTIS HAND OR POWER MACHINE

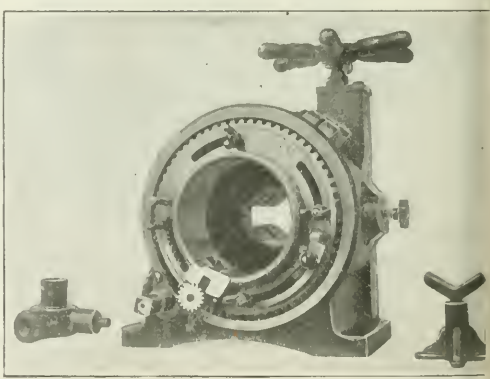


FIG. 13. CURTIS & CURTIS MACHINE WITH LEAD-SCREW ARRANGEMEN

## The Loew Machine

One of the simplest devices is that o the Loew Manufacturing Company, Cleveland, O. This apparatus is a hand o power machine consisting of two parts the pipe holding device, and the threading device. The pipe to be threaded is introduced from the rear, see Fig. 9, wher it is held between the jaws of a self-centering vise. This is operated by th large handwheel seen at the top. Th chasers are removably held in the head. During operation they remain fixed relatively to the head. However, they ma be set within the range of the machin for various sizes of thread diameter. Th various machines take care of pipe ranging from ¼ to 8 inches in diameter. Th hand machine is operated by turning th hand cranks seen to the right and le in Fig. 11. Certain of the power machines are belt driven; others are operated by electric motor, and still others receive their power from a directly connected gasoline engine. By setting th die head in motion and forcing the pip forward by means of the lever, seen bac of the head in Figs. 9 and 10, the threa is cut. The taper is secured by the for of the dies. There is a continuous scre back of the faceplate, by means of whic the dies with which it engages may be s for the various sizes.

## Curtis and Curtis Types

There is a similar machine man factured by Curtis & Curtis, Bridgepo Conn. This apparatus is provided with self-centering vise at the rear. Into th the pipe is slipped and brought into a proximate position relatively to t thread-cutting device which is in the f ward part of the machine. The han wheel seen at the top of both Figs. and 13 enables the pipe to be brought ce tral with the dies. If the pipe end is the bottom of a trench, the machine m be let down and brought into place. will be seen that with this apparatus,

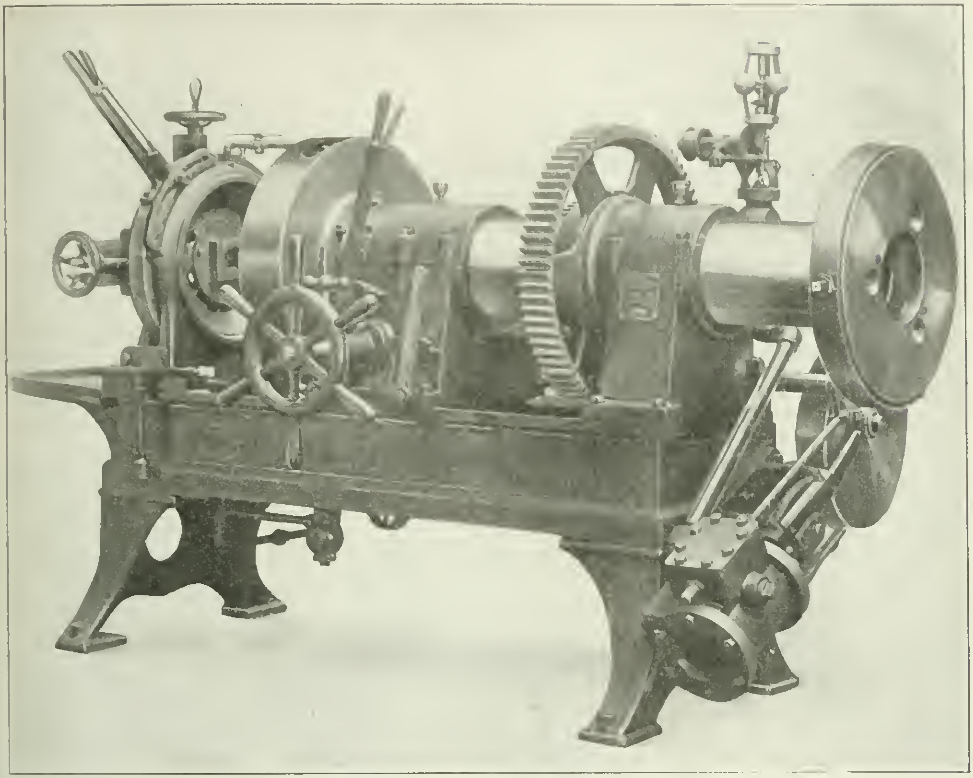


FIG. 14. NO. 4 CRANE PIPE MACHINE

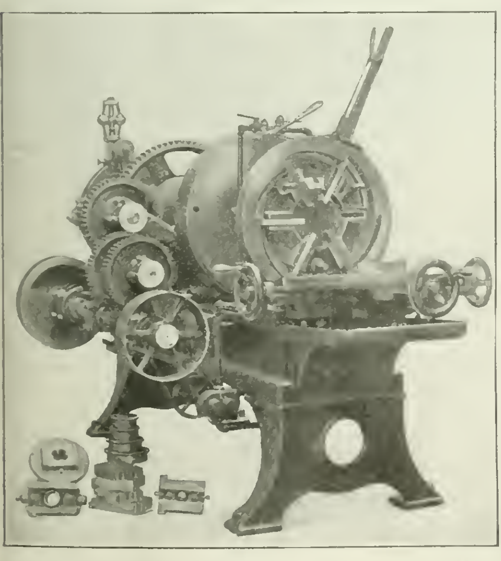


FIG. 15. REAR VIEW OF CRANE MACHINE NO. 4. DIE HEAD OPEN

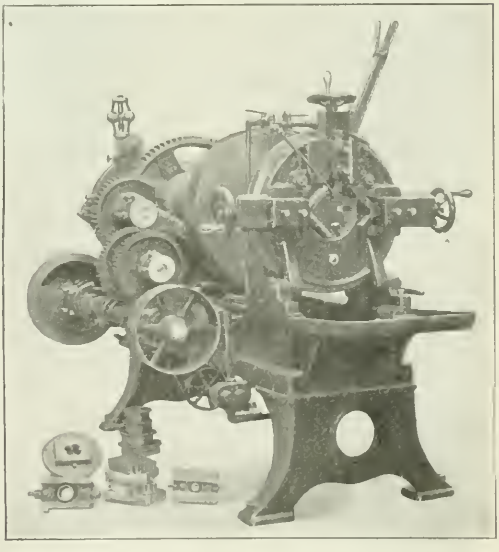


FIG. 16. CRANE MACHINE NO. 4. DIE-HEAD APRON CLOSED

with the Loew machine, the pipe is not revolved In both it is the die head which revolves, but between the two there is this difference

In the Loew machine the pipe held in the vise is brought forward and is fed, as it were, to the cutting mechanism. In the Curtis & Curtis machine, the pipe remains perfectly stationary and the necessary relative movement longitudinally is accomplished by the shifting of the die head which is really a gear wheel There is a piston of small diameter, but of considerable length, which engages with this gear. By referring to Figs. 12 or 13 the square end of one of the trunnions may be seen in front. The position of this pinion is fixed in the case, but the gear die head is permitted a back-and-forth motion—always engaging the pinion, however. This back-and-forth motion may be controlled by the lever handle seen at the top of Fig. 12. The dies are removable and may be set to size by suitably turning the faceplate.

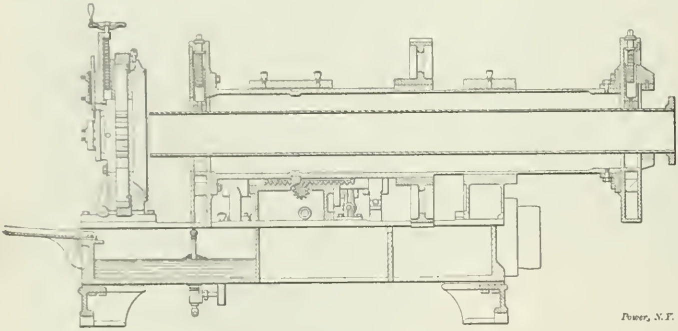


FIG. 17. LONGITUDINAL SECTION OF CRANE MACHINE NO. 5

In operating the machine by hand, a crank is slipped on the square end of the pinion, but if power is to be used the pinion is actuated by means of a gear at the rear. It is to be observed that the same machine may be used either way, and by disconnecting from the base, it becomes portable. The combination of small pinion operating a large gear enables heavy work to be done by hand. Thus a boy can operate the machine for the smaller sizes; while all sizes up to 15 inches are within the power of a single man. The depth of the casing permits sufficient movement of the die head to allow the cutting of lengths of thread equal to about double that of standard. Still longer threads may be cut by bringing the pipe further forward in the vise and then taking a fresh start with the thread-cutting mechanism. In this way, with proper care, threads of almost any length may be cut.

In Fig. 13 is seen a machine of the same general description. The lever is, however, omitted, and instead of relying on pressure and the threads already in the dies to accomplish the feeding operation, a lead screw is employed. This is cut on the back of the gear die head. Suitably threaded blocks are provided within the casing to engage with the lead screw, and as these blocks have no longitudinal movement relative to the casing, they secure such a movement of the dies. The lead blocks may be thrown out of engagement, so that it is not necessary to back out. The same concern manufactures still other varieties of the same general description. A cutting-off attachment may be seen in Fig. 13, near the square pinion end. An adjustable faceplate stop, seen in both figures, facilitates resetting to the same size.

### Crane Sliding-spindle and Sliding-head Threaders

The firm of Crane Company, Chicago and New York, makes at one of its plants located at Bridgeport, Conn., a line of power-driven pipe-threading machines in capacity ranging from the smallest sizes to 18 inches. These are splendid examples of this type of machinery. In all their machines the pipe is rotated. They are thus in contrast to the Loew machine and also to the Curtis & Curtis type. However, as the thread is being cut a reciprocating motion must be accomplished as between die and pipe. With the Loew type the pipe holder advances; with the Curtis & Curtis variety the die head recedes. The Crane Company manufacturers machines, in some of which the one procedure is adopted, while in some the other process is followed, but in all the pipe revolves.

In Fig. 14 is seen one of the large machines manufactured by Crane Company. Two horizontal journal boxes are bolted to the bed of the machine, and these boxes are not only of considerable length, but they are quite widely separated, so that they are able to maintain a correct alinement for the large spindle which passes through them. This spindle is hollow and is provided with an independent gripping chuck at each end. The pipe to be threaded is passed into the spindle from the rear and is firmly held by the chucks. Some of the machines manufactured by this company have a universal chuck at the forward (left) end of the spindle. It is important, however, that the rear chuck should be independent as pipe is frequently more or less crooked. Amidships of the spindle a large gearwheel envelops it. This gear is securely attached to the spindle and its office is to rotate the pipe.

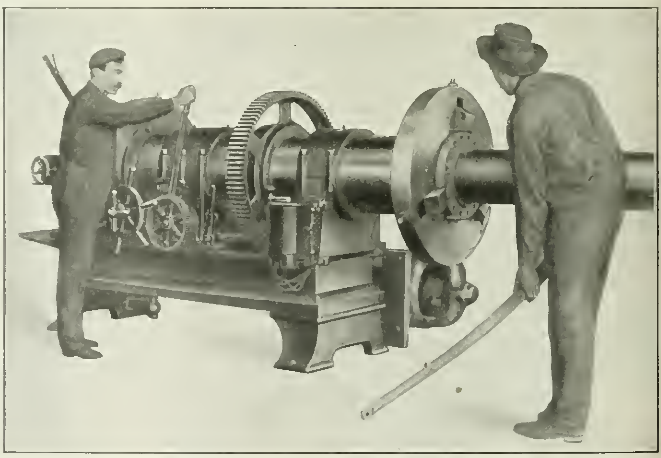


FIG. 18. MAKING JOINT WITH CRANE MACHINE NO. 5

In this particular type, the spindle is not only free to rotate, but may slide longitudinally. The dies are held perfectly fixed, so that after the threading operation has fairly begun they draw the pipe into them. Thus the spindle is impelled to slide forward. The pinion on the rear side which actuates the large gear was formerly made quite long to permit the sliding of the spindle to and fro. Another more recent method of ac-'omplishing the same result is by means of a sliding pinion. This pinion has a feather-and-slot arrangement on opposite sides of its own spindle. The grooves at the ends of the teeth on the periphery f the pinion are closed, so that the longi-udinal shifting of the large gearwheel 'arries the pinion with it. The head of he whole apparatus is bolted to the bed and it contains the removable dies. But hese, once set, remain fixed with the ead. Their adjustment is secured by scroll, Fig. 15, operated by the lever be seen in the illustration. There are six dies to a set for sizes up to and in-ding 8-inch, and 12 to a set for the es from 9 to 12-inch. By means of a itable attachment a solid die may be sed for small sizes. In setting the re-able dies, they are contracted upon a th-surface tapered gage. Locking em in position, the machine is ready for al work.

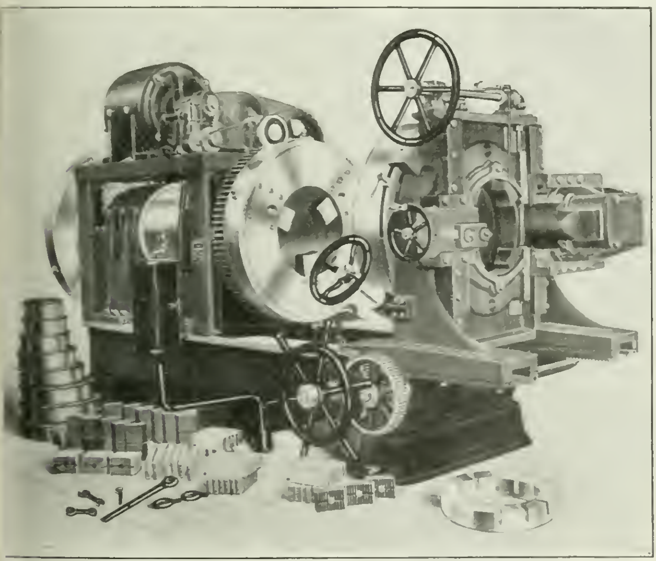


FIG. 19. CRANE MACHINE NO. 6, WITH CAPACITY OF FROM 8 TO 18 INCHES

Assuming that the pipe has been intro-ed into the spindle and properly cen-red, it may be brought into actual con-t with the inner edges of the dies. hese have all had their innermost reads partially ground away, so that e entire set provides a funnel-shaped iide, or lead, to the perfect threads. ntact with this beveled-off portion of e dies is secured by operating the cked wheel seen on the front side of e machine, Fig. 14. This motion is complished by means of a rack-and-nion. The rack is not secured to the ding spindle, and in order to permit the rotary motion of this spindle there is an annular channel formed upon the cylindrical surface. On the side of the rack next the spindle there is a projection which fits loosely into this channel. This arrangement enables the rack to control the spindle longitudinally, while permitting to it rotate freely, see sectional view, Fig. 17. When the threads of the dies have fairly gripped the pipe, they are sufficient to effect its advance. The heavy spindle with its chucks and gear wheel and load of pipe readily responds. This delicacy of action may be attributed to two causes: first, the long bearings widely separated; and second, the accurate workmanship bestowed upon the manufacture. In the machine capable of handling 12-inch pipe, the load thus slid forward must amount at times to between 2000 and 3000 pounds.

The tapering of the threads, to correspond to the Briggs standard, is accomplished, as with the majority of machines, by the form given to the dies. When the threads have been cut, the dies may be expanded, thus permitting the pipe to be withdrawn by a simple movement of the spoked wheel. There are slides cast in one piece with the head, Fig. 16, which control the movements of the guide jaws for centering the newly threaded pipe and also of the cutting-off tool. Changes of speed are secured by means of a cone pulley and appropriate gearing. The rear chuck, Fig. 18, is provided with jaws suitably placed to grip flanges corresponding to the sizes of pipe within the range of the machine. In order to make use of it for screwing on flanges, the flange is placed in the chuck and the pipe held in position with tongs. The pipe is entirely outside the spindle, so that when the flange is screwed on by power, the whole is removable by simply releasing the chuck. Further, there is no difficulty in flanging both ends of a pipe. The whole operation is accomplished at the rear where there may be plenty of room. Of the sliding-spindle type, the largest size machine, No. 5, has a capacity ranging from 4½ to 12 inches and is heavily built as may be judged from its weight of 4½ tons. In case of need, very small pipe may be threaded on the large machines by using solid dies. There are three smaller sizes, Nos. 2, 3 and 4, whose capacities are respectively 1 to 4 inches, 1 to 6 inches, and 2½ to 8 inches. All may be obtained with electric drive, if desired; likewise, high speed dies may be obtained and used.

Crane Company also manufactures another line of pipe-threading machines which likewise rotate the pipe, but do not permit its longitudinal movement when once secured in the machine. In these machines the spindle is not permitted to slide back and forth. Consequently certain arrangements are dispensed with or transferred to other parts of the machine. The required longitudinal movement is accomplished by mounting the head on a sliding way, Fig. 19. The spoked wheel seen in front actuates the head back and forth, together with its inclosed dies. The die head is moved up to the pipe by hand and held there until the threading is well under way. In expanding and contracting the dies on the monster 18-inch machine shown in the illustration, the required movement of the internal cams is accomplished by a worm and segment controlled by a handwheel. This apparatus handles pipe ranging from 8 to 18 inches. For all sizes except the smallest twelve dies made of high-speed steel are used. In order to guide the heavy pipe handled by this machine during the operation of cutting-off, a special device is used consisting of two guides which are controlled by slides on the head and right- and left-handed screws actuated by bevel gears and handwheel. This great machine weighs 7½ tons. There are four smaller sizes of the sliding-head type, Nos. 1¼, 2½, 3½ and 4½, whose capacities are respectively ¾ to 2 inches, 1 to 4 inches, 2½ to 6 inches and 2½ to 10 inches. All sizes are supplied with electric or belt drive, as desired.

These machines, both types—sliding-spindle and sliding-head—have wide ranges of capacity. A little consideration will show that this necessitates great variations in the length of dies used on the same machine. Consequently the manufacturers provide for all machines an extension die head for supporting the long dies used for the smaller sizes of pipe. Such an extension die head is seen on the floor at the right, Fig. 19.

The two smaller sizes of the sliding head machines are provided with a special reaming and gaging device. A tool post rises from the sliding platform on which the die bracket is located. This is furnished with a device which is a reaming tool at one end and a stop gage at the other. With the one the threaded pipe end may be reamed out; with the other nipples may be cut accurately to length.

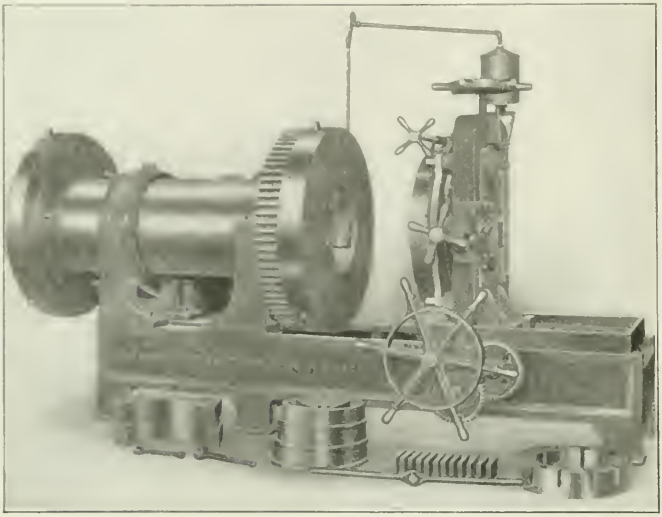


FIG. 20. FRONT VIEW OF SAUNDERS MACHINE NO. 9, BELT-DRIVEN

### Machines of D. Saunders Sons' Make

One of the principal manufacturers of pipe-threading machines, since 1865, is D. Saunders' Sons, Inc., Yonkers, N. Y. This concern makes a complete and varied line of apparatus with capacities permitting the threading of pipe from ¼ inch to 18 inches diameter. Certain of the smaller machines may be operated by hand, but an account will first be given of the seven-ton machine having a range of ten sizes from 8 to 18 inches, see Fig. 20. Similarly to certain other devices, the pipe is rotated and the die head prevented from rotation. The rotation of the pipe is accomplished by means of a large spindle mounted in two bearing boxes bolted to the bed. The spindle has no longitudinal movement. As a motion along the axis is absolutely essential somewhere, the Saunders company mount the bracket containing the die head upon sliding ways. Movement along these ways is secured in the first place by means of the large spoked wheel seen at the side of the bed. This is, of course, operated by hand. The dies are removably held in place in a die head whose mechanism permits expansion and contraction of the cutting diameter of the cluster of dies. The cams which effect these movements are controlled by a worm-and-segment device operated by a small spoked wheel—the second wheel of this kind above the large one at the side of the bed. By referring to the rear view, Fig. 21, this arrangement may be seen to advantage.

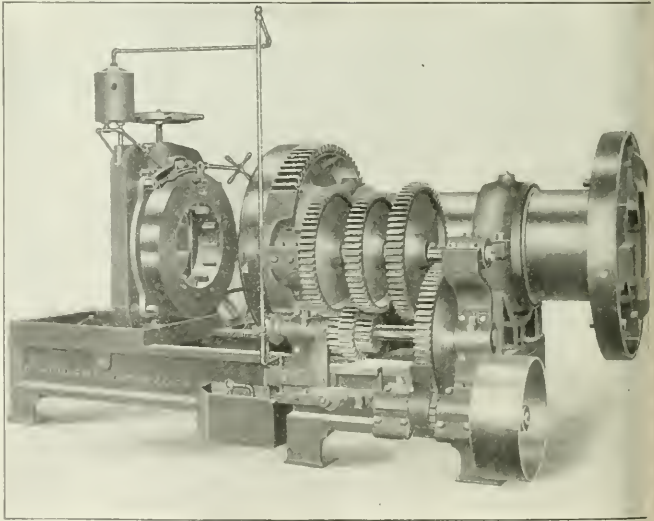


FIG. 21. BACK VIEW OF SAUNDERS MACHINE NO. 9

This view discloses likewise the gearing by means of which the surface speeds may be brought to approximate uniformity. A motor-driven apparatus of this type is built to order.

Before leaving the back view, attention may be directed to the rear chuck. It i equipped with suitable jaws for grippin the flanges. As with a similar arrang ment on certain other threading ma chines, flanges may be screwed on b power at the rear of the spindle and wit the pipe entirely outside, and both en of pipe may thus be flanged. Revertin now to the front view, it will be seen th the gear which drives the spindle is ju back of the forward chuck. When th actual cutting of thread is going on, th arrangement is advantageous in bringin the driving impulse to approximately th same point as the resistance in the jaw of the chuck. With the smaller machin this is not so necessary as the strains a lighter. The small spoked wheel, ju above the large one at the side of the be Fig. 20, controls the cutting-off tool whi is set in a holder sliding back and fort in vertical ways arranged on the brack at the front of the machine. In proxim ity to the cutting-off mechanism are tw semicircular jaws. These form a "res to support the pipe when being cut size, and are sufficiently strong and wel supported to force an out-of round pi to shape. There is a pair of the sem circular forms for each size of pipe, su a pair being shown on the floor to t left in Fig. 20. This "rest" is controll by the spoked wheel at the top.

When the thread has been cut, the di are expanded to permit a longitudi movement of the pipe. There is a st which sets a limit to this expansion. Ho ever, as it may readily be removed, t die may be opened further and thus pe mit removal of the individual dies with removal of the front plate of the die holder. In setting the dies to size blank gages are used. Three of these may be seen on the floor in front of the machine in Fig. 20. On the floor at the extreme right is seen a die supporter which is for use with the long dies used in cutting sizes of pipe at the lower limit of capacity.

In certain of the smaller machines manufactured by the Saunders' Sons company, there are devices of interest and importance. It is of considerable advantage in practical commercial use to be able to run the pipe through the head subsequently to the threading operation. In doing this quickly there is danger of injuring the dies. The Saunders people meet this matter in two different ways. Thus in their Nos. 7 and 8 machines, having ranges of 2½ to 10 inches and 4 to 12 inches, respectively, the die head is swung on a vertical axis to a convenient position off to one side. The pipe may then be run through the head without endangering the dies. In the No. 6 machine, range 2½ to 8 inches, and other smaller sizes, the die head is arranged in sliding ways. It may thus be slid to one side and out of the way. The chuck at the rear of the spindle in some of the smaller sizes is of the self-centering two-jaw variety operated by a screw having right- and left-hand threads. With some machines two die heads are furnished, dividing the range of the machine between them. This arrangement accomplishes the same purpose as is effected by the die supporter.

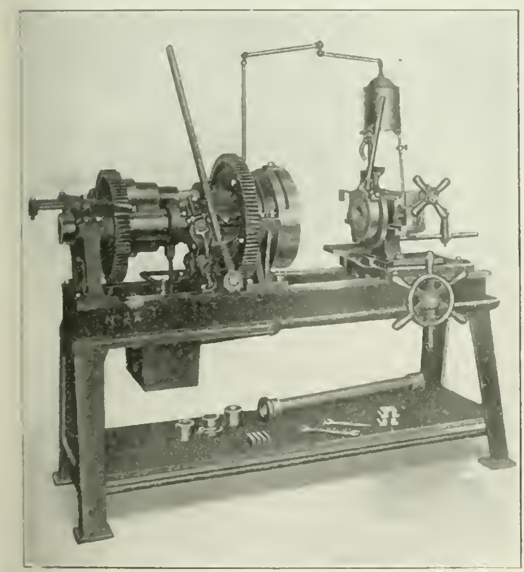


FIG. 22. SAUNDERS MACHINE NO. 2A

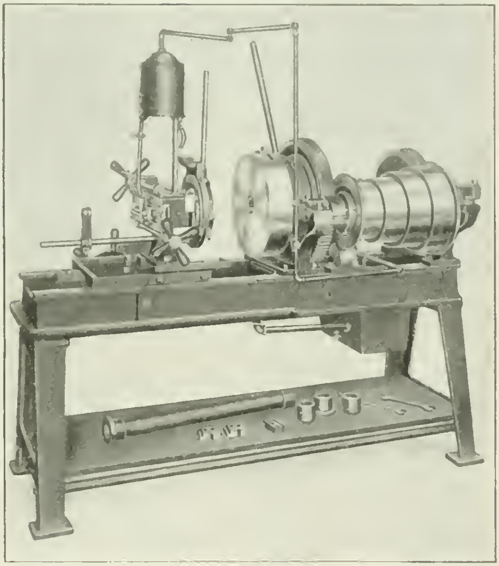


FIG. 23. SAUNDERS MACHINE NO. 2A, REAR VIEW

## Producer Gas from Texas Lignite

It is expected that the lignite-coal resources of Texas will be made more valuable than at present through the adoption of a process which has recently been the subject of study at the Pittsburg experiment station of the United States Geological Survey, the lignite used for the purpose being furnished by Texas mines. The manufacture of briquets from lignite coal had been extensively tried in Texas, but never proved successful. It was in the making of briquets that the experiments at Pittsburg were devoted. Until lately the trouble has been that it was necessary to put something with the lignite to form a binder after forcing out the moisture and taking away the byproducts. The average grade of lignite contains about 35 per cent. of moisture. In the manufacture of briquets the process which the Government experts have just perfected calls for the use of a certain heat and pressure which extract about 70 per cent. of the moisture, leaving the tar, or pitch, as a binder. In this way the necessity of adding something to agglomerate the fuel is obviated.

The lignite fields of Texas extend from Texarkana to Laredo, in a zigzag course across the State. The beds are practically inexhaustible. Mines are being worked at Lytle, Rockdale, Bastrop, Bear Grass, Evansville, Crockett and Alba. Excellent results are obtained in the manufacture of producer gas from lignite, and it is claimed that such gas makes the best fuel now known, although it is not an illuminant. In the experiments in the manufacture of producer gas from lignite the Government experts discovered a number of byproducts. One of these is ammonia, which can be derived in such large quantities that Texans claim it will not be long until their State will be producing enough of that product to supply the world.

Some of the largest producer-gas engines in the world are already in operation in Texas. It is stated that the largest lignite-producer-gas plant in the world is that of a cement company in Dallas. With this gas the company runs a 4800-horsepower engine. It is such a success that another large cement company in the same section is installing a still larger plant. In San Antonio a lignite-producer-gas plant is able to run a 2500-horsepower engine.

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The first of a group of three water-power stations on the rivers Toce and Devero, in northern Italy, has recently been put to work. The equipment, says *Electrical Engineering* (London), has a capacity of 20,000 horsepower, and the output is taken over a 50,000-volt transmission line to a main substation, from which a ring of feeders, at a lower pressure, supply further distributing substations. The two other large stations, when complete, will be connected up to the same main substation.

# Heating Feed Water with Exhaust from Gas Engines

One of the few installations in the country where the waste heat in the exhaust from gas engines is utilized is the power plant of the E. R. Thomas Motor Works, of Buffalo, N. Y. The gas-power plant comprises three 100-horsepower Bruce-Merriam-Abbott gas engines, each equipped with two cylinders, 14x14 inches, and driving by means of a flexible coupling a 62½-kilowatt Bullock dynamo at a speed of 275 revolutions per minute. There is also a 200-horsepower Skinner automatic engine, with a Bullock dynamo mounted directly on an extension to the engine shaft. This unit has a speed of 225 revolutions per minute, and all four machines are operated in parallel at 110 volts. Two 100-horsepower Keeler boilers supply steam to the Skinner engine, and also to pickling tanks for washing grease off the work and, in winter, for heating the shops, which have an aggregate floor area of about 250,000 square feet.

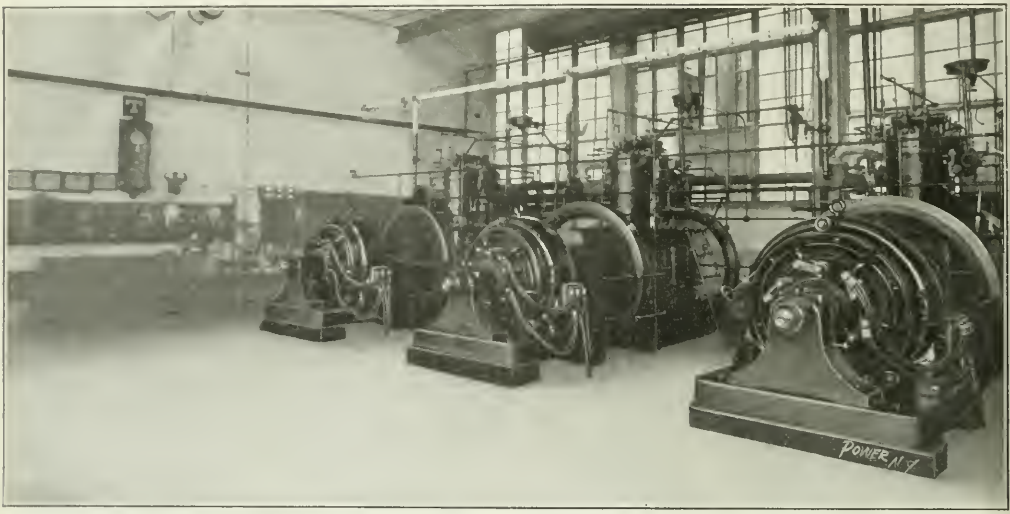

FIG. 1. THE THREE GAS-ENGINE UNITS

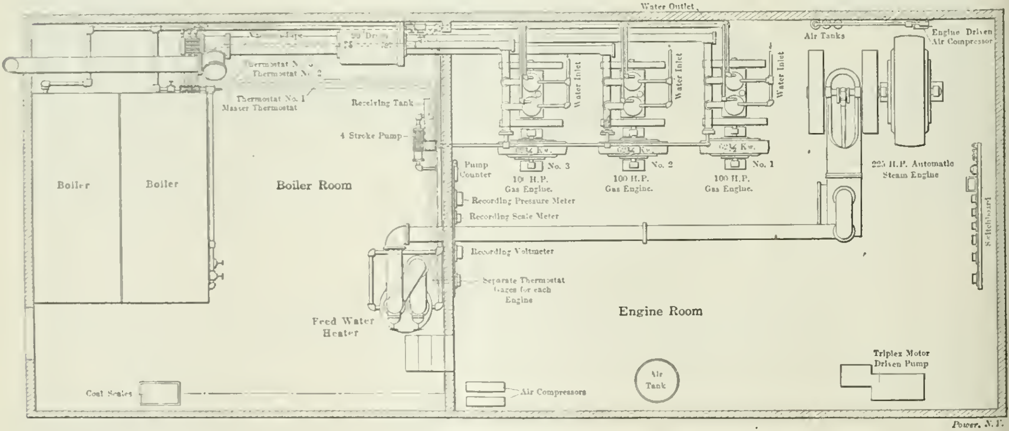

FIG. 2. PLAN OF STATION

The gas engines carry about full load in winter and half load in summer. In either case considerable heat was lost in the exhaust of the gas engines, and the ingenious arrangement shown in Fig. 2 was devised by George Bowmar, chief engineer of the plant, to reclaim as much of this heat as possible and utilize it in the boiler feed water.

Water from the shop-heating system and the jackets of the gas engines is returned to a receiver at a temperature of about 100 degrees Fahrenheit. From the receiver the water is taken by the pump and forced through a heater which receives the exhaust steam from the Skinner engine. From the heater, the water leaves at a temperature of about 140 degrees and is conveyed to groups of small pipes inside the main exhaust pipes of the gas engines. These are 6-inch pipes, and inside of each one are arranged four 1-inch pipes in parallel, as indicated in the drawing, to carry the water.

As will be noted, the three exhaust pipes from the engines terminate in a drum, which is 20 inches in diameter and

4 feet long, and from here on the exhaust gases pass through a single pipe to inches in diameter. Some distance from the drum a tee in the 10-inch pipe allows the gases to be conducted to atmosphere and the small 1-inch pipes to project through the outer flange. The small pipes terminate in manifolds, as indicated, and from each manifold a connection is made to the feed-water main at the rear of the boilers. In the exhaust pipe of No. 1 engine there are 240 feet of 1-inch water pipe, consisting of four 60-foot lengths in parallel. That of No. 2 engine houses 200 feet of pipe and that of No. 3, four 40-foot lengths.

The water enters the boilers at a temperature of from 230 to 240 degrees Fahrenheit. The entering temperatures are measured by separate thermostats for each engine, and indicated on gages located on the board shown just under the clock in Fig. 1. On this board there are also a recording pressure meter, recording scale meter which gives the pounds of coal burned, a recording voltmeter and other instruments showing at a glance all the operating data of the station except electrical, which is registered on the switchboard at the opposite end of the room. The system as designed and installed by Mr. Bowmar has been in service for some little time and has given the best of satisfaction.

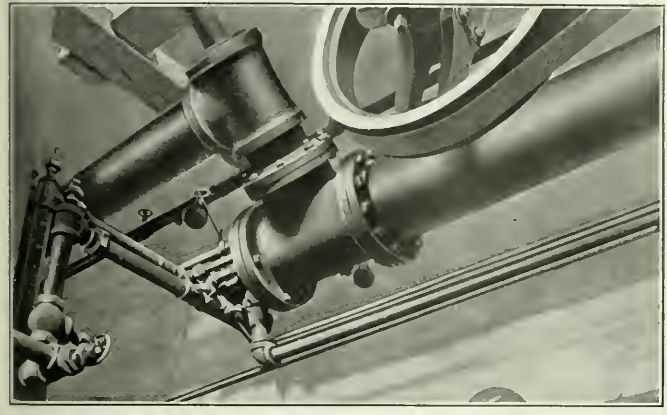

FIG. 3. WATER PIPES EMERGING FROM TEE OF EXHAUST MAIN

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In razing the walls of the oldest building in Pottsville, Penn., a casket was unearthed which contained lumps of primitive coal and a unique document. The parchment states that these lumps were chippings from peculiar "black stones," by Colonel George Shoemaker, of Pottsville, taken in 1829, before the commercial value of anthracite was known as a commodity for domestic or even industrial purposes.

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# A High Pressure Turbine Operated as a Low Pressure Unit

By W. O. Rogers

An interesting and novel feature in steam-plant operation is found in the electric-light plant of the Canton Electric Company, Canton, O. In the engine room are two Russell engines of 500 horsepower each, one 600-horsepower McEwen engine, and one Allis-Chalmers cross-compound engine with cylinders 18 and 30 by 36-inch stroke, running at 115 revolutions per minute and exhausting into 12-inch pipe at atmospheric pressure. There are also a Curtis turbine of 500 kilowatts capacity and a 500-kilowatt Allis-Chalmers turbine.

The Curtis turbine was originally installed with the intention of operating it with live steam, and this was done for some time, until General Manager W. C. Anderson devised and put into practice the idea of operating the turbine with the exhaust steam from the Allis-Chalmers cross-compound engine. This scheme worked so successfully that it has been made a permanent feature.

The Curtis turbine is piped in between the Allis-Chalmers engine and the condenser. The exhaust steam from the engine passes through a 12-inch pipe at 3 pounds above atmospheric pressure and exhausts into the turbine between the first and second stages, the work being done on the second stage. The turbine then exhausts into the condenser, which carries a vacuum of from 27½ to 28 inches. Fig. 1, representing an elevation and part sectional view of the unit, shows the manner in which the exhaust steam is delivered to the turbine.

With the engine carrying its full load of 400 kilowatts, the turbine will develop about 340 kilowatts from the exhaust steam. Owing to the fact that the turbine

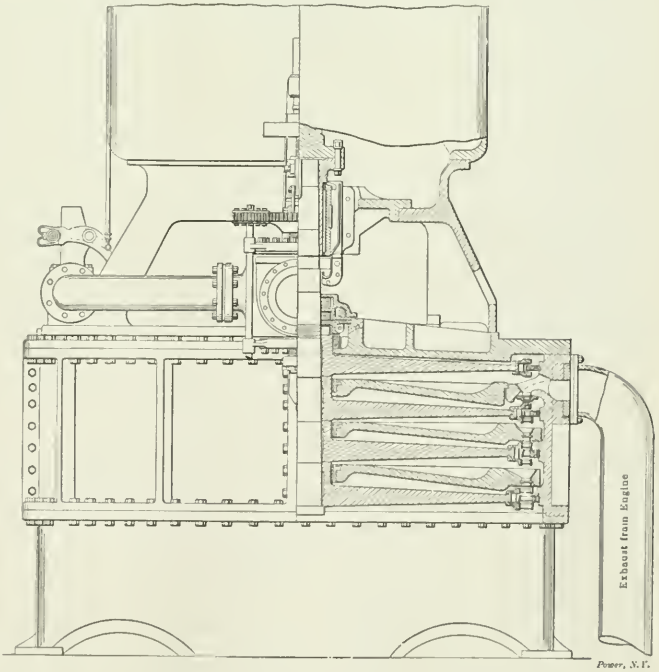


FIG. 1. METHOD OF ADMITTING STEAM TO THE SECOND STAGE

runs at about 2 per cent above normal speed, the steam valves remain closed, because the governor is then inoperative, due to excessive speed, and, therefore, the entire load is carried without the aid of live steam. There are exceptions to this case, however, as when the load becomes so great that the exhaust steam will not supply sufficient power the speed of the turbine decreases, which permits the governor to become operative and enough live steam is then admitted to the turbine to carry the additional load above 340 kilowatts. With a load above 500 kilowatts, the pressure in the exhaust from the first stage is above the exhaust pressure from the engines, so exhaust steam is of no avail, and live steam must be used.

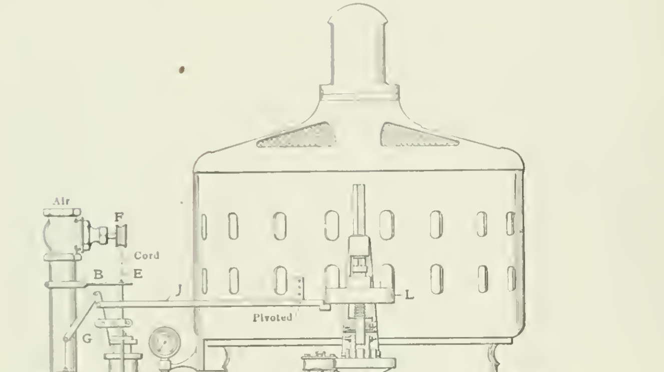


FIG. 2. SHOWING ATTACHMENT OF VACUUM-BREAKING DEVICE

It is evident that if no precaution were taken for governing the speed of the turbine, there would be danger of its running away in case the circuit-breaker should fly out or the load be suddenly taken from the line. In order to prevent such an occurrence, a homemade vacuum breaker has been constructed, which is illustrated in Fig. 2. The connection between the base of the turbine and condenser is fitted with an upright pipe, on the end of which is placed an ordinary globe valve, the stem being fitted with a pulley *F*. Two guides *A*, only one of which is shown, are supported by the brace *B* at the top, and secured to the turbine base at *C*. They are for the purpose of guiding the weight *D* as it descends. To the top of the weight *D*, a cord *E* is attached, the other end being wound around the wheel on the valve stem at the top of the air pipe, as shown at *F*. This weight is sustained by the catch *G*, which is held in position by the weight *H* on the end of the lever connecting thereto.

Extending from the catch *G* is a lever *J*, which is pivoted and is so designed at the end that the weight *L*, on the stop valve, when it operates due to excessive speed, will just touch the end of the rod *J*, forcing it down, which disengages the catch *G* and permits the weight *D* to fall with its attached cord, which in turn revolves the valve wheel *F*, thus opening the valve and allowing air to rush into the condenser, breaking the vacuum, when the turbine comes to a stop.

The piping from the different engines is so arranged that the steam from any engine can be used in the turbine, the exhaust header being placed under the engine-room floor and all engines exhausting into it. In this manner, if one engine is not running another engine can be utilized to supply the exhaust steam, which is simply drawn through the turbine on its way to the condenser.

The writer is indebted to Chief Engineer A. L. Platt for data pertaining to this combination in turbine practice.

## Preserving Water Power Sites

To frustrate an alleged attempt on the part of combinations to obtain control of the water-power sites of the country, and to carry out the policy of the administration for the conservation of natural resources, approximately forty-two thousand acres of land for water-power sites were temporarily withdrawn recently in Colorado, Montana and Utah by Mr. Pierce, acting secretary of the interior.

The withdrawals consisted of 28,410 acres of land along the Grand river, in Utah; 9997 acres along the Judith river, in Montana, and 3529 acres along the Blue river, in Colorado. This is the largest number of temporary withdrawals made in a single day, and indicates that the policy of preserving these great water-power sites to the Government will be vigorously pursued. Mr. Pierce declared that combinations have undertaken to acquire control of the country's water-power resources, and that with a view to preventing monopolization of them, lands on which water-power sites are located are gradually being temporarily withdrawn.

All the withdrawals will be reported to Congress and recommendations made for legislation to preserve power sites to the Government.

One of the new 10,000-horsepower turbines in power house No. 3 of the Niagara Falls Hydraulic Power and Manufacturing Company broke down recently and two employees were injured. The casing burst, and a piece of metal was hurled across the station, which was partly flooded with the outrush of water. At the time the wheel was moving under abou 75-pound pressure, but has withstoo much higher pressure. A defect in the casting is suspected as being responsibl for the break.

Strange, that the man who connects up a fan to discharge dust into an air-tigh box often fails to understand why it doe not work.

# Engineers' Examination Questions Answered

## These Are Believed to Be Accurate Answers to the Selected List of Examiners' Questions Which Were Published Some Months Ago

### BY F. L. JOHNSON

In POWER AND THE ENGINEER for September 8, 1908, a number of engineers' examination questions were published. All of these questions were asked by examiners in different localities where engineers' license laws are in force. The questions, with what are believed to be the correct answers, follow:

1. It is desired to carry 125 pounds steam pressure on a horizontal tubular boiler 16 feet long by 66 inches in diameter.

(a) What thickness of plate would you use in the shell of this boiler, assuming a tensile strength of 60,000 pounds per square inch in the plate?

The type of seams to be used must be decided upon before the thickness of the plate can be calculated. With he tensile strength of the plates 60,000 pounds per square inch, a factor of safety f 5 and a quadruple-riveted double-strap butt joint of 94 per cent. of the strength of the sheet, the thickness of the sheet is determined by the formula for the thickness of the sheet:

$$\text{Thickness} = \frac{\text{Working pressure} \times \text{factor of safety} \times \text{radius}}{\text{Strength of plate} \times \text{strength of joint}}.$$

Substituting numerical values and working out the equation gives:

$$\frac{125 \times 5 \times 33}{56,450} = 0.365,$$

or practically $\frac{3}{8}$ inch for the thickness of he shell.

(b) What thickness of plate would you use in the heads of this boiler, assuming the strength of the plate as 60,000 pounds per square inch?

The heads should be $\frac{1}{2}$ inch thick.

(c) What type of girth joints and longitudinal joints should be used and what is the strength of the plate?

As the stress upon the girth seam can only be one-half the stress upon the longitudinal seam a single-riveted seam with a calculated strength of 56 per cent. of the strength of the whole or undrilled heet may be safely used. For the longiudinal joints, a quadruple-riveted doubletrap butt seam having a strength of 94 er cent. of the whole sheet will be taken.

(d) How many braces should be used n this boiler and what is the strain per quare inch that you should allow the races?

The area unsupported by the shell and he tubes should be supported by $1\frac{5}{8}$-inch through stays of steel, each stay to support by means of crowfeet, angle, tee, or channel bars 96 square inches, which would bring a stress of 12,000 pounds on each stay, or 6000 pounds for each square inch of cross-sectional area of the stay. If the ends of the stays pass through the heads and are secured by nuts, they should be 2 inches in diameter where the thread is cut.

Allowing the top row of tubes to be one third of the diameter of the shell from the top, and assuming that the head is sufficiently supported to a line 2 inches above the tubes and 3 inches from the shell, will give an area of 658 square inches to be supported by the stays. The pressure upon this surface would amount to 82,250 pounds, and at 12,000 pounds per stay would require seven stays. If a manhole is put in the front head under the tubes, two additional stays, each side of the manhole, should be used.

(e) Where should the water-column, steam and feed water openings be located?

Steam and water connections for the water columns should be made through the front head, that for steam near the top and the one for water about 1 foot below the top of the upper row of tubes. The feed-water pipe should enter through the front head just above the upper row of tubes, pass to the rear of the boiler, cross to the opposite side and discharge downward between the shell and the tubes. These pipes should all be $1\frac{1}{2}$ inches in diameter. The bottom gage cock should be placed 3 inches above the level of the top row of tubes.

(f) How should a dome, 30 inches in diameter by 30 inches high, be constructed and attached to this boiler?

If a dome is used it should be of the same material and thickness as the shell, with double-butt and strap, double-riveted seam. It should be flanged and double-riveted to the shell of the boiler. The head should be dished upward, $\frac{1}{2}$ inch thick, single-riveted to the shell of the dome and furnished with a nozzle for steam connection or with a reinforced-manhole opening. The opening through the boiler shell to the dome should be of the same size as the opening in the head of the dome.

2. How would you inspect a new boiler?

In inspecting a new boiler it should be thoroughly examined inside and out. Stays and rivets should be sounded with a hammer, the strength of all seams and reinforced openings calculated and an hydrostatic test applied.

3. How would you inspect the same boiler after it had been in service two years?

After two years of service a thorough search should be made for signs of defects, such as bags, blisters, cracks, corrosion, pitting, leaking tube ends and rivets, loose and broken stays, and for anything wrong in steam, feed-water, blowoff and water column connections. The safety valve and steam gage should be tested, also.

4. Name the various types and kinds of boiler liable to be found in use in the city of Detroit.

In a city of the size of Detroit it would be expected that examples of nearly every type of boiler would be found in use, stationary, portable, marine, fire-tube and water-tube and numerous varieties of each type.

5. What are the particular points in each of the foregoing types which should receive especial attention when these boilers are inspected?

All parts which are accessible and are liable to deterioration should receive especial attention.

6. What parts of a boiler may be safely constructed of cast iron and what steam pressure, under such construction, would you allow to be carried on said boiler?

Cast iron may be safely used in return-tubular boiler construction for steam- and safety-valve nozzles, water columns, manhole ring in the shell and manhole covers, and the pressure to be carried would be determined by the strength of the longitudinal seam of the boiler if the cast-iron parts were correctly designed.

7. In case you found a boiler or appliances in an apparently unsafe condition, what would you do about it?

When a boiler is found operating in an apparently unsafe condition it should be shut down at once and made safe, if possible. If repairs which will make it safe are not possible the boiler should be condemned.

9. How often should boilers be cleaned in the city of Detroit? Is there any difference between the summer and winter seasons?

This must be determined by experience in each case. Where a boiler is operated to the limit of its capacity 24 hours a day it will probably be necessary to clean it four times as often as one which is worked easily for 10 hours a day.

There should be no difference between summer and winter in the attention given to keeping boilers clean.

The streams which feed the lake and furnish the water which is used in Detroit may be lower in the summer than in the winter and if so would carry a larger percentage of solids during the summer months.

10. Would you recommend the use of any solvents or compounds to prevent scale formation in boilers? If so, how should this compound be used?

There are several conditions where the use of solvents or compounds is advisable, such as in boilers already badly scaled and in boilers using water which has a large per cent. of scale making matter in solution. It should be fed into the boiler with the feed water in correct proportions and as regularly as possible, not intermittently.

11. What precaution would you suggest in laying up a boiler?

It should be thoroughly cleaned inside and out, and the handhole and manhole covers taken off to allow a free circulation of air. All of the accessible outside surface should be scraped and painted.

12. Give formulas for estimating safe working pressure and bursting pressure of tubular boilers and drums of water-tube boilers.

To calculate the working pressure of a cylinder multiply the tensile strength of the sheet by its thickness and this product by the percentage of strength in the joint and divide this result by the product of the radius and the factor of safety. This rule is expressed by the formula:

$$\frac{\textit{Strength} \times \textit{thickness} \times \textit{strength of joint}}{\textit{Radius} \times \textit{factor of safety}} = \textit{Working Pressure.}$$

For the bursting pressure the rule and the formula are the same, with the omission of the factor of safety:

$$\frac{\textit{Strength} \times \textit{thickness} \times \textit{strength of joint}}{\textit{Radius}} = \textit{Bursting Pressure.}$$

13. Give the formula for estimating safe working pressure and bursting pressure of flat surfaces, such as fire boxes of fire-box boilers and water legs and tube headers on water-tube boilers, etc.

Such surfaces are regarded as supporting no pressure at all, this being distributed among the supporting braces or stays, and the bursting pressure will be the tensile strength of the stay divided by the area supported by the stay.

The formulas for the bursting and working pressures of flat-stayed surfaces would be:

$$\textit{Bursting Pressure} = \frac{\textit{Strength of stay}}{\textit{Supported area}}.$$

$$\textit{Working Pressure} = \frac{\textit{Strength of stay}}{\textit{Supported area} \times \textit{factor of safety}}.$$

In the headers of water-tube boilers the weakest section is the ligament between two tube holes or handholes and the bursting pressure is calculated by dividing the strength of the ligament by the area supported by it. The formulas would be:

$$\textit{Bursting Pressure} = \frac{\textit{Strength of ligament}}{\textit{Area supported}}.$$

$$\textit{Working Pressure} = \frac{\textit{Strength of ligament}}{\textit{Area supported} \times \textit{factor of safety}}.$$

14. If stay bolts are 4 inches from center to center, with 100 pounds gage pressure what would be the steam pressure on each stay bolt?

With a pitch of stay bolts of 4 inches from center to center each would support an area of 16 square inches less the cross-sectional area of the stay. If the pressure is 100 pounds per square inch each bolt will sustain a stress of 1600 pounds minus 100 pounds for each square inch of cross-sectional area of the stay.

15. What is the value of a hydrostatic test on a boiler; how much above working pressure should such a test be made? Why?

It reveals leaks at rivets, tube ends, seams and other points that could not otherwise be found. It should be carried 50 per cent. of the working pressure above the regular working pressure to insure a working margin of safety.

The hydrostatic pressure should not exceed the elastic limit of the material of which the boiler is made.

16. How long should this test pressure be maintained?

Pressure should be kept on the boiler long enough to make a thorough examination of all seams, tube ends, rivets, stay bolts and all other points where leaks or weakness might show.

17. Would you use hot or cold water for such a test? Why?

If possible, lukewarm water should be used. If the water is much colder or hotter than the boiler, strains caused by unequal contraction or expansion might start leaks.

18. What examination should be made of a boiler after applying such test?

Thorough external and internal inspection should follow the hydrostatic test and the safety valve and steam gage should be tested and, if necessary, adjusted.

19. Which should be next to the boiler, a globe valve or a check valve?

In order to provide means of examination or necessary repairs to the check valve a stop valve should be placed between it and the boiler.

20. Where should a blowoff pipe be attached to a boiler?

In a horizontal tubular boiler the blowoff pipe should enter the bottom of the shell near the rear end, unless there is a mud drum, when it should be taken from the bottom of this drum. In all classes of boiler it should be taken from the lowest possible point in the water space.

21. Name four different kinds of brace in a boiler and describe each, telling where used, etc.

Gusset stays, screw stays, palm stays and through stays. Gusset stays are triangular strips of sheet metal secured to the heads and shells of boilers by angle- or T-iron "feet." They are largely used in Lancashire and similar boilers. Screw stays, commonly called stay bolts, are used to support the flat sides of fire-box boilers, the tube boxes of Heine boilers, etc. They are threaded the entire length, screwed through both sheets and headed over at the ends. Palm stays have enlarged flat ends, one of which is riveted to the boiler head and the other to the shell. They are also sometimes used to support the flat ends of steam domes.

Through stays pass from end to end of the boiler and are usually made with enlarged ends, threaded and fitted with nuts inside and out on both heads. They are used above the tubes and usually, also, below where there is a manhole in the head below the tubes.

22. What parts in a boiler are first affected by low water?

It would be the top of the fire line; the crown sheet of a locomotive boiler, the top of the furnace in a Scotch boiler and the rear head just above the tubes in a horizontal return-tubular boiler.

23. What is a pressure gage used for and does it contain water or steam?

It is used to indicate pressures ir boilers, closed vessels, pipes, etc. I should contain water.

24. What kinds of boiler are mostl in use? Describe them.

Probably there are more horizonta tubular and locomotive fire-box boilers i use than any other types. The horizonta tubular boiler consists essentially of cylindrical shell closed at the ends by fla heads through the lower two-thirds o which, from end to end, pass tubes. Thos parts of the heads not supported by th tubes are braced by stays of some kind The horizontal tubular boiler is usuall inclosed in brickwork. A locomotiv or fire-box boiler is composed of cylindrical shell riveted to a rectangula fire box, with a semicircular top and wit vertical sides. The fire-box portion i double, having a water and a steam spac between the inner and outer shells, whic are supported, where necessary, by sta bolts and crown bars.

25. What is the space called in whic combustion takes place?

In the horizontal tubular boiler th space back of the bridgewall is commonl called the combustion chamber. In som types the combustion takes place entirel in the fire-box or furnace.

26. What is a butt joint and what is lap joint?

Two plates placed edge to edge with th joint covered by one or two cover plat are said to be butt-jointed. A lap joi is one in which one plate overlaps th other.

27. What is a safety valve for?

To prevent pressure in any closed ve sel, steam boiler or system of piping fro exceeding a predetermined limit, by opening and relieving the pressure as the limit is reached.

28. What is a steam gage used for?

To indicate the pressure of steam within the boiler.

29. If your boiler were foaming, how would you remedy it enough to keep on running, without shutting down the plant?

By feeding and blowing. It may be necessary to slow down or even stop the engine long enough to find the water level in the boiler. If the boiler has a surface blow it should be used freely.

30. What is priming, and what is the cause of it?

Priming is the carrying of water from the boiler, in the form of spray, with the steam into the main steam pipes. It is caused by restricted steam space, poor circulation and the forcing of the boiler beyond its normal capacity.

31. What will sediment in a boiler cause?

If in large quantities it sometimes settles over the surfaces exposed to the fire, keeping the water from coming in contact with the iron, causing "bagged" sheets, collapsed furnace tubes, dropped crowns, etc.

32. If you should step into your boiler room and the steam gage showed 40 pounds more pressure than the usual blowoff pressure, what would you do?

Reduce the pressure to normal by covering the fire, checking the draft, etc. At normal pressure, lift the safety valve slightly by the lever; later, test both gage and valve.

33. Give two causes of the water glass not showing the true level of the water in the boiler.

Foaming of the water in the boiler, and the pipe leading to the gage glass becoming closed.

34. What causes boilers to bag? How would you prevent it?

Bags are caused by overheating portions of the sheet while under pressure. Sediment, mud or masses of scale settle on the sheet, preventing access of water and the metal, being softened by the heat, yields to the pressure and stretches into the form of a pocket or bag. It can be prevented by keeping the boiler clean.

35. If the water in the gage glass should drop out of sight, what would you do?

Cover the fire with coal or ashes, close the damper and search for the cause. If not found, close all openings to the boiler and allow it to cool. It should be inspected before being fired again.

36. What part of a horizontal return tubular boiler is first endangered by low water?

The rear head just above the level of the upper row of tubes.

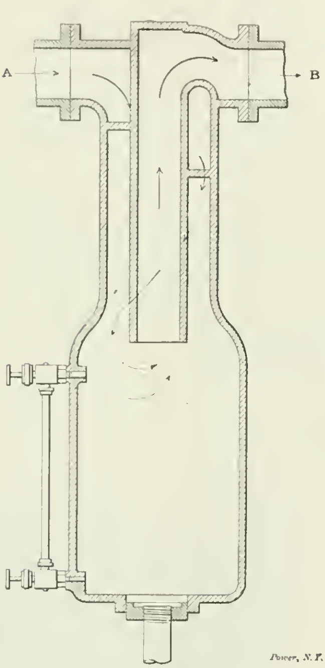
37. Diagram a separator and explain it.

In the design of a separator an effort is made to deflect the water in the steam from the path which the steam follows. In the type shown by the accompanying sketch steam enters at *A* and is given a swirling motion by the shape of the inlet which throws the water to the side of the separator, downward, whence it runs to the receiver, while the steam passes upward through the central pipe and out at *B*.

38. What pressure can you get with a pump having a 7½-inch steam piston and a 5-inch water piston, with 80 pounds gage pressure?

The area of a 7½-inch circle is 44.179 square inches. The area of a 5 inch circle is 19.635 square inches. If friction of the pump is neglected, then

$$44.179 \times 80 \div 19.635 = 180$$



A STEAM SEPARATOR

would be the pressure obtainable. Or, as the areas of all similar figures are proportional to the squares of their corresponding dimensions, 80 times the square of 7½ divided by the square of 5 will give the correct result, 180.

39. If a pump will force water 100 feet upward, how far will it force it to add a 20-foot suction lift?

Adding to the suction lift will not alter the hight to which a pump will raise water. It will force water 100 feet, or 80 feet under pressure and 20 feet by what is called suction.

If 100 feet is the limit of hight to which the pump will force water without suction lift then there will have to be as many feet taken from the column of water above the pump as are added to it below. If 20 feet are added to the suction lift then the pump will force the water only 80 feet above itself.

40. How far will a pump draw water, vertically and horizontally?

At the sea level the vertical limit is about 34 feet with a perfect pump, but there would be no flow at this hight, as the atmospheric pressure on the surface of the water would be balanced by the weight of the column of water in the suction pipe, and there must be an unbalanced pressure to cause a flow. The satisfactory practical limit is found to be about 10 feet less. With an air-tight suction pipe water may be drawn horizontally any practical distance.

41. Why will not a pump lift hot water?

Because as the pressure on the surface of the water is reduced steam is generated, which flows to the pump instead of water.

42. Should a pump become steam-bound several times in a day, how would you remedy it?

If possible the vertical distance between the pump and heater should be increased. As the pump must be below the source of supply when pumping hot water the head should be sufficient to lift the suction valves and fill the cylinder with water as the piston recedes.

If this is not practicable, a little cold water may be let into the suction pipe to reduce the temperature of the water within working limits, or it might be possible to increase the head by carrying a higher water level in the heater.

43. What is the difference between a single- and a double-acting pump?

Strictly speaking, a single-acting pump is one which acts in one direction only. This definition would limit single-acting pumps to those with valves in the piston, such as common house pumps and the ordinary jet-condenser air pump. Plunger and piston pumps which draw in and force out at one end of the cylinder only are frequently called single-acting.

A double-acting pump is understood to be one in which the piston while drawing water into the cylinder at one end is at the same time forcing it out at the other; that is, the piston acts or forces on both strokes.

44. What is the least number of valves required in the water end or the water cylinder of a duplex pump?

As a duplex pump is usually double-acting, there must be one suction and one discharge valve at each end of each cylinder, or eight valves in all.

45. Which pipe in a pump should be the larger, the suction or the discharge pipe? Why?

The suction pipe should be larger than the discharge pipe, in order to reduce the friction in the pipe to the lowest amount, so as to allow the pump cylinder to fill as rapidly as the piston recedes.

46. Which piston would be the larger on a boiler feed pump, steam or water, and why?

If the steam piston were not larger than the water piston, the pump could not force water into the boiler which furnished the steam to operate it.

The total forward pressure on the steam piston must be greater than the total back pressure on the water piston in order to move the water piston against its back pressure.

47. What is the advantage of the suction chamber on a pump?

It tends to produce a steady flow of water in the suction pipe instead of an intermittent one corresponding to the motion of the water piston.

48. What causes the water to flow into the cylinder of a pump from a source below the pump?

The motion of the piston in the pump cylinder reduces the pressure in the suction pipe and, the pressure of the air on the surface of the water being unbalanced, water is forced upward in the suction pipe.

49. Where would you place the globe valve on the discharge line of a boiler-feed pump, and why?

A valve should be placed as close to the pump as possible, in order to allow of cutting the pump out of service without disturbing the pipe, or interfering with other methods of feeding.

There should be three valves in the pipe leading from the pump to the boiler; one between the boiler and the check valve, one convenient to the boiler front to be used in the feed regulation, and one close to the pump.

50. How would you give a steam valve on the engine more lead?

Increased lead may be given by moving the eccentric or by reducing the lap.

51. What effect has increasing the lead on the various operations of the valve?

If the increase in lead has been brought about by moving the eccentric all operations of the valve will be earlier. If it has been accomplished by reducing the lap the cutoff will occur later.

52. How would you increase the speed of an engine?

Slight changes may be made by increasing the weight the governor has to carry, by adding to the weight or increasing the tension of the springs, when springs are present. If the change is to be great the pulley on the governor shaft should be changed. The governor is designed to run at a certain speed and the pulley changes should be such that when the engine is running at the new speed the governor will still run at the speed for which it was designed.

53. What is a horsepower? Give the rule for finding the horsepower of an engine.

A horsepower is the equivalent of 33,000 pounds raised 1 foot in one minute, or 550 foot-pounds per second. To compute the horsepower of an engine, multiply together the mean effective pressure, the area of the piston and the piston speed, and divide this product by 33,000.

54. Give two methods for increasing the horsepower of an engine.

The horsepower of an engine may be increased by increasing the mean effective pressure or by increasing the piston speed.

55. What benefit is derived by using a flywheel on a steam engine?

Energy developed in the cylinder is stored by the flywheel and given out while there is no work being done in the cylinder, producing an even rotating effect when passing the center.

56. Describe the operation of a compound engine.

Steam is admitted to the high-pressure cylinder from which it is exhausted to the low pressure cylinder. Steam is usually used expansively in both cylinders of a compound engine but sometimes, as in the case of direct-acting steam pumps, the steam is used full stroke, expansion taking place as the steam is exhausting from the high-pressure cylinder into the low-.

57. What is a receiver of an engine?

Receivers usually used with compound engines are vessels into which the high-pressure cylinder exhausts and from which the low-pressure cylinder draws steam.

58. Why are condensers attached to a steam engine?

To condense the steam and thus avoid the necessity of forcing it out of the cylinder against the pressure of the atmosphere.

59. Explain how an engine passes over dead center?

In multi-crank engines, no two cranks being on the center at the same instant one crank is carried past the center by pressure in a cylinder other than its own. In single-crank engines the momentum of the flywheel moves the crank during the interval in which no work is being done in the cylinder.

60. What is compression?

It is the reduction of the volume of exhaust steam trapped in the cylinder by the closing of the exhaust port before the end of the stroke of the piston.

61. What is the travel of a valve?

It is the distance over which the valve moves in passing from one extreme position to the other.

62. How would you equalize the piston clearance in an engine cylinder if the rod is keyed to the crosshead?

By the use of shims or liners at the connecting-rod ends.

63. How many working edges has a plain slide valve?

Four: two on the outside for steam and two on the inside for the exhaust.

64. Give in full all you would do in getting ready to start and operate a steam plant, consisting of boilers, engines, pumps and feed-water heater and all piping, after it had been shut down for one year?

The first step would be a thorough inspection of the boilers, engines, pumps, piping, shafting, pulleys, belts and everything connected with the plant. Boilers, heaters and all piping subject to pressure should be filled with water and pressure applied. If everything is found to be in good working order, steam should be raised and all piping blown free from dirt and scale. The feed pump and other boiler feeds should be tried; then the engine and other machinery.

## Navy Department Announces Examination of Engineers for Training Station

The navy department has announced an examination of applicants at the Federal building, Chicago, Ill., August 24 next, for the purpose of filling the positions of engineer-in-charge of power plant, at $5.04 per day, and assistant engineer, at $4 per day, at the United States Training Station, Great Lakes, Northern Chicago, Ill.

The candidate receiving the highest average will be appointed to the $5.04 position and the candidate receiving the next highest average will be appointed to the $4 place.

The examination will be open to all comers who can give evidence of experience in the kind of work for which they seek employment, and who are citizens of the United States. Persons now holding positions at the station will be admitted to competition on the same footing as other applicants.

Applications will be addressed to the "Commandant, Naval Training Station, Great Lakes, North Chicago, Ill.," and must be delivered to him on or before Saturday, August 21, 1909. No application received after that date will be considered.

Each applicant will state in his application his name, age, residence, citizenship, present occupation, and previous employment or work done.

The applications will be accompanied by evidence of citizenship and by certificates, preferably from previous employers, as to character, habits of industry and sobriety, and skill and experience in work of the kind required.

Applicants will be informed of the date upon which they will be required to report for examination.

The examination will be practical in character, having reference exclusively to the requirements of the positions to be filled.

The applicant's antecedents and experience, as well as the character of his previous work, will be duly considered by the board in making its recommendations.

# Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think,
Know or Want to Know About Your Work, and Help Each Other

## WE PAY FOR USEFUL IDEAS

### Increasing the Power of a Gas Engine by Cooling the Exhaust

In Power for July 13, in the article on the Diesel engine, the idea is presented that by reducing the volume of the exhaust gases, by cooling, the work done in expelling them against the pressure of the atmosphere is reduced and that *hence the power delivered by the engine will be correspondingly increased.* The same idea was brought forward some months ago in another trade paper. This is certainly important if true.

Now why not apply the same principle to the steam engine and use a condenser without any vacuum pump. The volume of the exhaust steam would be reduced to almost nothing and the work of expelling it from the condenser to the atmosphere would be insignificant. Probably no one would expect to gain any power by such an arrangement, but the principle is exactly the same as in the gas engine.

The fuel used by a gas engine contains a definite amount of energy. Part of this energy is carried off by the jacket water in the form of heat, another portion is converted into mechanical energy, and the rest passes out through the exhaust valve. The amount of energy left in the exhaust gases *as they leave the cylinder* is not reduced by subsequent cooling, unless this enables us to reduce the back pressure. It would be *possible* by the use of a large air pump in connection with this exhaust cooler (or condenser) to reduce the back pressure, but the smaller volume of condensed steam makes this method much more feasible for steam than for gas engines.

W. W. Wells.

Clyde, Ohio.

### Cooling Jacket Water

I note in the June 15 number, page 1059, a method of cooling gas-engine jacket water. There is also another method which I think is much more preferable, and this is using spray nozzles, as shown in the illustration. The table gives the results of tests from such a cooling plant, which is installed on the roof of a building.

Joseph M. Foreman.

Philadelphia, Penn.

TEMPERATURE TEST OF SPRAYING WATER AFTER PASSING AROUND THE CYLINDER AND COMBUSTION CHAMBER OF A DE LA VERGNE 125-HORSEPOWER GAS ENGINE, AND SPRAYED THROUGH FOUR NO. 10, OR 1-INCH S. & K. SPRAY NOZZLES, EACH THROWING 1000 GALLONS PER HOUR, UNDER A PRESSURE OF 20 POUNDS AT THE NOZZLE.

| Date, Sept., 1908. | Temperature of Hot Well, Deg. F. | Temperature of Water After Spraying, Deg. F. | Difference in Temperature of Water, Deg. F. | Dry and Wet Bulb, Deg. F. | | Difference in Temperature, Deg. F. | Relative Humidity. |
|---|---|---|---|---|---|---|---|
| 2 | 94 | 80 | 14 | 76 | 68 | 8 | 67 |
| 3 | 92 | 76 | 16 | 76 | 58 | 18 | 33 |
| 4 | 92 | 74 | 18 | 67 | 61 | 6 | 71 |
| 8 | 88 | 75 | 13 | 75 | 57 | 18 | 30 |
| 9 | 91 | 77 | 14 | 81 | 64 | 20 | 32 |
| 10 | 94 | 78 | 16 | 82 | 65 | 17 | 58 |

FOR COOLING JACKET WATER

### Filing Clippings

In the July 13 number is a letter by Elmo N. Owen on filing clippings. I have used a system much similar to this for several years and believe that I can improve somewhat upon his suggestions. In the first place the envelops used by him are too small, requiring that the pages of the paper be either folded or trimmed down, something which could be avoided with slightly larger envelops.

Again, I notice that he pins the pages together. After experimenting with several kinds of fastenings I now prefer to paste one corner of each sheet to the corner of the next. Library paste is very convenient for this and fastens the sheets securely without interfering with the ability to read both sides and without the lump caused by the pin.

I do not think that his plan of filing the articles in envelops marked with the initial letter of the name of the subject is as good a plan as to file each subject separately, or with related matter. From his letter I should judge that valves, for instance, are filed in more than one envelop, together with all other matter beginning with V. A better plan would be to keep all of the articles on valves in one envelop until this was outgrown and then to subdivide them under the various types of valve, giving each a separate envelop.

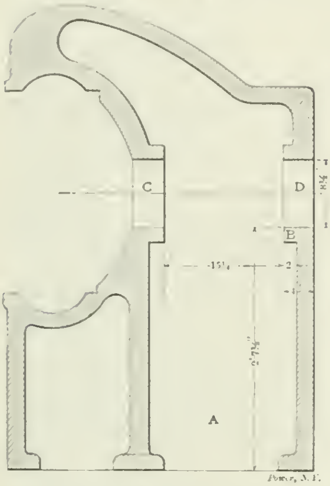
A system of this kind should make unnecessary the use of the card index, which is quite an addition to the work of cutting out and filing away the articles. In conclusion, I would suggest that the name or initials of the paper from which the article is clipped, together with the date, be placed upon each clipping so as to be sure of having the authority from which the statements were taken

G. H. McKelway.

Brooklyn, N. Y.

## Fishing for a Crosshead Pin

While removing a crosshead pin for repairs it was dropped in the cavity at *A*,



FISHING FOR A CROSSHEAD PIN

see illustration. Anyone not having the experience of getting a 200-pound pin of this size out of such a place might think it easy. The chief remarked it would be an all-night job, but after several schemes proved unsuccessful, I looped a wire over the threaded end, and set the pin on end. With a rope I put a half hitch at the center of the pin, one end being out of the opening at *C*, the other at *D*, and then lifted it high enough to reach the bottom of the pin. Then I put one feedbag inside another, and put the pin in the sacks. The sacks kept the top of the pin from catching under the boss at *B* and made a rough surface so that a rope around the bottom of the pin and out through the hole *C* would not slip to the top. We thus guided the pin out at the hole *D*. The operation required less than five minutes.

F. A. Miller.

Zollarsville, Penn.

## Raising Water

I should like information from men who are engaged in raising water for water-works service, or any other purpose from a great depth in the ground, by compressed air, direct deep-well steam pumps, walking-beam pumps, or any other means, regarding their experience under different conditions, such as the amount of work they are doing, the cost of coal, the depth of the water, the size of the pipe, the amount of steam pressure or the amount of air pressure, the size of the casing, and all the information that is required to get a comparative statement of the advantages and disadvantages of one style over another.

James W. Sherman.

Columbia, Mo.

## Cost of Cleaning Boilers

I note Mr. Crane's comments in the issue of July 13 on the cost of boiler cleaning. Every engineer should be well posted on this subject. It is quite possible to remove iron rust, clay, mud, vegetable matter and other suspended particles at practically no expense after suitable apparatus is once installed.

It is true that coke filters are effective when new, but deteriorate in time, cause considerable annoyance and often at least partially fail to perform their work. I have seen small bits of coke from these filters get into the water meters and put them out of action.

Such trouble can be prevented by using some arrangement in which linen terry is used as a filtering medium. A terry filter has the further advantage that it can be put into the feed line at the last point before the water enters the boilers. It therefore removes suspended particles of oil from the condensation and also the floating impurities from the makeup water. When a terry filter is placed in the feed line in this way there is no chance for other impurities to get in at a later point in the cycle. Terry has long been used in marine work where the trouble, of course, is confined mostly to oil from the condensation.

If the filter is so constructed that all entering water must pass through double cloths, there will be no difficulty experienced from any very small particles which may pass. It is rather surprising to know what a wide range of impurities terry cloth will retard. I have known instances where thick mud from river water, particles of coal tar, sewage, white lead and crude oil have been stopped, and in every instance with satisfactory results. There need never be any doubt as to the condition of cloths, as the line may be provided with gages on each side of the filter. The difference in pressure on the two sides of the filtering medium will indicate clearly as to whether or not it should be cleaned.

It is somewhat of advantage to use a filter with double separated terry cloths so that when the first layer gets dirty the second layer will catch such particles as tend to be pushed through the first. There are a number of practical filters using terry cloth, and they are almost all arranged so that the cleaning operation is very simple. I have in mind one of suitable size to filter 150,000 pounds of water per hour in which the foul filtering media can be removed and replaced by clean and the filter put to work again in less than ten minutes.

The frequency of cleaning varies according to the conditions in the plant, but in the average case cleaning may be required from once a week to once a month. The cleaning of such a filter requires so little labor on the part of the engineer that he is not inclined to shirk the job, and as the foul media can be boiled out in soda to remove all oil, etc., and used indefinitely, the cost of upkeep, including labor, is small. I know of several terry-cloth systems of filtration that overcame all troubles from suspended particles in plants where charcoal filters, line-separating devices and open heaters failed to do the work.

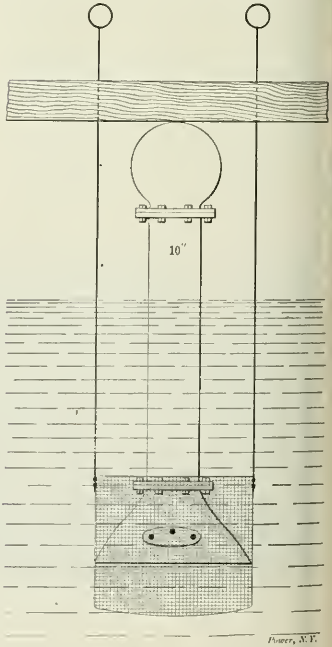
In fact, I believe where terry cloth is used that the removal of suspended particles makes them by far the least troublesome of feed-water impurities.

Robert D. Heine.

Brooklyn, N. Y.

## Suction Pipe Strainer

The strainers on the suction pipes of our condensers used to get choked up.



SUCTION-PIPE STRAINER

They often had to be cleaned once a day, and sometimes, in the fall of the year, twice a day.

We cured the trouble by making a basket as shown in the illustration, which can be cleaned at any time without stopping the pump by lowering it and lifting it clear of the pipe The old method was to break the joint at the elbow and lift p the pipe with a chain hoist, which made xtra work, besides putting the condenser ut of commission.

Thomas Sheehan

Pittsfield, Mass.

## Do You Believe It ?

A published list of questions discussed nd answered by one of the engineers' asociations contains among others the folwing

*Q*—How many pounds of water are required to yield one horsepower with our est engines?

*A*—From 25 to 30.

*Q*—What is the consumption of coal r hour on a square foot of grate surace?

*A*—From 10 to 12 pounds.

*Q*—What is the water consumption in unds per hour per indicated horse wer?

*A*—From 25 to 60 pounds.

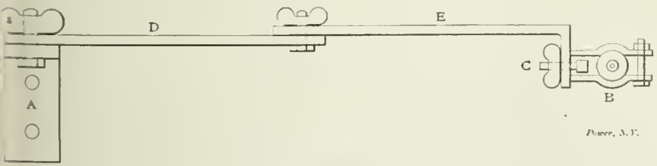
There are some others that are funny, ut what do the readers of Power think f these?

Ralph Waldo.

New York, N. Y.

## Dirt in Boiler Rooms

Dirt in many boiler rooms is caused the dust from unloading coal. Most, not all of it may be prevented in the owing manner. Take some strap iron nd make a hose bracket, as shown in the ompanying sketch, with arms *D* and *E* justable by the thumb screws. The amp *B* is also made of strap iron, its rpose being to hold a spraying nozzle. he piece *A* may be secured to any conenient support. By adjustment of the mb screws, the bracket may be turned any direction and the nozzle turned up down by adjusting the thumb screw *C*. hus the coal may be sprayed as it is rown into the bin.



IMPROVISED HOSE BRACKET

When flues are blown from the back end the boiler, a great deal of soot often mes out through cracks around the e caps and doors of the boiler fronts. a jet is put in the smoke box, and rned on while blowing the flues, it will nd the soot up into the stack and prevent it from flowing out into the boiler room.

R. L. Rayburn

Decatur, Ill

## The Denver Boiler Explosion

I read the account of the boiler explosion in Denver, and in my time I have known of four explosions under similar circumstances. In 1856, a boiler exploded in Toledo, O. It was to carry 60 pounds, which was the prevailing custom in those times, and had been cleaned and refilled ready to fire up. The engineer got the fire in on time but when 7 o'clock came he only had 40 pounds shown on the gage. He opened the throttle and at that instant the boiler left him, somewhat the worse for wear but still alive.

Some twenty years later a small 40-horsepower boiler in Little Rock, Ark., went out one Monday morning under the same conditions. The instant the engineer opened the throttle the boiler exploded. Some months afterward a boiler in the South exploded. The fireman was on top of the boiler to cut it in with a battery. At the instant he opened the valve the boiler exploded; and by all accounts the Denver boiler was being cut in and at that instant the explosion came.

All these boilers had been in service and showed no sign of weakness. They had been inspected and pronounced sound. Was there any outlet for the air in the steam room or was the boiler steam- and air-tight? If so, how many B.t.u. were there in the water that was required to generate the necessary steam pressure? If there were more heat units than required, what effect would it have when the air was suddenly released? In two of the cases I have referred to the boilers were air-tight, and as soon as the air was turned loose the surplus heat in the boiler generated more steam than the boiler would hold

J. H. Hermann

Hot Springs, Ark

## Mandrel for Babbitting Boxes

The illustration shows a good device for rebabbitting the shells for crank boxes. By having this device properly made, the crank box comes off the spool ready to receive the oil grooves and be placed on the engine. It consists of a smooth plate having a recess counterbored in the same, as shown at *D*. This spool has fillets formed upon the ends so that the babbitts will not have sharp corners to be scraped off. A cap plate *C* is necessary, also a through bolt for clamping the rig firmly together.

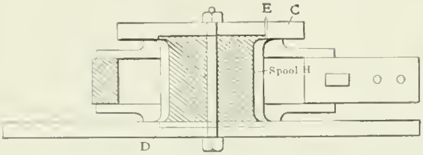


FIG. 1.

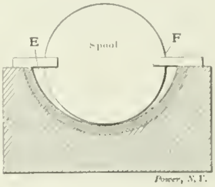


FIG. 2

The shells are placed in the straps and then placed centrally over the round mandrel and firmly clamped; pouring the babbitt through the gate *E*, in the top plate. This mandrel has slots cut in its sides as shown at *F* in which are fitted plates which separate the babbitt in the two halves of the box. Bearings cast on this form of spool are ready to go on the engine with the exception of cutting the necessary oil grooves.

The spool should be made slightly larger in diameter than the crank pins, so that the boxes will not bind on the edges when placed upon the crank shaft. At *E* is shown an exaggerated view of how the bearing should fit. I have found that the spool on which a 6-inch crank box is to be cast should be made $6\frac{3}{64}$ inches in diameter.

C. R. McGahey.

Richmond, Va.

## Graphite for Lubrication

Personally I favor the graphite in flake form, as it appears to me to "fill in" better than the powdered. I also believe that the flakes take a better hold on the bearing surfaces than the powder, which appears to squeeze out Again, I imagine that the powdered graphite could hold more grit without a person discovering it in time than the flake could.

One plant which came under my notice, where flake graphite is used, consists of a 13x23 flat-valve steam engine, several hydraulic [illegible] pumps and a lot of different machinery and shafting. In this plant only one barrel of cylinder oil is used yearly [illegible] pounds and one barrel of engine oil every twelve months, with about 15 pounds of flake graphite every year. Such a thing as a hot bearing is not known, and I believe few plants of the same size, where oil alone is used, can show such a small oil bill, or have as little trouble with the bearings. A wrinkle used in the same plant is to use the powdered form. Mixed with common black japan as a boiler front paint, it gives it a far longer life.

James E. Noble.

Toronto, Can.

I prefer the flake graphite in place of the finely ground, for the reason that the flaked graphite is harder to adulterate than the fine. I have no doubt that the fine graphite would be equally good if it could be got pure and kept clean. I have never had any success with fine graphite, as it seems to contain too much foreign matter.

One should use judgment in using any kind of graphite. For instance, if one uses too much, and perhaps with a poor grade of oil, hard lumps form that will cut ordinary soft shafting.

The best thing for a bearing that is inclined to run hot is to use first a mixture of white lead and water, say one pound of lead to six quarts of water. This will wash out the bearing and at the same time lubricate it if used in sufficient quantity, and until the liquid comes out nice and white. One will notice that when this is first applied it comes out in a very dark color, due to the iron cuttings and dirt. Then after it comes clear, mix about two tablespoonfuls of flake graphite with about a pint of medium-weight oil for a day or so and watch the bearing closely. After this, if possible, lubricate the bearing with some kind of suitable grease. It is sometimes advisable to mix a little graphite with the grease.

G. A. Nestler.

Homestead, Ore.

## Reducing Rig for a Vertical Engine

In the July 6 issue, Julian C. Smallwood has an article on a reducing rig for a vertical engine. This rig is exceedingly simple and at first glance should be successful. It has, however, possible defects, especially for the higher-speed engines.

The first is the possibility of stretch of the cord. The second is the sway of the cord, which will probably be considerable, as none of the vertical engines running at high speeds is absolutely rigid. For the larger-size engines, the stretch of the cord will be even more important, and swaying, although not quite so likely of occurrence, is even greater in its effect.

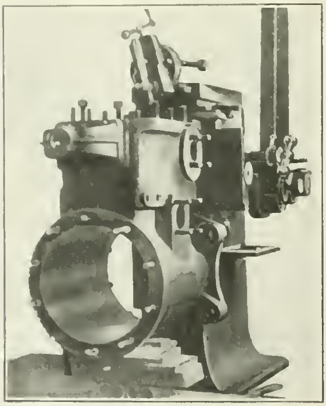
A rig similar to this was tried on a large vertical engine using the triple cord as suggested and was a failure, due mostly to the stretch of the cord. A flat-steel spring was substituted for the cord, and better results obtained, but the sway or slap of the spring was sufficient to distort the diagram to a considerable extent. Better results were obtained through the use of a permanent rigid indicator rig.

Henry D. Jackson.

Boston, Mass.

## A Difficult Repair Job

Recently in making repairs to our college power plant, it was deemed advisable to face off the valve seat on one of the large air compressors used in pumping water by the air-lift system. The machine had been in use for ten years, and the valve and seat were badly worn and cut. In this compressor, the steam cylinder and steam chest were cast together, and the seat was, therefore, about 8 inches below the edge of the casting. It was discovered that the combined cylinder and steam chest was too large for our shop planer, and we had about decided to work the seat down to a bearing by hand, when our machine-shop instructor solved the difficulty by bolting the cylinder to the front of the shaper as shown in the photograph.



A DIFFICULT REPAIR JOB

The cylinder casting weighed more than the shaper, and to support it a track was laid on the floor and made parallel to the travel of the shaper bed. Several pipe rollers were placed on this track, and the cylinder blocked to rest upon them. By using a long, stiff tool and many light cuts the job was satisfactorily completed.

Albert Barnes.

Agricultural College, Miss.

## Detroit Boiler Inspection Rules

Detroit recently passed a boiler-inspec
tion ordinance requiring an annual ex
amination of boilers used for power an
heating purposes, exempting railroad loco
motives and heating boilers in priva
residences. It is interesting to note som
features of the new law: for instance, th
factors of safety. For boilers carryin
pressures not exceeding 100 pounds th
factor is 4; for pressures not exceedin
125 pounds, 4.5; and for boilers carryin
not to exceed 150 pounds, 5; for wate
tube boilers carrying pressures of from 1
to 200 pounds the factor is 6, but cas
iron headers on water-tube boilers w
not be allowed more than 160 pounds.

The law makes no mention of exceptio
of boilers constructed with the sear
parallel to the axis of the shell being but
joint, double-strapped, triple- or quadrupl
riveted, all of the foregoing factors bein
based on the lap-joint type of constru
tion. Iron plates are taken at 45,0
pounds and steel at 55,000 pounds tens
strength; iron rivets in single shear, 3
000 pounds; double shear, 70,000 pound
and steel rivets, 42,000 and 78,000 poun
respectively. In computing the safe wor
ing pressure the formula is

$$\frac{T.S. \times T.E.}{R. \times F.} = \textit{allowed pressure.}$$

No provision is made for an increa
in the factor of safety by reason of t
boilers being very old, and persons m
therefore be allowed the same pressu
when a boiler is fifteen years old th
would be allowed a new one of the sa
construction.

The factor of safety of 4 will doubtl
be used on from 60 to 90 per cent. of t
boilers in Detroit, and in this connecti
the fact is that the Massachusetts, Phi
delphia and Chicago rules give a factor
5 on boilers coming under this rulin
The factor is never less than 5 under t
percentage rule in Chicago and Phi
delphia, while Massachusetts is 5 for la
joint construction up to 10 years, 5.5
15 years, 5.75 to 20 years, after which
is 6.

Massachusetts rules give a factor
4.5 on butt-strapped seams, thus inte
gently favoring this superior constructi

It would appear, therefore, that Detr
has taken a step backward in using
factor of safety of 4 on boilers with
lap-joint seam, and to show this clea
take a 60-inch horizontal tubular 5
inch shell plate of 55,000 tensile streng
with 70 per cent. joint; the bursting pr
sure would be 401 pounds, and the pr
sure allowed would be 100 pounds
Detroit, while in Chicago and Philadelph
80 pounds would be the allowance, wer
12 years old, and in Massachusetts
pressure would be 72.9 pounds.

To compare again: If the shell pl
of this 60-inch boiler were 3/8-inch pl

and the lap joint were used, the boiler pressure would be 181 pounds and the factor of 4.5 would allow 107 pounds, although the plate is 20 per cent. stronger.

Such ruling favors old boilers of the lap-joint construction as against new ones having butt-strapped joints, wherein the bending action of the lap joint is eliminated and the real safety against explosion increased.

It is to be regretted that the authors of the ordinance did not have this in view, together with the higher factors of safety that obtain in Massachusetts, Philadelphia and Chicago. Note, also, the factors of 5.5 and 6 on water-tube boilers. In comparing these with the low factors on lap-joint tubular boilers, it seems that it should be borne in mind that the drums on such boilers are not usually exposed to the direct products of combustion, as the tubes receive the highest temperatures. Massachusetts laws recognize this fact and use a factor of 5 as regards the drums, irrespective of the age. It would seem, therefore, that as the factor of safety is from 5 to 6 on water-tube boilers, as against 4 on any old lap-joint tubular boiler operated at or under 100 pounds pressure, the authors have discriminated against this type. As the boilers in large plants are usually of the water-tube type it is probable that protests will be made, and in case the law is amended let us hope that the factor of safety of 4 on lap-joint boilers will be increased to 5, which is that approved by the laws of Massachusetts, Philadelphia and Chicago.

The safety-valve area question is disposed of regardless of pressure by requiring 1 square inch area for every 2 square feet of grate surface. This rule is a safe one and prudent for low pressures, but taken in connection with some recent history on pop-safety valves it would appear that the valve area is excessive for pressures of from 125 to 200 pounds.

Massachusetts laws have covered safety valves very creditably (as indeed they have all joints) and while ample discharge is secured, excessive discharge is not wanted, as it introduces an element of danger in the way of inducing water lift and water hammer. Take a horizontal-tubular boiler 72 inches by 18 feet, with 36 square feet of grate surface, operated with the safety valve loaded to 125 pounds: The required area of the valve would be 18 inches. The nearest commercial size would be a 5-inch valve. Now the day for lever valves is past and pop valves have practically supplanted this type, but the engineering public does not want a 5-inch valve, being of the opinion that it is too large.

For the pressure required, Massachusetts laws would allow 39.4 square feet of grate for a 3½-inch valve and 80 square feet for a 5-inch pop valve. Of course two valves could be used, as required in Philadelphia, but with the existing boilers this involves additional expense, in some cases without securing added safety. Chicago rules allow 3 square feet grate surface to 1 square inch with pop valves, as does Indiana.

The Detroit law requires that in installing new boilers of the horizontal-tubular type, having a length of 18 feet or less, the shell must be built with two-ring courses, and exceeding 18 feet with three-ring courses. No doubt this ruling is to avoid having a girth seam located at or in front of the bridgewall, and is to be commended, Scranton, Penn., to the contrary, notwithstanding. But why in the name of the sacred codfish did they not include in this law that all boilers to be installed hereafter shall have the longitudinal-seam butt-strapped construction, as required in Massachusetts and Chicago? May the engineering public hope for an amendment along this line; public opinion has no place for the lap-joint construction, save on the scrap heap.

Manufacturers of boilers must soon employ experts to get out digests in order to have boilers pass inspections in the various localities where sold, or get together and secure uniformity in inspection laws. But in event of the latter it should be borne in mind that public opinion is in favor of a higher factor of safety, together with approved construction. The Massachusetts rules are the modern ones—the Detroit represent in some respects the obsolete. In the interim, pending proper amendments to the Detroit law, let us hope that the junk shops of Massachusetts will not be permitted to supply a market in the city by the lakes.

JOHN SMITH.

New York City.

## A Misleading Gage Glass

For several days it was observed that the hight of the water in the gage glass of a heating boiler varied through an unusually wide range. In investigating the cause of this, a leak was found which permitted steam to escape between the gage glass and its upper fitting, due to the deterioration of a washer.

The action of the leak on the water level in the glass was as follows: When there was no steam pressure the water in the glass assumed the same level as the water in the boiler. When steam pressure existed the leak allowed a continuous flow of steam through the upper gage-glass valve into the atmosphere. This flow of steam through the valve resulted in a drop of pressure, so that the pressure of steam on top of the water in the glass was less than the pressure on top of the water in the boiler. The higher pressure in the boiler caused the water in the glass to rise until the difference in level balanced the difference in steam pressure.

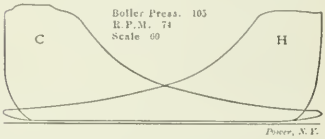
The leak caused the gage glass to be deceptive, indicating the presence of more water in the boiler than was actually there. This was confirmed by partly closing the upper valve when steam pressure existed. This increased the loss of pressure and caused the water to rise higher in the glass. When the leak was repaired the fluctuations of level in the glass ceased.

F. P. McDERMOTT.

Elizabeth, N. J.

## Trouble with Seams over Bridgewalls

In our plant are three boilers, each 54 inches by 22 feet and containing fourteen 6-inch tubes, one 20x48 Harris-Corliss engine, one 6x4x6 duplex pump and one 8x36 deep-well pump. The boilers, which have been in service 10 years, are connected by one steam dome and one mud drum. Each is made of three 5/16-inch triple-riveted sheets. No. 1 boiler is about as good as new; in No. 2 boiler 16 rivets in the seam over the bridgewall have been renewed seven times and some of the holes have been reamed out. The plate around some of the holes is cracked. No. 3 boiler is in about the same condition as No. 2. It is necessary to carry 115 pounds of steam on the boilers. They have been generating about 300 horsepower. They are free from scale, as the water is very pure.



DIAGRAMS FOR CRITICISM

The inspector recommends cutting out the first sheet in each of the affected boilers to above the fire line, leaving two longitudinal seams in the sheet. This seems an unnecessary expense and I think that cutting out about 30 inches of the first sheet, or to just above the fire, and enough of the second sheet to include all the large rivet holes will be just as satisfactory.

The engine has been in use about 32 years. It has an 18-foot flywheel and runs at 74 revolutions per minute. Is it safe to increase the speed to 85 revolutions?

The accompanying diagrams are submitted in the hope that some reader will comment upon them, figuring the horsepower, etc. Also, I should like opinions regarding the proposed repair to the boilers.

E. F. BRUNO.

Belleville, Ill.

## Unnecessary Refinements in Calculations

The writer was considerably attracted by F. Webster's article on "Allowance for the Difference in Water Level when Testing Boilers," which appeared in the June 22 number. Mr. Webster gives us his formula, and illustrates it with an example.

In his notation Mr. Webster states that *h* is the B.t.u. in the water in the boiler, or in other words, the heat of the liquid at boiler pressure and then calmly proceeds to substitute for *h* the temperature of saturated steam at that boiler pressure. The next nine lines of the article are somewhat mixed. However, assuming the substitution in the formula to be correct, Mr. Webster obtains for the total feed water 71,624 pounds. Now omitting from the formula the terms inside of the brackets and by so doing, simplifying the computation, we have

$$25 \times 55.73 = 1393$$

pounds, and by adding this to the feed water pumped we obtain for total feed water

$$70,500 + 1393 = 71,893$$

pounds, or a difference in the two ways of figuring of

$$100 \times \frac{71,893 - 71,624}{71,893} = 0.38$$

per cent., showing that Mr. Webster is making a refinement wholly beyond the limit of accuracy of the test.

The coal is usually weighed only to the nearest pound and unless weighed in larger than two-hundred pound quantities is liable to an error of 1 part in 200, or ½ of 1 per cent. The quality of the steam cannot be relied upon nearer than ½ of 1 per cent. and this error is the sum total of the errors of careful observation and of those due to inaccuracies of the pressure gage and thermometers and to radiation. Then it is by no means certain that the sample represents the average quality of the steam in the pipe from which the sample was taken. The moisture in the coal is an uncertain item at best and it is very probable that the sample of coal will lose some moisture during mixing and quartering before the first weighing. Especially is this true if the day happens to be dry and windy or the boiler room happens to be very hot. The maximum assumed possible error of the test, when using the "alternate" method of starting and stopping, will give some indication of how closely the results of a boiler trial may be relied upon; and since different authorities disagree as to which method is the better, this argument will apply equally well to the "standard" method. It is assumed that an error of 1 inch may be made in estimating the thickness of the fire at the beginning and at the end of the trial, and that these errors are cumulative, thus making a total error of two inches over the entire grate. Taking Mr. Webster's example and figures let us assume that the water evaporated per pound of coal as fired is 6.5, which is below the average. Then the coal fired during the test is

$$\frac{71,624}{6.5} = 11,020$$

pounds, and if the grate area is 30 square feet,

$$\frac{2}{12} \times 30 = 5$$

cubic feet of coal at 48 pounds per cubic foot = 240 pounds of coal error, or

$$100 \times \frac{240}{11,020} = 2.18$$

per cent.

These figures show the futility of making corrections or refinements in calculations unwarranted by the accuracy of the observations.

F. H. Bentley.

Holyoke, Mass.

## Engine Repair

The engine in question was of the vertical inverted two-stroke-cycle water-cooled type. The water jacket was a separate casting, set down over the cylinder and secured by four tap bolts screwed into a flange, on the cylinder head, the lower end resting on a millboard gasket, Fig. 1.

When the jacket water froze, instead of expanding laterally and splitting the jacket, it expanded lengthwise and raised the jacket about half an inch, taking with it the flange and a portion of the cylinder head and leaving a hole 2 inches long by 1½ inches wide, besides cracking another piece at the edge of the hole, as shown in Fig. 2.

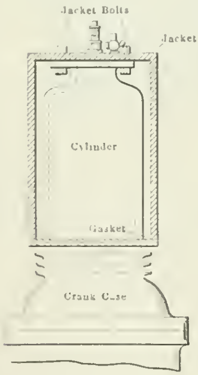


FIG. 1

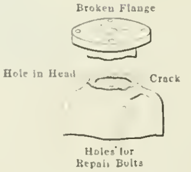
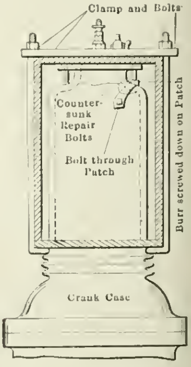


FIG. 2



*Power, N.Y.*

FIG. 3

I drilled and tapped two holes into the cylinder head and one on the side and, after coating all surfaces with "Smooth On" of the consistency of thick cream, I bolted all together, as in Fig. 3, putting clamps over the jacket to help hold it in place. That was more than two months ago and the cylinder shows no sign of failure.

J. L. Donovan.

Vancouver, Wash.

## Receiver Pressure

On page 115 of the July 27 number, C. T. McKnight is skeptical about carrying receiver pressure as low as 2 pounds, and says he carries it higher.

We should all remember that old proverb: "Prove all things; hold fast that which is good."

If anybody can carry a back pressure and reduce the efficiency of the high-pressure side and make it up by allowing the low-pressure piston to move through any large portion of the stroke with vacuum on both sides, and save fuel, of course that is the way for him to run.

If the high-pressure side can do its work without back pressure it will be at its highest efficiency. All that the low-pressure can do with the pressure at the atmospheric line, or below, costs nothing but the cost of producing the vacuum.

If the high-pressure can be made so efficient as to produce a horsepower with the consumption of 26 pounds of water, and the low-pressure does an equal amount of work, the total consumption will not exceed 13½ pounds of water, and if the high-pressure side can get down to 24 pounds of water then the total consumption will be down to 12½ pounds. This will not be done with a high receiver pressure and vacuum on both sides of the low-pressure piston through one-third of the stroke.

He asks if the proportions of the cylinders do not have something to do with it. That and the boiler pressure have a great deal to do with the amount of receiver pressure necessary to carry the terminal pressure in the low-pressure cylinder so that it will be at atmospheric pressure.

An electric-light company put in a 19 and 30 by 48-inch engine to run with 125 pounds steam pressure. After a term of years they had work enough to warrant their putting in a larger power in a turbine unit. With this they put in boilers to carry 200 pounds of steam.

This pressure on the 19-inch cylinder would be more than the parts on that side would stand, so they took off the 19-inch and put on a 14-inch one made to carry the 200 pounds pressure. This did the work of the old 19-inch cylinder and supplied the low-pressure side with the same receiver pressure as before.

Had the 19-inch cylinder been able to sustain the 200 pounds pressure there would have been the necessity of carrying a much higher receiver pressure and the economy would have been reduced.

On the same page E. W. Jackson relates the breaking of the high-pressure cylinder and running with the low-pressure and says that "the strange part of the experience was that the low-pressure required less boiler pressure than when running compound." In other words, a few pounds pressure counts on a big cylinder. On a compound locomotive the low-pressure side is made sufficiently strong so that in starting a heavy load steam from the boiler is turned directly into the big cylinder

Recently I ran across a funny reason for putting in a compound engine. The machine was 16 and 30 by 42-inch and the manager of the factory stated that the room they had to put it in was very narrow, so they had to put in a tandem compound. To the gentleman who was with me I said: "They have a 30-inch low-pressure cylinder, while if they had a simple engine it would have required only a 24 inch." He replied: "Somebody worked them, didn't they?" The engine was run noncondensing.

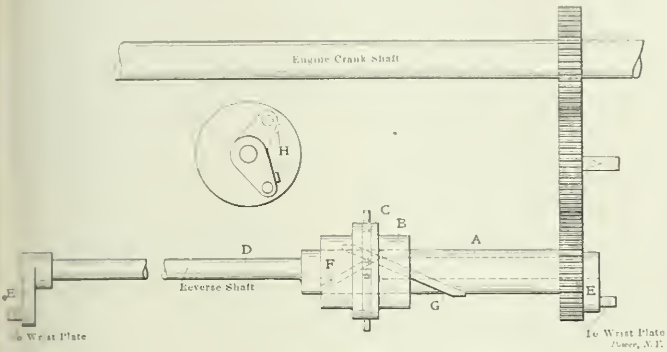
W. E. Crane.

Broadalbin, N. Y.

## Reversing Valve Gear

The illustration shows a reverse motion which is used a great deal on large Corliss hoisting engines

The hollow shaft *A* is driven from the main shaft through a train of gears, and on the opposite end is cut a right-hand quick pitch screw *A*, the pitch of the screw being proportional to the amount of the travel given the sliding sleeve *B*. The yoke *C* drives the sliding sleeve *B* along the shaft, and the reverse shaft *D* has a crank *E* on both ends and also a left-hand quick-pitch screw *F* cut on it. To rotate the shaft *D*, the sliding sleeve *B* is pushed lengthwise of the shaft. Lugs *H* are cast on the gear to serve as stops for the crank *E*.



REVERSING VALVE GEAR

Thomas Galloway.

Marquette, Mich.

## Sewer Gas in Boilers

While reading over the issue of July 20, I noted with interest the article by James E. Noble, regarding the explosion of sewer gas as noted in a former issue of Power. There are thousands of boilers connected directly to the sewer by means of the blowoff and, as Mr. Noble states, if such conditions are possible the more light that can be thrown on the subject the better it will be for the community. Sewer gas is not inflammable unless mixed with other gases and, as stated in Mr. Noble's article, when sewer gas is present in large quantities it will put out a light and cannot be ignited, neither in a hot boiler nor otherwise, owing to the fact that sewer gas is a carbonic gas devoid of oxygen which, of course, is absolutely necessary to make it inflammable. This lack of oxygen seems to prove to me that it was not sewer gas that caused the explosion.

On the other hand, cases have been noted when manhole plates of sewers have been blown high in the air and great damage done by explosions in sewer wells, but the source of the trouble, if traced out, will most always be found to be a leak from a gas main in close proximity to this particular sewer, or to the presence of other gases. In the case in question the theory that is advanced is that the water being drawn off the boiler, and cooling over night, a vacuum was formed; thus drawing the gas into the boiler. It seems to me that a little neglect was in evidence, as when blowing a boiler off it is advisable to open one or more of the gage cocks, thus admitting air into the boiler and producing atmospheric conditions. It, however, is very poor policy to condemn an engineer who has lost his life in the performance of his duty, but I think that the direct cause was a combination of gases and not sewer gas alone.

Charles H. Taylor.

Bridgeport, Conn.

## Kerosene for Removing Boiler Scale

As an experiment, I put a piece of scale in a dish of kerosene and left it there for over a week and then found the scale just as hard as ever. On examining the scale I found that the oil had not penetrated at all. A steam-plant engineer across the street from me has been using kerosene for years, and the scale gets so heavy that it becomes necessary to change the flues every two or three years, although using practically the same water that I do.

We experimented with soda ash and found that it would cut the scale and cause it to come down in big sheets and chunks. I took charge of this plant last November and had to roll tubes about twice a week all winter. I put in a new set of tubes this spring and on taking out the old ones found them imbedded in mud and scale for about 8 inches from the rear tube sheet; this accounts for the leaking and also was the reason why I could never get the tube sheet clean at this end.

A. A. Blanchard.

Oak Harbor, O.

Recently the writer had charge of an electric-light plant containing two horizontal return-tubular boilers taking feed water from a town service. They had been in use about one year and the tubes and plates were badly grooved, pitted and scaled. I began using kerosene and caustic soda, stopping the action of the water on the plates, and five years after the tubes and plates were apparently in as good a condition as at the end of the first year after installation. At the same time I had charge of the steam and power end of a marine railway in the same town and used the same solution in the boiler. The same boiler has been in use now for nine years and shows very little deterioration of the tubes or plates from the action of water using the same town service. Either the kerosene or the soda used alone had not the proper effect in removing the scale. To get the best results the writer dissolved the soda in the water, then added the kerosene, introducing them together at the bottom handhole before refilling, thus the solution rises with the water, spreading over the interior of the boiler and getting at the scale before evaporation takes place, the oil doing its work first and the soda cleaning the oil. In cleaning out better results are obtained by allowing the boiler to stand a reasonable time under pressure, until circulation has stopped, and then blow down until the water leaves the gages, then close the blowoff valve until the boiler has cooled, and allow the water to run out of the boiler, when it can be more easily cleaned, as the deposit, being moist, can be removed more satisfactorily.

The objection that kerosene finds the weak spots in a boiler and causes leaks should not influence any engineer. If there are such weaknesses in a boiler, covered and kept tight by scale, they should be routed out and repaired if necessary

L. J. Dewar.

Hallowell, Me.

Kerosene oil is a great help in getting rid of scale in boilers, if used properly. I never had any success putting it into a boiler drop by drop, when under steam pressure. I generally put in about 1½ gallons after washing out the boiler, and fill the boiler slowly. After cutting out the boiler for cleaning again, I pump the kerosene into the boiler and let it cool down.

After the pressure is all off the water is let out of the boiler slowly, so as to give the oil time to soak into the scale and adhere to the shell and tubes as much as possible. Then, take off the manhole cover and wash out the boiler thoroughly, being very careful not to place a lighted torch or lamp in the boiler until it has been properly ventilated, after which I see that there is no loose scale left in the boiler.

Some years ago I took charge of a plant in Saginaw county, Mich., containing two boilers, 66 inches in diameter and 18 feet long, and when I took charge they were using the two boilers and it was uphill work. The fireman could hardly keep the steam up. At the end of the week we took off one of the boilers for cleaning. When I opened up, I found the space between the tubes almost filled with scale. We did not need the boiler for a few days so I thought I would use an experiment, and I nearly lost my job through the operation; but it came out all right in the end. I filled the boiler with water up to the first gage, and then put in about twenty gallons of kerosene oil, left the top manhole cover off and started a fire under the boiler. Then we boiled this mixture at atmospheric pressure for about twelve hours, keeping the water level at about two gages, until the rear tube sheet got to leaking so bad that we had to pull the fire.

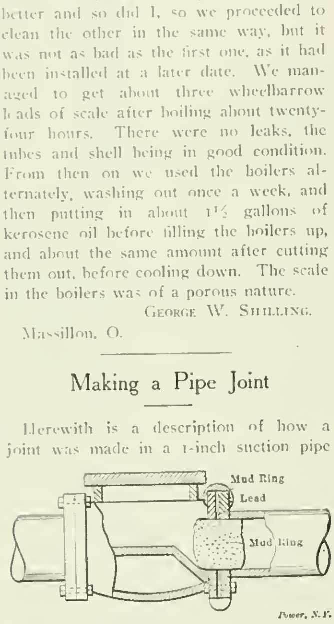
Well, then I was up against it. I called in the superintendent and he said I had no business to try and take the scale out of that boiler. He said that was what held the tubes in place, and kept them from leaking. I told him I knew it, and finally got him to understand that was not the proper way to hold tubes in a boiler, so we ordered new tubes and put them in the next day, getting the boiler ready for work in plenty of time. We found on starting up that one boiler was sufficient, after it had been treated with kerosene oil, then the superintendent felt better and so did I, so we proceeded to clean the other in the same way, but it was not as bad as the first one, as it had been installed at a later date. We managed to get about three wheelbarrow loads of scale after boiling about twenty-four hours. There were no leaks, the tubes and shell being in good condition. From then on we used the boilers alternately, washing out once a week, and then putting in about 1½ gallons of kerosene oil before filling the boilers up, and about the same amount after cutting them out, before cooling down. The scale in the boilers was of a porous nature.

George W. Shilling.

Massillon, O.

## Making a Pipe Joint

Herewith is a description of how a joint was made in a 1-inch suction pipe that could not be packed with sheet packing, on account of insufficient give in the pipe line to compress the packing by drawing up on the bolts.



MAKING A PIPE JOINT

The pipe was cut ¾ inch shorter than the correct length. One of the points was made up with sheet packing in the ordinary way; the bolts were then put in the other flanges, the check-valve cover removed and the valve taken out and a ring of clay put around the inside of the flange, and another around the outside, as shown, leaving a small hole through which the joint was poured full of lead. After the lead had cooled the bolts were drawn up tight and the point calked. This joint has now been in service two years and has given no trouble from leakage whatever.

Louis B. Carl.

Marshfield, Wis.

## Mysterious Shutdowns

A "mysterious shutdown" happened some days ago in a large power station.

Shortly after the shutdown the operator picked up in front of the switchboard what appeared, at first sight, to be parts of an ordinary bird's nest, probably blown in by the wind. On close examination it was found to be interwoven with fine wire, some of which had fallen across the busbars and caused the shutdown.

About a year ago in the same station a shutdown was caused by a large rat jumping from an iron support to the high-tension busbars. The cause of the shutdown was a mystery until the following day, when the remains of the rat were found.

H. J. Burton

Schenectady, N. Y.

## Problem of the Vacuum Bottle

The conversation of the "Vacuum Expert" was, for the most part, absolute nonsense. The "Inquisitive Caller" was right in his assertion that cold is merely an absence of heat. Thus, when a body becomes cooler, the heat is leaving it, and when it becomes warmer, heat is entering it. Also, under equal conditions, heat will enter or leave a body at identically the same rates of speed.

The reason why a liquid in a vacuum bottle, or in any other vessel, will remain cold three times as long as hot can be best explained by a water analogy. First, perhaps, a little study of relative temperatures is necessary.

If, on a hot day, with the mercury at 92 degrees Fahrenheit, a freezing liquid (32 degrees Fahrenheit) be put into a vessel, the liquid's temperature must rise 60 degrees in order to reach the temperature of the surrounding atmosphere. If, on the other hand, a boiling liquid (212 degrees Fahrenheit) be placed in a vessel with the outside temperature at the freezing point (32 degrees Fahrenheit), the liquid's temperature must drop 180 degrees to reach the atmospheric temperature. Thus a hot liquid on a cold day has three times the difference in temperature between itself and the surrounding air, that a cold liquid has on a hot day.

And now comes the application of the water comparison. As every engineer knows, or should know, the pressure of water varies directly as the "head." Thus the pressure of a three-foot column is three times as great as that of a one-foot column. Heat acts the same way. The difference of 180 degrees exerts three times the pressure, or tendency to change, that a temperature difference of 60 degrees does. Thus the 180-degree change will take place in one-third the time required for the 60-degree change.

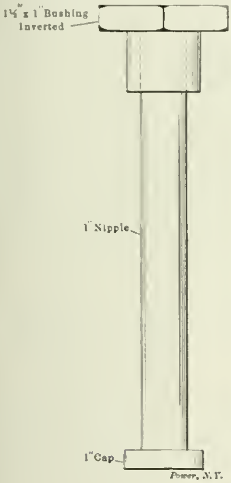
This is simply a rough illustration, but it will have served its purpose if it directs Mr. Ripley's investigations in the right direction.

Melvin E. Weil.

Chicago, Ill.

## Thermometer Cup

It was, at one time, necessary to obtain the temperature of steam at various points, and the attached drawing will show how I made a thermometer cup. I took a 1-inch brass nipple, 8 inches long, cutting threads on both ends, and put a 1-inch cap on one end and a 1½x1-inch bushing on the other, tapping the bushing out so it could be inverted and placed on the nipple. This allowed the cap end to go into the pipe far enough to escape the air that might be trapped in the tee or ell. Then, filling the cup with heavy engine oil, I got the proper temperatures with the thermometer.



THERMOMETER CUP

E. H. Marzolf.

Bellaire, Ohio.

## Location of Blowoff

In the issue of July 20, in an article by Thomas Sheehan, concerning the bursting of an ell on a blowoff pipe, there appears to me to be some rather risky complications in the case. In the first place these boilers must be in a rather poor condition to be scaled so badly as to block up the blowoff and in such a case or, in fact, in any case, frequent use of the blowoff should be resorted to, and by so doing not allow the pipe to get into such a condition. I know from experience that the water in the locality in which Mr. Sheehan is located is more or less liable to form scale, but a good boiler solvent compounded for that particular place and frequent blowing down will effectually remedy the possibility of blocked blowoffs.

Another point is this; that no fireman or engineer should open a blowoff while under pressure and go away and leave it wide open. The writer once had a similar experience in the way of a fireman who opened the blowoff of one of a battery of boilers to go around to the front of them. Something diverted his attention from the blowoff, with the result of a badly burned sheet. He did not have an opportunity to repeat the incident. Any person leaving a blowoff, if only for a couple of minutes, should close it, as water when being blown from a boiler travels very fast, especially when boosted out with a pressure of 125 pounds. Undoubtedly the cause of the present fracture was the sudden liberation of the mass of scale which being thrown against the ell caused it to let go.

When a valve is opened the pressure or strain is applied to the pipe and fittings gradually, but when allowed to go all at once it strikes the fittings with terrific force (something like a blow from a heavy hammer). I don't want to criticise Mr. Sheehan in the least, as I know that conditions alter cases, but it seems to me that as this was not the first time the trouble had occurred due measures should have been taken to prevent a repetition, either by removing the scale-forming qualities of the water or frequent alterations to the blowoff. I do not approve of the installation of a check as stated, as we are led to understand that blowoffs must be as free and direct as possible, and installing a check in the line would only add another obstruction. While it might be of some service, closing the valve while in the boiler would be better and should be done in all cases. Of course, I know anyone is liable to forget but forgetfulness is no excuse. I think on the whole if Mr. Sheehan will give his feed water a little scientific treatment and see that his firemen make a diligent use of the blowoff valve his fittings will hold satisfactorily.

Charles H. Taylor.

Bridgeport, Conn.

The best way is to have each blowoff pipe run outdoors separately, it being advisable to have the blowoff discharge into the open air, but in some plants this is not convenient, in which case they should be connected to one main pipe. Our plant has been running more than twenty years and I do not know of an elbow having burst during that time. We have a battery of seven boilers all connected together. No. 7 boiler is next to a solid stone wall 15 feet high. The boilers are set in a row, the outside door being next to No. 1 boiler, and the main conveying pipe for blowing off the boilers is laid on the ground floor.

The pipes leading to this pipe from each boiler have as few short turns as possible. When a pipe is connected, as shown in Mr. Sheehan's plan, and the steam pressure is suddenly turned into it, in making the short turns and suddenly striking the main pipe it causes water hammer, and something is pretty certain to give way

We use plug valves, instead of the kind shown in Mr. Sheehan's article, and to my way of thinking the plug valve is the proper valve to have on a blowoff pipe. We have them set below the second elbow, not between the two elbows. From the plug valve a short pipe is run into a Y-shaped connection with the main line and calked with lead. There is a thread on the pipe for a locknut to hold the lead down in the Y when the pressure is in the pipe, to prevent the steam from blowing out of the joint. A quarter of a turn with the wrench on the valve opens it. We sometimes find the pipe blocked up with scale, and by tapping the pipe with a hammer it jars the scale loose. Should this happen in the winter, the moment the scale is heard to move out, the valve is quickly closed (partly) with the wrench, to allow the pipe beyond the valve to expand slowly, and not cause a break in the Y or the pipe. Then the valve is opened wide to blow out the mud and scale

I think Mr. Sheehan would improve his blowoff connection if he would turn the ell that breaks so the drop pipe will slant in the direction it is to blow out, instead of dropping down into a tee. Also, place the valve in this drop pipe so the two ells will be between the valve and the boiler. The second elbow will then be nearly as warm as the first, reducing the chances of breaking an elbow by expansion and water hammer when the boiler is being blown off. I would not put in a check valve on a blowoff pipe.

Kalamazoo, Mich. A. I. Haight.

I suggest having long sweep bends instead of short right-angle elbows. I do not think it is very safe to have only one valve on each boiler. In addition to the valve shown in his sketch I should have a plug valve. Regarding cleaning and repairing the boilers, no practical man will ever enter a boiler connected with others without first examining all valves to see that they are shut. In this case, as it is a passage at the back of the boilers, I think it would be a good plan to have a couple of cards or boards painted and placed on each end of the passage displaying the words: "Danger, No. — Boiler Being Repaired." This would notify the fireman who was going to blow off any boiler and he could try the valve on the boiler that was cut out to make sure that it was shut. Looking again at Mr. Sheehan's sketch I think the reason the elbow lets go is because of expansion, no provision having been made for it. Regarding check valves, I have tried them and found them a failure.

George H. Handley.

Newburgh, N. Y.

## Cylinder Lubrication

In a recent editorial on "Cylinder Lubrication" some one is quoted as saying, ninety per cent of cylinder troubles are due to poor lubrication. What is meant by cylinder troubles? If it is cut and scored cylinders that are meant the statement is probably true, but the lubrication is poor, generally, not because of the quality of oil used but because the condition of the surfaces to be lubricated is such that they cannot be properly lubricated. Before the days of the electric light, when engineers had charge of the few steam plants, cut cylinders were unknown, whether lubricated with tallow, which the engineer got from the local butcher as he needed, or not lubricated at all.

When the man who knew about watts and voltmeters, resistance and lines of force came, he it was who specified that the cylinder of the engine should be made smooth, not, as he expressed it, ribbed like a washboard. The smooth-bore cylinder came and brought its troubles with it. Of course, wet steam added to the difficulties of lubrication, for the smoother the surface the less chance the lubricant had to get a foothold. Then came the man with the idea that the oil must be atomized and distributed through the steam. He had his innings and some more cylinders were cut because most of the oil which was atomized went out of the cylinder with the exhaust just as it came in with the steam, in the form of a spray, the most of which never got near the cylinder walls or valve faces at all.

The prime reason for lubricating a cylinder is to reduce the friction of the piston and an oil must be distributed over the surfaces of the rubbing parts to do this work. An oil which is distributed through the steam in the form of spray will not adhere to the walls of the cylinder already wet by moist steam. Neither will the water in the wet steam stick to an oil-covered cylinder. The right way to use cylinder oil is to allow it to run on the inside of the steam pipe to the cylinder, spreading in a film over the entire surface. Water will not adhere to this film but oil will, and if the cylinder is once properly coated with oil no amount of water in the steam will interfere with or hinder lubrication. When the cylinder is bored and the piston fitted the finishing cuts should be taken with a round-nosed tool which will leave a corrugated surface which will hold the oil better and wear longer than the mathematically correct surfaces usually found in modern engines.

Satisfactory cylinder lubrication depends more upon the character of the surfaces and the method of applying the lubricant than upon the quality of lubricant used. The whole subject may be summed up in a few words: The surfaces should not be smooth but corrugated and the oil should be applied to surfaces and not to steam. These two rules followed, any oil free from acid that will not vaporize at the temperature of the steam used, or even tallow from the country butcher, will give a lubrication that will keep a cylinder in first class condition more years than any one engineer should be expected to work.

W. J. Thomas.

Saugus, Mass.

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The editorial under the above caption brings up a subject that is, or should be, of interest to every engineer, for if there is a matter that is given less attention, in the average steam plant, I do not know what it is.

The average engineer is generally content to fill his lubricator when it runs empty, and after setting the feed to so many drops per minute, or to some particular point, designated by a notch cut in the valve wheel, the lubricator is allowed to feed without attention until it again runs empty. If a different grade of oil is bought the same rate of feed is maintained, regardless as to whether the engine requires more or less.

My experience has led me to believe that there are many instances where more cylinder oil is being used than the work of the engine demands, because the engineer has been told sometime or other that six, eight or ten drops of oil were required properly to lubricate a piston and valves.

While running my first engine plant this matter of cylinder lubrication was brought to my attention by noting the oily condition of the ground and pool of water under the exhaust pipe. Common sense told me that the engine hardly required the amount of oil that seemed to have been passed through the cylinder. One night it snowed and crusted over at sunrise. Before night the snow was badly discolored with oil, for a considerable area around the exhaust pipe. Experiments in cutting down the oil were then tried, and the drops were gradually reduced from ten to two per minute, when one of the steam valves indicated by the slight unusual noise that it was not getting enough oil. The feed was then regulated to three drops of that grade of oil per minute, and a saving in cylinder oil was thus made, and equally good results obtained from the engine.

This is a practice I have followed since, and whenever a different grade of oil is used the feeding of the lubricator is watched and the drops fed as the engine demands. On opening cylinders of engines after such treatment they have been found with a polished dark brown surface, which indicates that no wear has taken place between the piston and cylinder walls. By applying the finger or a piece of paper to the walls of the cylinder evidence as to whether sufficient lubrication has been supplied can be obtained. If there is no indication of oil on the finger or paper, a trifle more oil should be fed to be on the safe side against friction and wear.

Excessive oil feeding is also apt to occur with the oil-feed pump, if the engineer does not exercise care in adjusting the oil supply. The hand pump is also another source of waste, as it is no uncommon occurrence to see an engineer lower the oil supply considerably when first starting up an engine, and to keep up the practice at intervals during the run. Naturally there is a reason for this, which is that the engineer does not bother himself as to how much oil is used.

As pointed out in the editorial, conditions have much to do with the amount of oil fed to an engine cylinder. Dry steam has much to do with the problem of cylinder lubrication. If a boiler habitually primes, and many do, the engineer has trouble in getting an oil that will stick to the cylinder walls and lubricate properly. With cylinders in which considerable condensation takes place, helped on by wet steam and a long steam pipe, the same trouble will be experienced.

The experience of no one man will tell all there is to know about this matter of cylinder lubrication, therefore it is to be hoped that a discussion of this subject will be entered upon, so that we may learn from the experience of others.

W. H. Holland.

Pawtucket, R. I.

## Trying to Make Hot Water Run Down Hill

"Bill" Johnson was always considered as wise a fellow as there was in town, but I saw him stumped the other day. He runs a little repairing shop to bore out pumps, etc., and has a shingle stuck out with "Consulting Engineer" painted on it.

"Bill" got a job putting in a hot-water heater outfit. The heater was on the second floor, and we wanted to use it to put hot water over in another building which was some distance off. So they let the job out on bids, and "Bill" bid the lowest and got the job, and at it he went.

Well it was finally finished and a fire built in the heater, but the hot water failed to circulate. After about a week of fooling with no pay, someone told "Bill" that hot water would never run down hill and so he put a heating rig in the basement and things went all right.

When he told his friend, old man Plumber, the old man just laughed and asked how much he paid to find that water wouldn't run down hill when it was hot, and Bill told him about $100. The old man laughed again and said it cost him about that too.

Benjamin Edwards.

Philadelphia, Penn.

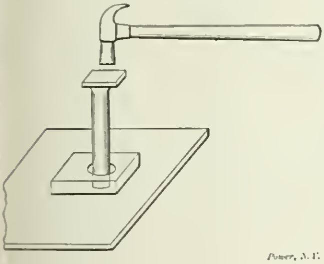
# Some Useful Lessons of Limewater

## A Short Lesson in Analysis, Showing How to Take Some Common Substances to Pieces and Learn How the Ingredients Are Combined

### BY CHARLES S. PALMER

You have probably by this time provided yourself with some good general chemistry, and perhaps with some elementary book on analysis, not to mention some reagents mentioned in the books. And all that is good, but you will learn much by doing some of this for yourself. You will find that the metals are most easily grouped into some seven groups, in which your friend lime is found in the fifth group. I am not going to write a treatise on analysis, but rather I prefer to show how one may take some of the common substances to pieces, with more or less care and accuracy; and how to reason out for one's self something as to how the ingredients are combined. Let us start with a piece of common white marble or limestone.

The first thing to do with any substance is to get it into solution; and in this case it is perfectly easy to do this. You could take either hydrochloric or nitric acid, but as hydrochloric acid is used to test for the metals of the first group we will stick to nitric acid. Take some pieces of marble and pulverize them to a powder. This means that you can buy a mortar, or you can use your ingenuity in devising something which will answer the same purpose. One of the best and simplest contrivances consists of a flat clean plate of iron or steel, several inches square, a large nut, say an inch inside diameter in the clear, and a large round bolt, not much smaller in diameter than the inside of the nut.



Power, N.Y.

FIG. 1

Put the nut on the iron plate and the pieces of marble inside of the nut, and crush the marble with the aid of a hammer and the bolt, holding your hand over the nut to catch the flying pieces of marble. (See Fig. 1.) It is not absolutely necessary to pulverize the marble, but it saves time in dissolving it in the acid. If you put the pulverized marble in a test tube and pour some dilute nitric acid (one part acid to four parts of water) over it, you will note violent bubbling as the acid "cuts" the marble.

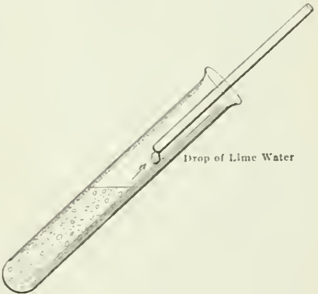
Of course you will want to know what sort of gas it is which is coming off from the action of the nitric acid on the marble; and of course you only have to be reminded of the great possibilities of lime by remembering that a drop of limewater held in the test tube, on the end of a stirring rod, will at once be clouded by the carbonic-acid gas which is coming off. This is shown in Fig. 2. Also, a bit of burning splinter if held in the test tube will be at once put out by the carbonic-acid gas. If you let the mouth of the test tube stand for a moment over a clean and empty tumbler, enough of this gas will collect in the tumbler to cloud a solution of limewater with that same plain carbonate of lime or calcium which you met many weeks ago. By this time your marble has nearly all disappeared in the dilute nitric acid, according to the following equation:

$$\underset{\substack{\text{Calcium}\\ \text{Carbonate.}}}{CaCO_3} + \underset{\substack{\text{Nitric}\\ \text{Acid.}}}{2HNO_3} = \underset{\substack{\text{Calcium}\\ \text{Nitrate}\\ \text{Soluble.}}}{Ca(NO_3)_2} + \underset{\text{Water.}}{H_2O} + \underset{\substack{\text{Carbon}\\ \text{Dioxide.}}}{CO_2}$$

What remains in the test tube is a solution of calcium nitrate, or nitrate of lime. If you plan to let the acid work on the marble so that the acid is completely exhausted, and so that there is still some marble left in the test tube, you will have a neutral solution. Take this test tube of calcium nitrate and put it in a bottle, labeling it "Calcium Nitrate;" note whether the solution is clear or cloudy, and if it is cloudy, filter it until it is perfectly clear.

The first test to make is to see whether or not there is any of the first group present or not, by adding a few drops of hydrochloric acid to a small portion of the solution of calcium nitrate in the labeled bottle. You will get no precipitate; and that means that there is no silver, no lead, no mercury (mercurous mercury), each of which is a metal of the first group. Of course, if you had taken a bit of your solution of silver nitrate, or if you had made a solution of lead by dissolving a piece of old lead pipe in some nitric acid, those solutions would give a cloudiness with hydrochloric acid. Well, this means that you have your friend lime in the form of a nitrate, and that it does not come down in the first group (silver, lead or mercurous mercury).

Remember also that the typical acid solution for the first group is a nitric-acid solution, which you must now change to a hydrochloric-acid solution for the test of the second group. You will make this change by taking about three-fourths of the solution in the labeled bottle of calcium nitrate, pouring it into a beaker or shallow saucer, into which also you will pour some hydrochloric acid, about twice as much as the solution of calcium. Evaporate this down to dryness, and when it is nearly dry, add some more strong hydrochloric acid to the residue, and again evaporate, so that the nitric acid will all be driven off, and the lime and any other metals present will be changed over to chlorides, according to the following equation:



Power, N.Y.

FIG. 2

$$\underset{\substack{\text{Calcium}\\ \text{Nitrate.}}}{Ca(NO_3)_2} + \underset{\substack{\text{Hydrochloric}\\ \text{Acid.}}}{2HCl} = \underset{\substack{\text{Calcium}\\ \text{Chloride.}}}{CaCl_2} + \underset{\substack{\text{Nitric}\\ \text{Acid.}}}{2HNO_3}$$

The point is to have hydrochloric acid in large excess.

The reason for all this is that in the next test you will need to use hydrogen sulphide, a reducer; and if you should lead it into a solution of a nitrate, you would get a useless battle between the reducing action of the hydrogen sulphide and the oxidizing action of the nitrate solution.

Meanwhile, we will suppose that you have already turned back to the chapter on hydrogen sulphide and have made a solution of this evil-smelling gas in water.

which you should label "Hydrogen Sulphide," and keep corked.

Now, turning to the solution of calcium nitrate which you have turned into a solution of calcium chloride by double evaporating with hydrochloric acid, take this up with half a tumbler of dilute hydrochloric acid, pour it into a clean bottle and label it "Calcium Chloride." Then take a bit, say an inch deep, in a separate test tube, and add a few drops of the solution of the solution of hydrogen sulphide, you will get no precipitate, because lime does not come down in this second group (mercuric mercury, copper, cadmium, arsenic, antimony and tin) with hydrogen sulphide. The advantage of taking only a little of the bottled solution of calcium chloride you will appreciate. You had better label each solution and each test tube with a bit of paper poked into the top of the test tube; this will help your memory as you go back from time to time to trace the steps.

Now go on to the third group by adding some ammonia to a bit of the old solution of calcium chloride until it is clearly alkaline when well shaken, testing with litmus and the nose. Keep your eyes open. If you see a little cloudiness here it would not be surprising, because many marbles are not pure, and of the three metals of the third group (iron, aluminum and chromium) iron and aluminum are liable to be found almost anywhere. The iron will show, if present, as a brownish red and the aluminum as a white gelatinous cloudy precipitate. However, the chances are that you will find nothing worth noting in this test for the third group, and if so you will set the test tube aside, labeling it. Then put in another test tube about an inch of the dilute bottled solution of calcium chloride, to which you will add both ammonia to alkaline reaction and also some of the solution of hydrogen sulphide. These two, the ammonia and the hydrogen sulphide, make what is called "ammonium sulphide," according to the following reaction:

$$\underset{\text{Hydrogen Sulphide.}}{H_2S} + \underset{\text{Ammonia.}}{2NH_3} = \underset{\text{Ammonium Sulphide.}}{(NH_4)_2S}$$

Later on it will not be a bad thing for you to make some of this solution of ammonium sulphide by leading some of the hydrogen-sulphide gas into a bottle of dilute ammonia water for half an hour or so, until it smells strongly of both ammonia and hydrogen sulphide, labeling it "Ammonium Sulphide;" this is the reagent for the fourth group (manganese, zinc, cobalt and nickel). But you have just tested for this fourth group, and you got no precipitate, so lime is not in this group, neither is it mixed with any of that group.

Now you are getting close to interesting matters. Going on to the fifth group, calcium, strontium and barium, you take another portion of your calcium-chloride solution (in this case you may as well take two or three inches) in another test tube, and add some ammonia until it becomes alkaline, then some ammonium carbonate, and await the result, which will appear as a decided cloudiness, growing to a good heavy precipitate. While you are waiting for this precipitate to settle, just note that from the third group on, in every case, you have added some ammonia to a strongly acid solution of lime in hydrochloric acid. Now this mixing of ammonia and hydrochloric acid is the same thing as adding to the solution some ammonium chloride at the same time. You will see this from the following equation:

$$\underset{\text{Hydrochloric Acid.}}{HCl} + \underset{\text{Ammonia.}}{NH_3} = \underset{\text{Ammonium Chloride.}}{NH_4Cl}$$

The reason for all this is that in analyzing a solution which may have several metals in the same solution, one must not only throw down each metal in its special group but must also keep other metals from coming down in that group; and the ammonium chloride, which is formed in the third group by adding ammonia to a strong hydrochloric-acid solution, will keep any magnesia which may be present (especially in lime solutions) from coming down in either the third, or the fourth, or the fifth group with lime, for example.

But to go back to the precipitate of ammonium carbonate. You will see that this is your old friend, plain calcium carbonate, only it is made in a way which you have not used before this. It forms here according to the following reaction:

$$\underset{\text{Calcium Chloride.}}{CaCl_2} + \underset{\text{Ammonium Carbonate.}}{(NH_4)_2CO_3} = \underset{\text{Calcium Carbonate Insoluble.}}{CaCO_3} + \underset{\text{Ammonium Chloride.}}{2NH_4Cl}$$

Now you must filter this off very carefully, and you will keep both the white precipitate of calcium carbonate on the filter paper, and the clear filtrate of—what? Let us see.

Make up a solution of one-third ammonium chloride (as by mixing ammonia and hydrochloric acid to neutrality), one-third ammonia and one-third sodium phosphate; this is called the "magnesia mixture." Add some of it to your clear filtrate from the calcium carbonate and let it stand for some time—from ten minutes to an hour, for some of these solutions are slow in coming down. You may or may not get a precipitate from mixing this magnesia mixture with your filtrate from the calcium carbonate; but you are quite likely to find some magnesia with most marble. You will have quite enough to do to turn back and examine the precipitates of calcium and magnesium; but this is enough for this lesson; only, note that instead of using some marble, as most of you will have to do, some of you can easily take some of that vexatious boiler scale (of temporary-hardness water). If you do this, you will almost certainly get some lime in the fifth group, some magnesia in the sixth group, as just described, and you will probably also find some iron and some aluminum in the third group. I will discuss this possibility in the next lesson and in closing this, suppose you cast a careful glance over the short scheme of analysis (see accompanying table) which throws the metals into the seven groups as described above.

SCHEME OF ANALYSIS.

| GROUP I | GROUP II | GROUP III | GROUP IV | GROUP V | GROUP VI | GROUP VII |
|---|---|---|---|---|---|---|
| Precipitated as Chlorides by Hydrochloric Acid | Precipitated as Sulphides by Hydrogen Sulphide | Precipitated as Hydroxides by Ammonia in presence of Ammonium Chloride) | Precipitated as Sulphides by Ammonium Sulphide in presence of Ammonium (Chloride) | Precipitated as Carbonates by Ammonium Carbonate (in presence of Ammonium (Chloride) | Magnesia Precipitated in presence of "Magnesia Mixture" as $MgNH_4PO_4$ Magnesium Ammonium Phosphate | Li. Lithium<br>Na. Sodium<br>K. Potassium<br>$NH_3$ Ammonia<br>$NH_4$ Ammonium<br>Special Precipitants |
| $AgCl$<br>Silver Chloride<br>$PbCl_2$<br>Lead Chloride<br>$Hg_2Cl_2$<br>Mercurous Chloride | $HgS$<br>Mercuric Sulphide<br>$CuS$<br>Cupric Sulphide<br>$CdS$<br>Cadmium Sulphide<br>$As_2S_3$<br>Arsenic Sulphide<br>$Sb_2S$<br>Antimony Sulphide<br>$SnS$ or $SnS_2$<br>Tin Sulphides | $Fe(OH)_3$<br>Iron Hydroxide<br>$Al(OH)_3$<br>Aluminum Hydroxide<br>$Cr(OH)_3$<br>Chromium Hydroxide | $MnS$<br>Manganese Sulphide<br>$ZnS$<br>Zinc Sulphide<br>$CoS$<br>Cobalt Sulphide<br>$NiS$<br>Nickel Sulphide | $CaCO_3$<br>Calcium Carbonate<br>$SrCO_3$<br>Strontium Carbonate<br>$BaCO_3$<br>Barium Carbonate | | |

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## Crude Oil Transformed into Liquid Gas

A Swiss experiment for the transformation of crude oil into liquid gas is reported by the American consul at Zurich to have met with great success. The product is a transportable liquid, which is simply evaporated as used, and can be used for lighting, heating, cooking, soldering and welding purposes. The gas is nonpoisonous, while its installation cost is said to be low, and manipulation simple and without danger.

---

On the afternoon of July 12, the flywheel at the plant of the Clatsop Mills Company, Astoria, Ore., burst and did considerable damage to the plant, but no person was injured.

# Single Phase Motors with Commutators

By R. H. Fenkhausen.

In last week's article, single-phase alternating-current induction motors were described, with the various methods commonly used to start them up from standstill. This article tells about single-phase motors provided with commutators similar to those used on direct-current machines. These are of two general classes, the repulsion type, in which the magnetic reaction of the armature or rotor winding against the field magnetism produces motion, and the series type, in which the field winding is connected in series with the armature, just like a series-wound direct-current machine. Both types have armature windings like a direct-current machine and both are self-starting; therefore hey do not require any "phase-splitting" levices.

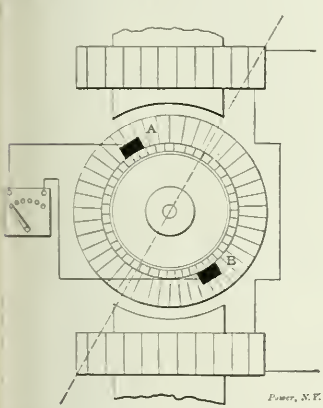

FIG. 1 REPULSION TYPE OF SINGLE-PHASE MOTOR

The repulsion type of single-phase motor is illustrated in Fig. 1. The stator winding is of the distributed type, although a pale winding is shown in the rawing, for simplicity. The rotor or rmature is equipped with an ordinary direct-current winding. This motor resembles the induction motor in the respect that there is no electrical connection between the field and armature, the rushes *A* and *B* simply serving to short-circuit a few of the armature coils situated so that the current induced in them by he field will exert a powerful torque. A still better torque is obtained by connecting the brushes either directly or through an adjustable rheostat by means of which he starting current may be regulated. The starting torque of this type of motor s so great that no type of clutch pulley s required to start the load and one source of trouble is thus eliminated, but the motor possesses the disadvantage that only a small proportion of the armature winding is available for driving the load at any one time, as it is only the coils which are short-circuited by the brushes that exert any torque. This type of motor may be reversed by shifting the brushes to the position indicated by the dotted line in the drawing.

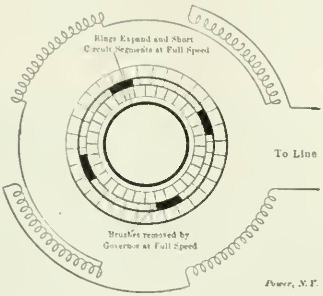
Rings Expand and Short Circuit Segments at Full Speed
To Line
Brushes removed by Governor at Full Speed
Power, N.Y.

FIG. 2. WIRING DIAGRAM OF WAGNER MOTOR

As the repulsion motor has varying speed characteristics, it is not adapted for constant speed service, but in the Wagner motor the powerful starting torque of the repulsion motor has been combined with the constant speed feature of the induction motor. In this type, the electrical features of which are represented by the diagram, Fig. 2, the machine runs up to speed as a repulsion motor; the commutator is then short-circuited by a centrifugal governor, which simultaneously lifts the brushes and prevents unnecessary wear of them and the commutator. The motor then runs as a single-phase induction motor, but in case the current is shut off, it automatically changes to a repulsion motor and will start with its load automatically when current is again turned on. The Wagner motor may be reversed in the same manner as was described in connection with the plain repulsion motor of Fig. 1

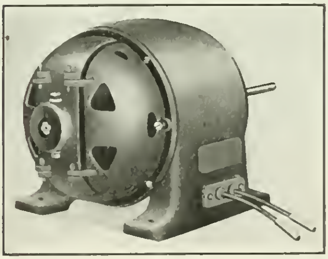

FIG. 3. NEW SINGLE-PHASE MOTOR

A type of single-phase motor possessing many advantageous features has recently been placed on the market by the General Electric Company. It is similar in appearance to a direct-current motor, (see Fig. 3), but is of the repulsion-induction type, possessing all the characteristics of the plain repulsion motor. It is provided with an extra pair of brushes connected to a compensating winding, as shown in Fig. 4. With all four brushes in place the motor operates at practically constant speed and has a good starting torque. If the brushes *C* and *D*, connected to the compensating winding are lifted from the commutator, the starting torque is increased but the constant speed feature is lost, and the no-load speed of the motor becomes excessive. It is therefore not advisable to use a belt drive with this motor unless the compensating brushes are in place. The motor may be run as an adjustable-speed machine by connecting rheostats in the leads to the brushes, as indicated in the diagram. Speeds below synchronism are obtained by means of the rheostat connected between the brushes *A* and *B*, which gives results similar to those obtained in a direct-current motor by putting a rheostat in the armature circuit. This rheostat may also be used to decrease the starting current of the motor. Speeds above synchronism are obtained with the rheostat connected in the compensating circuit, and when so connected, the results are similar to those obtained with a direct current motor by adjusting the shunt field excitation. To reverse the motor, shift the brush yoke to the other side of the center line and interchange the compensating brush leads if in use; if running without compensating brushes simply shift the yoke.

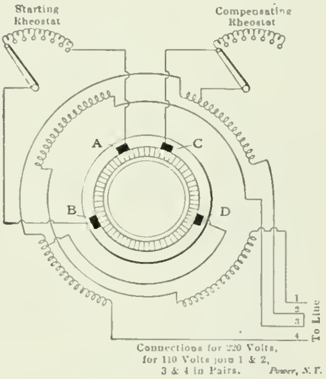
Starting Rheostat
Compensating Rheostat
A
C
B
D
1
2
3
4
To Line
Connections for 220 Volts, for 110 Volts join 1 & 2, 3 & 4 in Pairs.
Power, N.Y.

FIG. 4. CONNECTIONS OF MOTOR SHOWN IN FIG. 3

The series type of single-phase motor is coming into extensive use for hoisting and railway work, but in order to obtain satisfactory operation various changes were necessary to adapt series motors for single-phase current. The operation and direction of rotation of a series motor are independent of the direction of current flow in the motor circuit as a whole; it is necessary to reverse either the field r the armature leads alone to reverse the motor

If a reversing switch were connected in the circuit supplying a direct-current motor, and this switch were operated about 60 times a minute, no material difference would be noticed in the operation of the motor, although it would be operating on an alternating current of one-half cycle per second. This current would, of course, not be a true alternating wave, but the illustration is given to show that it is only when the higher frequencies commercially employed are used that radical changes are necessary in the design of the motor. It is, of course, essential that the entire field magnet be laminated, because of the rapid reversals of the magnetism. The first difficulty in series motor construction for alternating-current work lies in the self-induction of the field winding. In order to reduce the choking effect of the field as much as possible, comparatively few turns of wire must be used in the coils. Commutation was the greatest source of trouble in early alternating-current, series-wound motors. Fig. 5 shows that the armature coil short-circuited by the brush is in the neutral zone, and in a direct-current motor no sparking would occur. When alternating current is applied to the motor, a heavy current is induced in the short-circuited coil by the reversals of magnetism in the core. This would cause heavy sparking, and as the brush position obviously could not be altered, the sparking was reduced by reducing the short-circuit current. In modern motors this is accomplished by connecting the armature coils to the commutator through resistance leads, as shown in Fig. 6. The working current of the motor flows through two leads in parallel and the resistance causes no great loss. The short-circuit current, however, is compelled to pass through two leads in series, and the resistance of the two leads reduces the current to a low value.

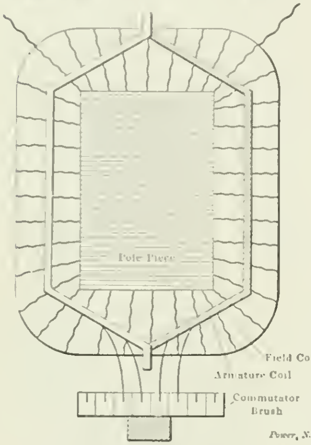

FIG. 5. ARMATURE COIL SHORT-CIRCUITED BY BRUSH IN NEUTRAL ZONE

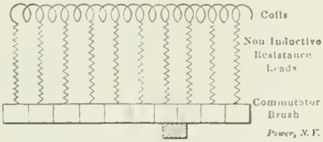

FIG. 6. METHOD OF REDUCING SHORT-CIRCUIT CURRENT

Besides the changes noted many minor improvements have been made resulting in a motor equal in performance to the direct-current machine, and one which may be run on either direct-current or alternating-current circuits, provided the frequency of the latter does not much exceed 25 cycles. For 60-cycle circuits the series motor can hardly be pronounced a commercial success, as yet, and for such circuits one of the types of motor previously described should be used.

## N. A. S. E. Joint Meeting in San Francisco

About 125 members of California Nos. 1 and 3, N. A. S. E., of San Francisco, assembled at a joint meeting at the rooms of No. 1, on July 29, to receive the final report of the general committee of arrangements on the convention and mechanics' fair, which was held at the Auditorium during the week of June 14 to 19, the unqualified success of which caused the members of the N. A. S. E. to commemorate in a fitting manner the conclusion of the committee's herculean labors, which have proved to be of incalculable benefit to the association in San Francisco.

After the routine business was disposed of, 27 candidates were ushered into the lodge room and were initiated by President A. C. Arbuckle, assisted by Vice-President Phil Ennor. Upon the conclusion of this ceremony, Chairman Phil Ennor of the general committee read the final report, after giving a short history of the labors of the committee. The report stated that the total sum taken in from all sources amounted to $4832.40; total expenditure, $3459.62; balance, $1272.78 to be divided between the two associations, leaving each the sum of $636.39.

A check for that amount being handed to the financial secretary of each association, President Arbuckle then called on William P. Millner, past president of No. 3, formally to discharge the committee from its duties, which he did, as far as pertained to convention matters, but he expressed the hope that the committee would retain its entity, as so efficient a body of men would be extremely hard to duplicate. Past President J. W. Maher of No. 1 then discharged the No. 1 contingent of the committee, expressing feeling terms the association's apprec tion of the committee's work.

The entire assemblage then adjourn to the banquet hall, where the recept committee had prepared a luncheon, gether with a musical program, wh were very much appreciated.

Toastmaster Dan Daniels stated the ject of the gathering, which was to honor to the committee and incidenta to initiate the large number of candida in a fitting manner. He extolled the w of the committee in an earnest man and stated that the members of the N. S. E. were proud of the fact that th fellow craftsmen could carry to success termination such a great undertaking. M Daniels then called on a number of members, who responded in a fitting ma ner, the musical program being render between speeches.

Among the speakers was President H. Ewell, of International Union No. who had just been initiated. Mr. Ew expressed in warm terms his pleasure being enrolled in this great educatio order and stated that the barrier betwe the union and the N. A. S. E. had be obliterated and that they were both co posed of engineers and as such were b banded by a common interest, educati

Past State President H. D. Saville al spoke of the feeling of fellowship a harmony which now existed among t engineers and outlined their duties towa each other in his usual lucid manner.

Vice President P. L. Ennor then pr sented to the retiring secretary, A. Peery, of California No. 1, a handso gold charm and fob as a token of a preciation from the members of No. for his untiring zeal for the welfare the association during a long term years. Mr. Peery was taken by surpri but responded with a few words of than which were received with hearty a plause.

Chairman Daniels then presented each association a frame in which we the photographs of all of the membe of the committee, with their names su ably engrossed. These frames were r ceived by the presidents of each associ tion, with thanks. The members disperse at 11 p.m., and all agreed that the joi meeting was a great success.

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A treatise on Indiana coals for the r port of the Indiana State geologist, whi will be issued about September, has be prepared by George H. Ashley, Unit States Geological Survey. He sees in t producer-gas industry a great opening f the low-grade coals of that State, whi until recently have been regarded as pra tically valueless. He says: "It has be plainly demonstrated that not only t medium-grade coals of the Mississip valley can be successfully used, but ev the lignites and peats."

## Universal Craftsmen's Convention

The seventh annual grand conclave of the Universal Craftsmen, Council of Engineers, met at Washington, D. C., August 2 to 6. There were seventy delegates present. The National hotel was the headquarters.

On Monday morning at ten o'clock, the convention was formally opened by the chairman of the local committee, Lewis Jones, who in a brief address introduced Hon. Henry B. F. Macfarland, president of the board of commissioners of the District of Columbia. Mr. Macfarland's address was responded to in fitting manner for the engineers by Grand Worthy Chief William J. Ranton and Herbert E. Stone of the Dearborn Drug and Chemical Works.

There were many entertainment features connected with the convention, including trips to places of interest about the city, the chief event being a steamboat excursion to Mount Vernon, visiting the tomb and home of George Washington.

On Thursday evening an enjoyable entertainment was given in the convention hall, by the New York "Bunch," who were ably assisted by Miss Robinson, William Taylor, Miss R. Jones, L. W. Potter, Jr., and Miss E. Murray.

The firms exhibiting were: Safety Cylinder Valve Company, F. W. Webb Manufacturing Company, Jenkins Brothers, V. D. Anderson, Garlock Packing Company, National Electric Supply Company, Peerless Rubber Manufacturing Company, Dearborn Drug and Chemical Works, Lunkenheimer Valve Company, Lagonda Manufacturing Company, POWER, John Adt, Griscom-Spencer Company, McVey Company and W. B. McVicker Company.

At the closing session the following grand officers were elected for the ensuing year: Walter S Cadwell, worthy chief; John Cope, assistant worthy chief; Thomas H. Jones, secretary; A. K. Young, treasurer; James N. Bunce, warden; H. C. Seure, guard; A. M. Wickens, chaplain; Benjamin Dettleback, N. G. Carney and John MacMorris, trustees.

The next meeting of the grand council will be held at Buffalo, N. Y., early in August, 1910.

DELEGATES AND GUESTS AT UNIVERSAL CRAFTSMEN'S CONCLAVE, WASHINGTON, D. C., AUGUST 2-6, 1909

## A. O. S. E. Field Day

The second annual outing and field day of the American Order of Steam Engineers, of Philadelphia, was held at Washington Park grove, Camden, N. J., on Saturday afternoon, August 7. A large delegation of the members and friends, which included a generous number of the fair sex, took advantage of the pleasant sail on the Delaware river to the grove.

Outdoor sports of all kinds were indulged in, the most interesting attraction being the baseball match between the Blue Ribbons (engineers) and the Pink Garters (supplymen), which resulted in a victory for the engineers, after an enjoyable contest, the score being 10 to 3. A valuable prize was awarded the winner in each event, the lucky baseball team receiving a handsome silver cup.

The occasion was voted a most enjoyable one, and the day's fun was due to the efforts of the following committee: J. H. Holand, C. P. Williams, William Pairent.

POWER
AND THE ENGINEER

DEVOTED TO THE GENERATION AND
TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT McKEAN, Sec'y.

505 Pearl Street New York
355 Dearborn Street Chicago.
6 Bouverie Street London, E. C.

Correspondence suitable for the columns of POWER solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "POWPUB," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During 1908 we printed and circulated 1,836,000 copies of* POWER.

*Our circulation for July, 1909, was (weekly and monthly)* 141,000.

*August* 3 ........ .... 42,000
*August* 10.. .. .... 33,000
*August* 17 . ..... .. 33,000

*This paper reaches* 42,000 *separate readers each month and* 33,000 *each week.*

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*

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## Small Leaks Count

Instances are found in engineering practice which indicate that, although the engineer is desirous of operating a steam plant economically, he begins at the wrong place, and neglects some of the things that it is absolutely essential to remedy if his aims are to be fully realized.

"Robbing Peter to pay Paul," as the saying is, amounts to nothing; but "Robbing Peter and not paying Paul" is worse. Hunting for leaks where none exists and allowing visible leaks to continue will never produce economy. The reason why most of the wasteful plants exist is due to the engineers' lack of understanding of the significance of the minor causes of power and steam losses.

Much has been said and written about boiler efficiency, combustion, heat units in coal and how to obtain the highest evaporation of water per pound of coal; but of what use is all this if the steam is allowed to escape through numerous leaks, so that even if the conditions in the boiler room were ideal the losses overbalance the refinement of boiler-room operation and produce on the whole a wasteful plant?

Loss of steam and water is mainly traceable to leaking valves. It is no uncommon thing for an engineer to enter the boiler room in the morning and find the water showing in the glass below the bottom gage cock. He does not understand where it has gone, for the boiler had been filled not only to the third gage when shutting down the night before, but even to the top of the glass. The disappearance of the water is easily accounted for, and can be traced to a leaky blowoff valve, leaking valves to various steam-pipe lines or a leaking safety valve.

In the first instance the water in the boiler wastes past the valve to the sewer or underground waste pipe. Because the end of the blowoff pipe is not visible, the engineer does not know whether the leak is a large or small one and, therefore, does nothing to remedy the matter.

If a blowoff pipe is hot outside the valve it is a sure indication that the valve is leaking and should be attended to at once. As a safeguard against such leakage two valves should be placed in the blowoff pipe.

Leaking valves in pipe lines are another source of considerable loss. In one plant the heating pipes throughout the factory were connected to a header in the engine room, which was so connected that either live steam from the boiler or exhaust steam could be used. Each heating line had a valve next to the header. The engineer upon taking charge of this plant found less than one gage of water showing in the glass each morning and an examination of the blowoff valve showed that it was tight. Further investigation showed that most of the valves on the heating-system pipes were leaking, due to broken disks and cut seats. When they were made tight there was no more trouble from low water in the morning.

In another plant the safety valve was in a leaking condition, so much so that a good sized cloud of steam could be seen escaping day and night. The engineer of this plant had difficulty in maintaining a proper water level over night, but when the valve was made tight this difficulty disappeared.

In the instances mentioned it was not merely the fact that the boilers were found with low water each morning, but the same loss would occur each working day and in some cases double the amount, due to the high steam pressure carried when running. Such losses must be made up and the coal necessary to evaporate the amount of water that would occupy twice the volume in the boiler represented by the distance between the top and bottom of the gage glass and the length of the boiler would be saved each day in the year if the valves were kept tight.

It does not appear to amount to much, but suppose you figure it out, using your own boiler as a basis for calculation, and the result will be a surprise to you and cause a commotion in the office if the management "gets wise."

## Cooling the Exhaust of a Gas Engine

In the Letters department of this issue will be found an interesting communication in which one of our readers points out the fallacy in attempting to effect a large increase in economy by cooling the exhaust gases of an internal-combustion engine. While our correspondent evidently appreciates the real distinction between gas-engine and steam-engine conditions, he does not "point it" quite as broadly, perhaps, as some of the younger readers might desire.

The whole reason why it is impossible to get anything like the same economic results by condensing the gas-engine exhaust as by condensing exhaust steam is that steam at, say, twenty pounds absolute pressure in condensing to water shrinks to much less than one-thousandth of the volume which it occupied as steam, while exhaust gases, even at one thousand five hundred degrees Fahrenheit, absolute would shrink only to one-third their exhaust volume if cooled to seventy-three degrees, thermometric temperature. It i the enormous shrinkage of the steam i condensing which makes the increase i economy worth the expense of condensation; on the other hand, the shrinkag of exhaust gases by cooling is not grea enough to justify any appreciable expens for the cooling of them.

Our correspondent is not entirely righ in intimating that condensing without th use of a "vacuum" pump would not theo retically produce a gain in the economy of a steam engine. If it were not for the air that leaks into the system and is entrained in the steam, a surface condenser could be made to operate without any air pump and would increase the economy of the engine. The controlling reason for the gain due to condensing is the shrinkage of the steam. Of course, going still farther back, the foundation of the gain in economy is the extension of the temperature range through which the engine works, but that is a question of thermodynamics which need not be discussed in order to make clear the difference between gas-engine and steam-engine conditions with reference to "condensing."

## National Boiler Inspection Law Desirable

Comparisons are odious, but it is sometimes impossible to avoid making them when the results of the different methods of treating the same problem that obtain in different industries is forced upon the attention. In the United States during the past ten years there have been killed an average of three hundred persons per year, and over five hundred injured, by the explosion of stationary boilers, while the annual average number of injuries resulting from the failure of locomotive boilers has been less than ten, and the number of fatalities was fifty-five for the entire period.

In the matter of destruction of property no comparisons can be made, as the difference is practically beyond comprehension. There is no reason why stationary boilers should be less safe than locomotive boilers and the almost inconceivable differences in property destruction, injuries and fatalities can only be ascribed to one cause, that of inspection. It is, or should be, well known by every one directly or even indirectly connected in the remotest degree with the use of steam boilers that the almost total immunity of locomotive boilers from explosion is due to the fact that the railway managements of the country insist upon complete, careful and intelligent inspection.

This proves as nothing else can the necessity for the enactment and enforcement of adequate inspection laws in the United States.

One of the States which has laws that leave little to be desired in the matter of boiler construction, installation and inspection is Massachusetts, where new boilers of the lap-seam type above thirty-six inches in diameter are forbidden entry into or use in the State, and the installation of boilers of this type which were in the State prior to the passage of the act is so regulated that it is practicable to use them for low-pressure heating purposes only. It is to be hoped that other States will follow Massachusetts in matters of legislation which are founded on an attempt to make the operation of steam boilers devoid of danger to life and property

## $CO_2$ Again

In a recent issue there was published an article dealing with the question of increasing the percentage of $CO_2$ in the furnace gases escaping to the atmosphere, the increase amounting to a saving of $6500 per year in a steam plant of 8400 horsepower capacity, or practically 77.5 cents per horsepower per year.

This amount saved per horsepower may seem small, but with a 100-horsepower boiler the saving would amount to $77.50 per year. The greater number of boiler plants contain two or more boilers, therefore it is well worth while for the engineer in charge to look more thoroughly into this matter of $CO_2$ in the furnace gases.

It is not a dry subject, as many imagine; it is not a difficult one to understand, although there are a good many conditions to conform to before one can obtain a gas analysis showing the highest per cent. of $CO_2$. It is these elements that make the subject of interest to the one who is striving to produce the greatest economy in the operation of his boiler plant.

A steam-engine indicator will reproduce on a piece of paper certain lines which indicate to the engineer, who has the knowledge for reading the true meaning of those lines, the actual occurrences in the engine cylinder. The indicator has become so common that where a few years ago one man was able intelligently to read a diagram, today there are hundreds, and no one thinks it at all wonderful.

When it comes to an indicator for determining the performance of a boiler furnace it seems to be a "cat of another color," and engineers do not take kindly to it.

Now the method of indicating a furnace is no more difficult to understand than indicating an engine, and is just as important. If entering a horse in a 2 10 trotting race, one would not, for one moment, think of allowing one of the wheels of the gig to work hard and spend all his care and wheel grease on the other. But it would be just as sensible as to spend hours indicating an engine, setting and resetting valves, getting rid of friction here and there, and not give the furnace a thought. This is just what is being done in a lot of instances and everybody concerned seems to be satisfied

The adage "half a loaf is better than no bread" may apply to some cases, but it does not in steam-plant practice, where practically the whole loaf may be had. Do not be satisfied with a smooth-running and economical engine, but see that the best results are being obtained from the fuel in the furnace. This can be done by so operating the air supply that the highest average $CO_2$ is obtained through the working day.

For example, take a well-set boiler; how is one to know how much excess air is permitted to enter the furnace, combustion chamber and smoke uptake? There is no method of determining this other than by testing the gases escaping up the stack, and that by analysis. How can one tell whether an excessive amount of air is being admitted to the furnace through the grates and furnace doors if the escaping gases are not indicated for $CO_2$? The appearance of the stack cannot be used as an indication, although it can, and does, indicate the pressure of CO and other combustibles. One might as well attempt to tell the condition of the valves of an engine by shutting one eye and stroking the left ear with a rabbit's hind foot, as to attempt to tell the percentage of $CO_2$ without a proper analysis of the escaping gases.

The day is here when engineers must know more about flue gases and how the low percentage of $CO_2$ means a loss in furnace efficiency.

## American Society of Engineering Contractors

The *Journal* of the American Society of Engineering Contractors, Vol. 1, June 1, 1909, has come to hand. It contains the constitution and list of members, besides the proceedings of the first meeting of the society. The objects of the society are the advancement of engineering knowledge and contracting practice; the maintenance of a high professional standard among its members; the elimination of those practices and abuses that now exist in the engineering and contracting business; and to strengthen the bond that should exist between engineers and contractors.

A member shall be either an engineer, a contractor, a manufacturer of materials and equipment used in engineering construction or persons engaged in allied businesses. A member shall have been engaged in his particular line of work for at least seven years. Graduation from a school of engineering of recognized reputation shall be considered as equivalent to two years' active practice. There are also associate and honorary members.

The society, which was organized last April, has already a large membership in the United States and Canada. Beginning in November next, meetings will be held monthly. The headquarters are in New York City, but branches will be established from time to time The first annual convention will be held at Chicago, Ill., February 24, 25 and 26, 1910. The secretary is Daniel J. Hauer, Park Row building, New York City.

# Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

## "Ideal" Automatic Controlling Valve

Several of the various designs of automatic-controlling valve manufactured by the Ideal Automatic Manufacturing Company, 125 to 129 Watts street, New York City, are illustrated and described herewith. Fig. 1 shows an automatic-pump governor, known as "style A." This governor has an oil-control piston actuated by a pressure-controlling valve for governing pumps working under a specified pressure. With the slightest leak in the pressure line the governor will immediately start operating the valve, thereby supplying steam to the pump. Its operation is as follows:

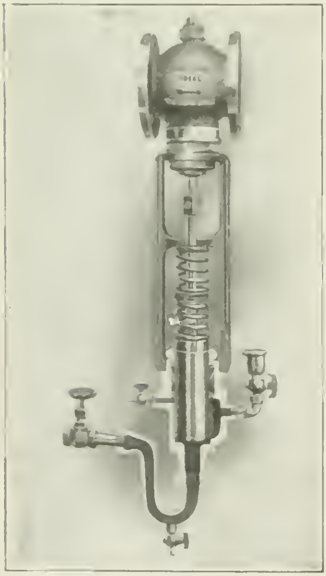


FIG. 1. "IDEAL" AUTOMATIC PUMP GOVERNOR

The pressure rising in the standpipe and against the body of oil in the trap and the water-pressure cylinder compresses the oil against the piston, which causes it to move upward against the tension of a spring, and when the pressure becomes equal to the tension at which the spring is set, the steam-throttle valve on the pump is closed, stopping the pump, in which position the pump remains until the pressure on the standpipe or line is released. The pressure then being decreased, the spring forces the piston down against the body of oil, thereby opening the throttle valve and starting the pump; this operation being repeated as many times as the pressure in the line is changed. At the bottom of the oil trap of the governor is a pet cock to blow off any dirt or sediment that may collect.

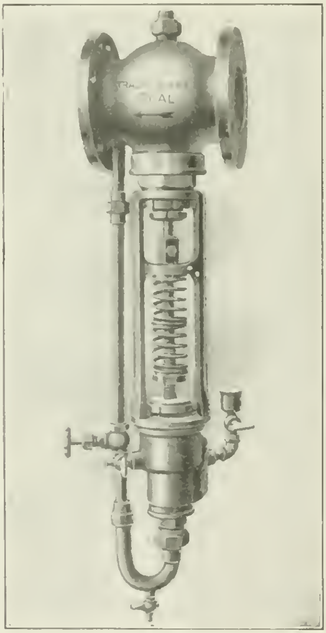


FIG. 3. "IDEAL" PRESSURE-CONTROLLING VALVE

The device is simple. There are no diaphragms nor leather cups used. It is easily adjusted and is extremely quick in action. As it is automatic it requires no attention and prevents excessive pressure in the water main.

Another type of control valve is shown in Fig. 2, termed "style B." This valve has been designed for use on hydraulic apparatus where decidedly different pressures are required for different kinds of work. It is designed on the same lines as the type already described, but gives a greater range of pressure than is possible with a single spring-operated piston. With this type of governor, if a low pressure is needed the low pressure spring is in action; if a high pressure is required, the high-pressure spring is brought into play by the lever tension on the high-pressure spring compounding or bringing into action both springs until the desired pressure is obtained.

A feature of this valve is that in case of accident to the apparatus being handled, it can be used as a stop valve by reversing the lever to an upward position on the quadrant, thus bringing the lever into contact with the flange nut on the valve stem proper, shutting off the steam valve and stopping the pump. The pump will stand in this position until the lever is shifted to the low-pressure or such position on

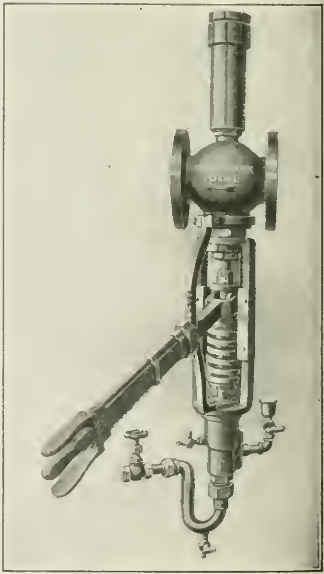


FIG. 2. "IDEAL" COMPOUND-PRESSURE PUMP GOVERNOR

the quadrant that the low-pressure spring is in operation, and again by shifting the lever in a downward movement on the quadrant to any desired position for any pressure by bringing into operation the high-pressure spring.

"Type C," shown in Fig. 3, is designed for use on lines carrying high pressure and requiring a reduction of pressure.

As shown, a bypass pipe is connected from the main valve to the pressure cylinder, and the pressure, backing through this pipe to the oil chamber, forces the piston in an upward direction against the pressure of the spring, the tension of which is adjustable.

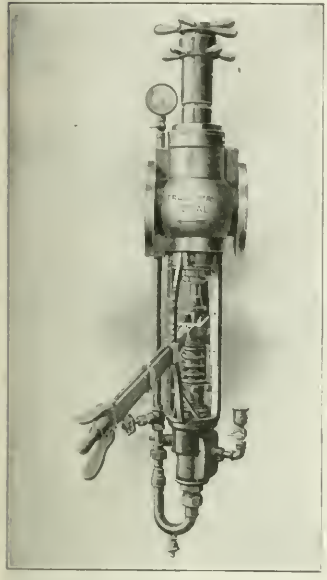


FIG. 4. "IDEAL" HIGH-PRESSURE CONTROLLING VALVE

Fig. 4 shows "type D," which is adapted for use on high-pressure mains where the water pressure at the nozzle can be varied to suit conditions. By using the gage shown, any pressure desired may be obtained by regulating the lever to bring into action either or both springs.

## Two New Hydraulic Jacks

The new Watson-Stillman shop jack, illustrated in Fig. 1, is made in eleven sizes, of from 20 to 50 tons capacity and lifts of 12 and 18 inches.

The wheels on the base and the handle on the cylinder facilitate moving the jack quickly from one place to another. As the wheels touch the floor only when the jack is tilted, they are never in the way during the lifting operation. If it is desired to use the jack at an angle it can be tilted in the opposite direction to the wheels, and when it is laid flat upon the side, the ram will push out its entire lifting length. The head is enlarged sufficiently that the jack will not stop working for lack of filling, even if there has been slight leakage. An independent steel claw (not shown in the illustration) can be used when desired for lifting from near the ground. The jack is made of steel, and the parts under greatest strain, such as the ram and cylinder, are machined from a solid bar of high-carbon steel.

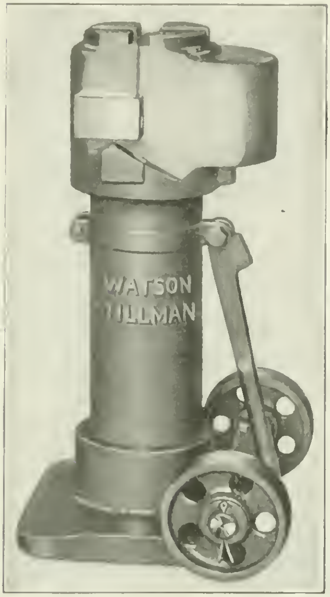


FIG. 1. NEW SHOP JACK

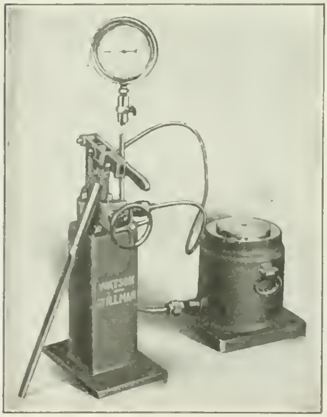


FIG. 2. INDEPENDENT PUMP HYDRAULIC JACK

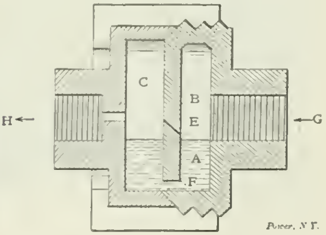
The independent pump hydraulic jack shown in Fig. 2, is made in 53 sizes, of from 2 to 1200 tons capacity. The various sizes of the jack proper have maximum ram movements of from 4 to 8 inches. The pump is connected to the jack by means of flexible-copper tubing, which may be of any length suitable to the work in question. The jack may be operated up to a pressure of 450 pounds per square inch on the ram by means of the hand lever shown on the pump, and further worked to full capacity by means of the extension lever. The gage may read in pounds per square inch, or in tons load upon the jack, or both. When equipped with the gage, the jack may be used between two fixed platens for making compression tests, testing the tightness of forced fits, etc.

Both of these jacks are made by the Watson-Stillman Company, of New York.

## "Union" Trap

The "Union" trap is constructed as a union, the male side being made with a chamber *A*, and when in connection with the female side the partition *B* divides the trap into two chambers *A* and *C*. Two ports *E F* connect these chambers, the lower port being the larger and at the lowest level of the two chambers; the other connects the two chambers from two different levels.

The water and steam enter from the radiator at *G*, and the water level soon closes the port *F* to the direct passage of the steam, the small port allows the steam to pass from the chamber *A* to the chamber *C*, and equalizes the pressure on the entrapped water. This steam passes from the chamber *C* to the return line at *H*, in which a vacuum is maintained, and vaporizes before it can destroy the vacuum. The water level then rises until it seals the port *E* in the chamber *A*, shutting off the supply of steam to the chamber *C*, when an unequal pressure is formed. The water level in *A* drops and rises in *C*, being drawn out into the return line. When the level of the water in the chamber *A* has dropped sufficiently to open the port *E*, the steam short-circuits the seal and equalizes the pressure and the seal returns to a level common to the two chambers, still sealing the port *F*.



CROSS SECTION OF "UNION" TRAP

This action is so frequent that the discharge is in the form of a heavily saturated vapor and does not affect the vacuum. The trap is made in several models to economize space and do away with numerous fittings. It was designed by W. O. Wheeler, 278 Park avenue, Worcester, Mass.

# The Rothchild Engine Valve

The latest, and what is claimed to be the only successful, solution of the problem of a continuously rotating steam-engine valve, which will give economical steam distribution and a sharp cutoff, and allow of a simple and practical reversing gear, is found in the steam engine valve now being introduced by the Rothchild Engine Company, 102 Center street, New York City. Compared with the steam-engine valve familiar to the engineer, a fundamental difference is noticed. Instead of performing functions of admission, cutoff, release and exhaust closure by reciprocating over and past the port openings in the valve seat, it rotates continuously in the same direction as the engine shaft, and reversal of direction of rotation is obtained by a change in the inclination of the cutoff valve, which is free to oscillate inside the main valve.

Joseph Rothchild, mechanical superintendent of the company, invented this valve, which is a cylindrical sleeve with its axis parallel to the engine shaft, with openings or ports for the admission and release of steam 120 degrees apart. Placed directly on the cylinder, the valve chest forms the cylinder head, and with its short steam passages reduces clearance to the minimum. As the valve is not reversed at each stroke of the engine and makes but one-third as many revolutions as the engine, it is claimed that wear will be slight. The valve-driving mechanism is simple, being a chain-and-sprocket arrangement with a three-to-one reduction, leading directly from the engine shaft to the valve spindle. Provision is made for taking up the wear of the chain in such a way that the relation of the valve to the piston is not changed, and any amount of chain stretching will not alter the valve setting.

Fig. 1 is an exterior view of the engine. In Fig. 2 are shown sectional views of the valve, with its three equidistant ports, which serve both for admission and release under control of the oscillating cutoff device. Compression is independent of cutoff and occurs always at the same point in the stroke and is slight. In Fig. 3 are shown sectional views of the cylinders of a four-cylinder engine, with the position of the valve in four stages of the valve cycle. View I shows the beginning of the admission; III shows expansion following cutoff; II shows the beginning of exhaust, and IIII shows just before compression begins. The valve is surrounded by a casing which, being one piece with the head, has an opening into the cylinder equal in width to the distance between the ports in the valve. Inside of the valve is the piece called the cutoff, which is approximately shaped like a letter D, with a part of the back cut out, and with the convex side toward the cylinder. This piece separates the live-steam space from the exhaust space.

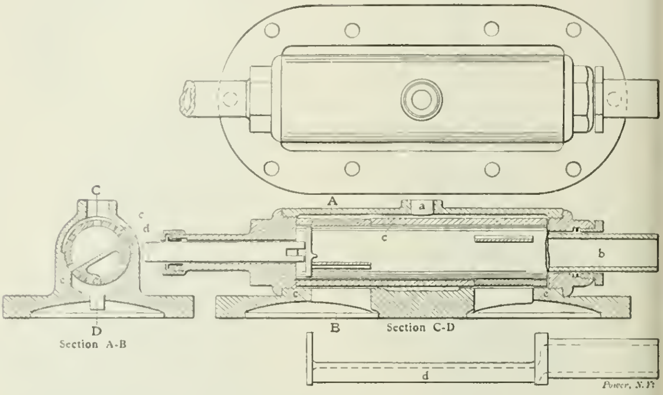


FIG. 2. DETAILS OF THE ROTHCHILD VALVE

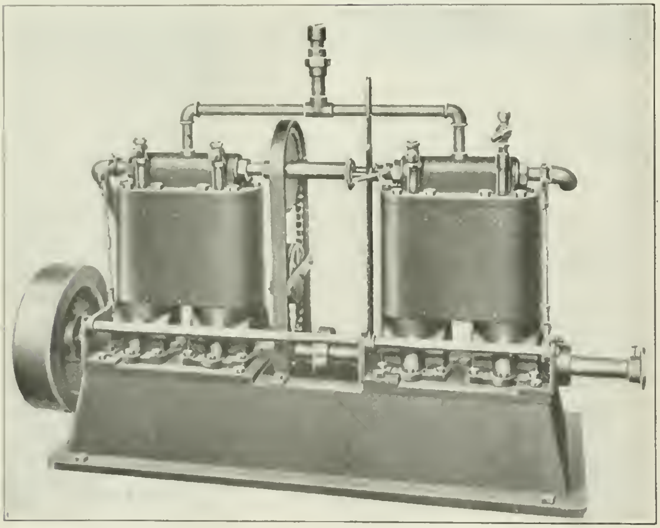


FIG. 1. EXTERIOR VIEW OF ROTHCHILD ENGINE

Referring to Fig. 2, the steam inlet is at *a*; the exhaust outlet at *b*; *c* is the valve; *d* is the cutoff; *e* is the casing. The cutoff has a rocking adjustment, so that it can be rotated about 60 degrees in either direction, and by its position determines the speed and the direction of rotation of the engine. Steam being admitted through the valve casing from above, the steam passes through one or both of the otherwise idle ports to the interior of the valve, and by the greater area offered the downward pressure the valve is held firmly on its seat in the casing, making it self-compensating for wear. Similarly, the greater pressure on the flat side of the cutoff valve holds that member in close contact with its seat, so that in the whole mechanism there is little or no chance for leakage.

As shown in Fig. 2, the valve proper has a hub extension, through which the rotary motion is imparted. The opposite end of the valve casing contains an extension of the cutoff member, through which exhaust takes place. The quill extension of this piece has attached to it a rocker arm, which is connected by a link to a second rocker arm on the rock shaft with the controlling lever. This one lever gives entire control to the engine. In its central position the cutoff valve is horizontal and the engine is stopped, while by the movement of the lever to either side the engine may be started in the corresponding direction and at a speed depending upon the extent of the throw of the lever and the load, as the greater the throw of the lever the longer is the period of admission, while from an examination of the engine on exhibition it would seem that it would be especially adapted to hoisting and yacht engines of the single-acting type. It is claimed by the manufacturer that it is equally well adapted to double-acting engines of all types, stationary, marine and locomotive.

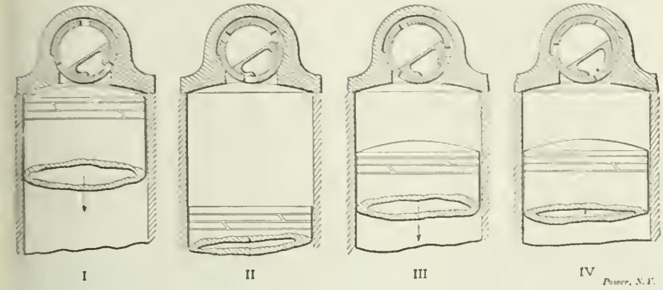


FIG. 3. DIAGRAMS OF THE RELATIVE POSITIONS OF THE VALVES OF THE FOUR-CYLINDER ENGINE

An example of the effectiveness of the control lever was shown in the demonstration of the exhibition engine; the lever was repeatedly thrown from full gear forward to full gear backward, with the throttle wide open, and the engine instantly reversed, without shock or jar. In case the engine is to be operated at a constant speed under variable loads this lever can be controlled through a governor.

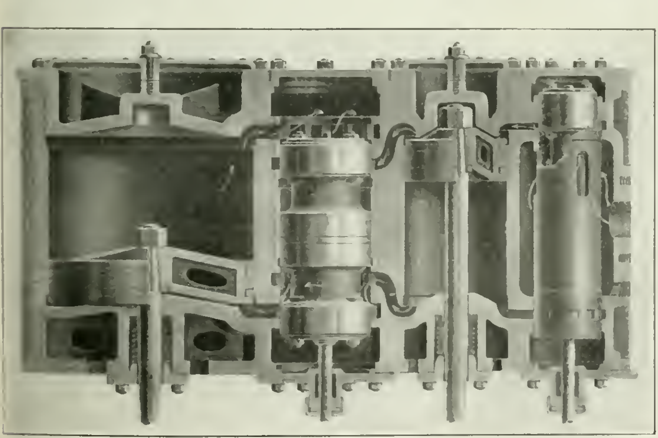


FIG. 1 SECTION THROUGH VALVES AND CYLINDERS OF IMPROVED REEVES ENGINE

Instead of building the engines with this valve the company proposes to sell the patent rights of the valve to engine builders.

## Improvements in the Reeves Steam Engine

Several improvements have been brought out in the Reeves steam engine which is now being manufactured by the Trenton Engine Company, Parker and Randolph avenues, Trenton, N. J. One of the improvements is the placing of what is termed a watershed between the engine frame proper and the cylinder. This is for the purpose of preventing water of condensation that may leak past the stuffing boxes of the piston rod and valve stem from dropping down upon the lower part of the engine. The watershed is in the shape of a plate fitting around the valve stems and piston rods, with a cone-shaped projection on the upper side, which, as the piston rod moves on its downward stroke, wipes the water from it and conveys it outside through a drip pipe.

As another departure from an old practice all medium- and larged-sized compound engines have conical pistons and cylinder heads for the purpose of getting rid of any water which may accumulate in the cylinder. It is said that this feature adds greatly to the smooth-running qualities of the compound engine.

Engineers are aware that if a cylinder is not thoroughly drained when first starting up, the water of condensation will collect and be surged back and forth by the motion of the piston, making a disagreeable sound. The idea, in this construction of piston, is that as the piston passes by the exhaust port the water, owing to the conical shape of the piston, will run down and escape through the exhaust port at a much more rapid rate than could be expected with a piston of the old flat type. This feature is illustrated in Fig. 1.

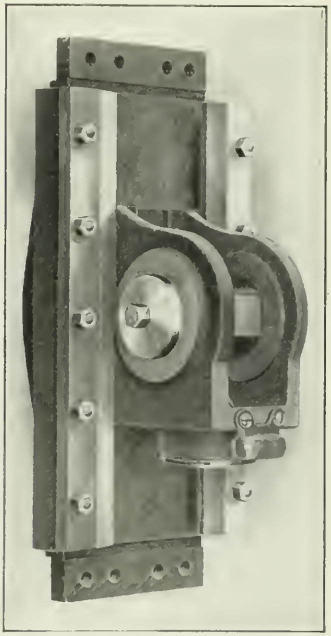


FIG. 2 GUIDE AND CROSSHEAD

Another interesting feature is illustrated in Fig. 2, which shows the very broad and liberal-sized guide that is now being used for the vertical engines made by this company. This would seem to insure smooth running at this point, the wearing surface being such that little if any wear can take place, which would eliminate the necessity of frequent adjustments of the crosshead in the guide.

## Obituary

Roderick P. Curtis, president of the Curtis & Curtis Co., who was injured in an automobile collision at Westerly, R. I., a few weeks ago, died at his home in Southport, Conn., August 9. Mr. Curtis was 49 years old and was born in New York City. With William Forbes he founded the Curtis & Curtis Co., in 1880. He was prominent in golf circles, being president of the Connecticut League Golf Clubs. He was also president of the Connecticut branch of the Sons of the American Revolution.

## Personal

A. G. Christie has been appointed assistant professor of steam engineering at the University of Wisconsin, Madison, Wis., to have charge of the steam and gas-engineering laboratories. Mr. Christie is well known through association with the early development of the Allis-Chalmers steam turbine, having had charge of that branch of their erection work for several years. Latterly he was chief engineer of the Western Canada Cement and Coal Company.

## Business Items

The M. W. Kellogg Company, 50 Church street, New York, recently closed a contract with the Corn Products Refining Company for 13 chimneys for its Argo plant. Also, a contract for a chimney 266 feet high by 12 feet internal top diameter for the Solvay Process Company, Syracuse, N. Y.

The new power plant of the Southwestern Portland Cement Company, El Paso, Tex., will contain two 600-kilowatt Westinghouse steam turbines driving 750-kilovolt-ampere Westinghouse revolving-field alternators, delivering 60-cycle three-phase current at 440 volts. Excitation current is furnished by a 55-kilowatt 125-volt Westinghouse engine-driven generator, and by a motor-generator set comprising 55-kilowatt and 20-kilowatt direct-current generators driven by a 115-horsepower type CCL induction motor. The turbines exhaust into Westinghouse LeBlanc condensers, which maintain a vacuum of 28 inches. The motor equipment of the mill, also Westinghouse apparatus, comprises a number of type CCL three-phase 440-volt induction motors of both vertical and horizontal types and ranging over 100, 75, 50, 30, 20, 15, 10 and 5 horsepower capacities, besides a 35-horsepower HF motor and 1- to 5-horsepower SA variable-speed motors. All motors were furnished complete with starting apparatus by the Westinghouse company. The power plant of the Southwestern Portland Cement Company supplies lighting service in addition to operating the cement mill.

Textile industries, as a rule, have been slow in taking up modern labor and fuel-saving devices for the boiler room. It is therefore interesting to note that the Frederick Ayer mill, which, it is said, will be the largest single textile mill in the world, and is now in process of erection by the American Woolen Company, will have in its power plant Murphy automatic smokeless furnaces. There are several noteworthy features of this installation. The initial plant will consist of eight boilers of six hundred horsepower each, attached to which will be the largest single stoker units ever built by the Murphy Iron Works. Each of these furnaces will be capable of burning more than 4000 pounds of coal per hour and will weigh 55,000 pounds. Being automatic in all their functions, not only feeding and distributing the coal, but also cleaning the fires and removing the ash and clinkers, these furnaces will, it is claimed, cut the labor cost in two and effect a very large saving in the coal bills. The new mill when completed will employ 3500 hands and will be connected by subterranean passages and overhead bridges with the Wood mill, where more than 5000 persons find employment. The Ayer mill is intended for the manufacture of worsted yarns, and with the other two Lawrence mills of the American Woolen Company will employ nearly 15,000 operatives.

The Dodge Manufacturing Company is in the midst of plant-extension work at the factory in Mishawaka, Ind. The main or south machine shop is being enlarged by the erection of a large addition, which, when ready for occupancy, will be a complete building itself. The addition is 280 feet long and 122 feet wide, like the older portions of the shop, but the side bays will be higher to accommodate a second floor or gallery. The frame work of the structure is of steel, the supporting columns resting on concrete foundations. A cream brick is being used for the walls with metal sashes. Light and ventilation are always big items in the Dodge buildings, and the new one will contain 158 windows and two good sized doorways. When the old shop is thrown into that under construction, the total length will be 585 feet on the crane runway in the center bay. Two electric traveling cranes, 25 tons and 10 tons, respectively, will serve the main middle bay, where all machines are placed and where all heavy work is done. In the side bays several lighter electric cranes will handle the smaller work. The traveling cranes are of the Whiting and Niles types. They have a speed of 300 feet per minute and much time and labor is saved by their use in moving heavy products and placing them in cars which are brought directly into the plant for this purpose. The top floor will be devoted to the production of Dodge split friction clutches, this department of the Dodge works being overcrowded by the continued growth of the business, even though at this time it covers a space of more than 12,000 square feet. Elevators will be used between the two floors for transportation.

The International Acheson Graphite Company is enlarging the output capacity of its branch works in Niagara Falls, Ont. This company has for many years operated a Canadian branch with facilities far in excess of the demands of the Canadian trade. It, however, recognizes in the hydro-electro development now so active throughout the Dominion and the new trade spirit and energy everywhere present throughout Canada, an indication of additional industrial enterprise, and it is to meet the prospective demand for its product likely to be created by the new conditions that it is increasing the size and output capacity of its plant in Niagara Falls, Ont. A new furnace room providing for a 1000-horsepower unit is being built, and on completion the new furnace installation will be placed in operation. This will be an important aid in the development of Canadian resources, particularly now that so much attention is being paid to new processes which mean much for the future of the Dominion. Especially is this true of electrometallurgy and electrochemistry, the product of the enlarged works of the International Acheson Graphite Company at Niagara Falls placing all such industries in comparatively close touch with a ready supply of electrodes. Furthermore, it will place Canadian manufacturers in many other lines in closer touch with their basis of supply, which means more prompt service in far-reaching lines. It may be noted that the International Acheson Graphite Company is the only maker of graphite in the world. All Acheson-Graphite is made in the electric furnace; all other graphite is mined. The business of the company stretches out into every country on the globe, and it may be looked upon and accepted as a most significant verdict of the future of Canada that it has recognized the advisability of enlarging its Canadian facilities.

## Help Wanted

*Advertisments under this head are inserted for 25 cents per line. About six words make a line.*

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

AGENTS WANTED to sell Burgmann celebrated engine packings in territories not yet covered. See our advertisement on page 75.

PARTNER WANTED, with several thousand dollars, in New York established steam specialty firm; unquestionable honor required. Box 88, POWER.

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# The Internal Losses of a Steam Turbine

## Review and Analysis of Published Results of Tests in England, with a View to Determining Where Losses Occur and What Is Their Nature

BY A. G. CHRISTIE

Although the steam turbine has been on the market in this country for almost ten years, very little is generally known regarding the exact nature of the heat changes in the turbine and the relative efficiency of its various sections. Up to the present, engineers have had to be satisfied with a knowledge of the steam consumption and efficiency of the turbine as a whole. No tests have been published in which the turbine has been analyzed step by step to determine where the losses occur and what is their nature.

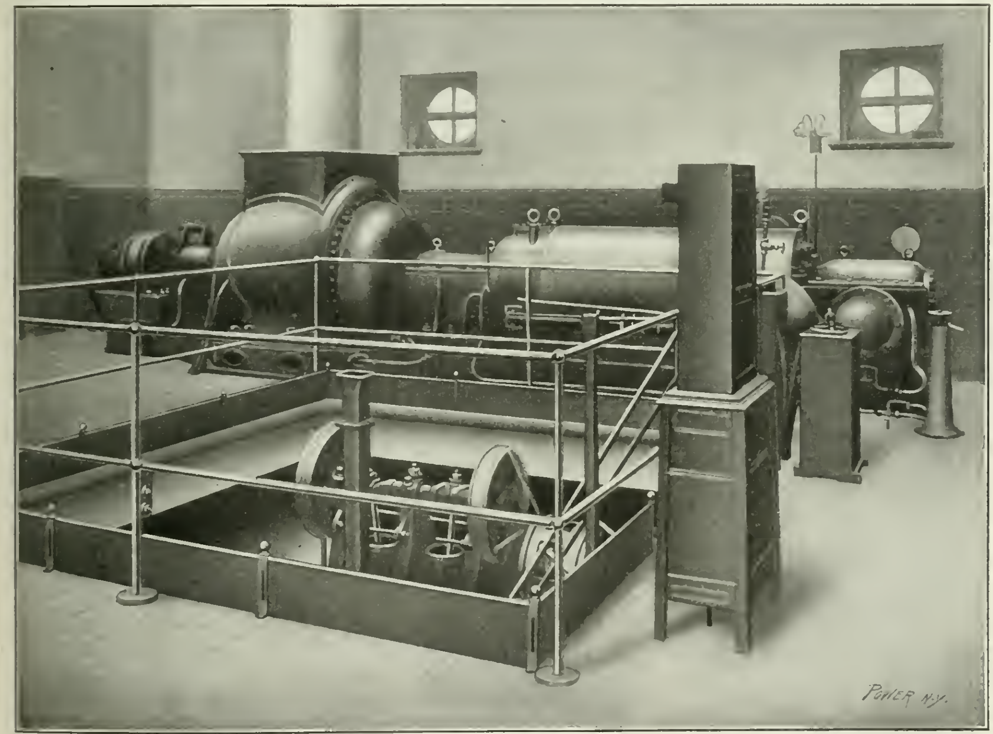

FIG. 1 EXTERIOR VIEW OF TURBINE

In general the internal losses in steam-turbine operation are due to: (a) leakage past the tips of the blades and past diaphragms or balance pistons, (b) the friction of the revolving disks or drums, (c) steam eddies and friction in blades and channels, (d) radiation loss and (e) the loss due to the velocity in the steam as it leaves the last row of blades. These losses have formerly been estimated from experiments made with disks revolving in steam of various densities, with nozzles and blades of various descriptions, etc. The losses have also been deduced by mathematical methods. Such results, however, are not easily applied to any individual turbine. This is partly because of special features of design and partly because of the fact that as all losses occur simultaneously, they are correlated to some extent. An alteration in one source of loss produces direct effects on some of the others. For this reason, the experimental determinations referred to, in order to be of the greatest value, should be combined with a turbine analysis showing the sum total of the internal losses at each section of the machine.

Such an analysis of the action of the steam in a turbine can be made as follows: The condition of the steam at the beginning and end of a stage or row of blades can be found by reading pressures and temperatures, if the steam is superheated, or pressures and qualities, if the steam is in a saturated or moist condition. When the condition of the steam is known, the heat contents can be determined either by the use of steam tables or a Mollier "heat-entropy" diagram. The use of the Mollier diagram is recommended as it presents a graphical method of representing the actual expansion curve by joining the observed points. A comparison of this actual expansion curve with the adiabatic affords a means of calculating the efficiency of the various portions of the turbine.

A careful analysis of this expansion curve for the whole turbine will show where the excessive losses occur and render it possible to improve the efficiency of these sections. This involves a study of the design of blades, nozzles, channels, etc., which will point the way to required alterations.

The improvements in steam-turbine performance that have been made up to now have been generally the result of cut-and-try methods. These have depended to a great extent on the ability of the designer to draw correct conclusions from tests and experiments which only indirectly indicated the magnitude and location of the losses.

It is not proposed in this article to go into the details of making tests for heat analysis. A partial investigation, as outlined, has already been made on a Parsons steam turbine which was recently tested in England. This test was reported in *Engineer* London, on February 26, 1909, in a paper called "Trials of a Steam Turbine Plant," by George B. Storie. This will be briefly reviewed and a portion of the results dealing with the losses in a turbine will be presented and discussed in the following paragraphs.

### The Turbine and Governing Conditions

The turbine in question, is of the Parsons type, manufactured by the Brush Electrical Engineering Company, and is nominally rated at 500 kilowatts when running at 3000 revolutions per minute and supplied with steam at 200 pounds per square inch, gage pressure, superheated to 550 degrees Fahrenheit, and with a vacuum of 28 inches of mercury at the exhaust.

The generator is a three-phase alternator with a revolving field, operating at 500 volts and 50 cycles, and supplying current to induction motors in a cotton mill at Greenvale Mill, Littleborough, England. The exciter is direct-driven by an extension of the alternator shaft.

The turbine is shown in section in Fig. 2, and an exterior view is shown in Fig. 1. The design embodies the main characteristics of Parsons turbines, with which most engineers are familiar. The features which differ from American practice are mainly of a mechanical nature, some of which are as follows: The emergency valve is placed on the opposite side of the steam turbine to the governor valve. The blades at the high-pressure end of the rotor are made of drawn copper and those at the low-pressure end of drawn bronze. The blades are held in dovetailed grooves by calking pieces in a manner similar to that employed in Westinghouse turbines. The tips of the blades are thinned off so that they will wear but not strip, should rubbing contact occur. The glands at each end of the cylinder are sealed with steam. The turbine appears to be much longer be tween bearings than the newer America turbines. The steam enters the turbin through a 4-inch pipe and, therefore, th steam velocity in the piping is highe than would be the case in America practice, where usually a 5 inch pipe i provided for this size of machine. Th resulting drop in pressure from boiler t turbine at the time of the tests wa eight pounds.

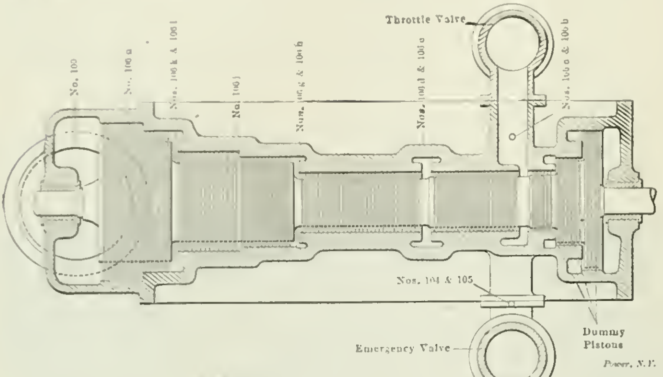

FIG. 2. SECTIONAL VIEW OF TURBINE

The turbine exhausts into a surfac condenser of 1200 square feet of coolin surface, which is supplied with a centrif ugal circulating pump and two Edward air pumps capable of maintaining : vacuum of 28 inches with full load on th turbine. All pumps are motor-driven They consumed 2.61 per cent. of the full load power of the turbine at the time o the tests. The steam consumption o the turbine was accurately determine during the tests by weighing the con densed steam discharged from the con denser.

The generator load during the tests wa supplied by a water rheostat. The electri cal instruments were carefully calibrate just before the tests at the Mancheste School of Technology.

One innovation in this plant is of par ticular interest. A blower on the gen erator rotor draws in air at the tempera ture of the engine room and forces i through the generator for cooling an ventilation. This air leaves the generato at a temperature of 117 degrees Fahren heit. It is then conducted through flue to the various departments of the mil and is used for heating and ventilating As this heating was formerly done b live steam, it is estimated that a savin of $2\frac{1}{2}$ tons of coal per day will be effecte by this method of utilizing otherwis waste heat.

This use of heated air from generator has been proposed in several America

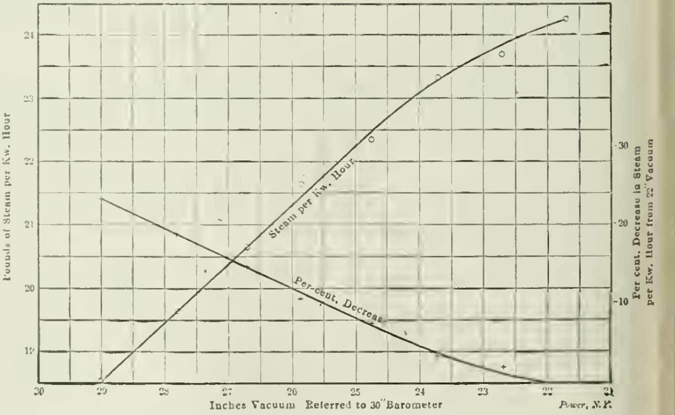

FIG. 3. EFFECT OF VACUUM AT HALF LOAD

plants but the writer is not aware of its actual application. However, it seems to be worth serious consideration where turbines operate continuously and such heating and ventilation are required.

### Notes on the Tests

The observations and general data presented in Table 1 have been copied from the results of the test as published in *Engineering* of February 26, 1909. The only alteration is that the gage pressures have been changed to absolute pressures to simplify later discussion. The numbers opposite the observations correspond to numbers on Fig. 2 and thus denote where the readings were taken on the turbine.

TABLE 1

| | |
|---|---|
| Duration of trial | 4 hours |
| Barometric pressure | 14 3 lb. per sq.in |
| 101. Pressure of steam entering throttle valve. | 213 3 lb. per sq.in |
| 105. Temperature of steam entering throttle valve | 550 deg. F. |
| Superheat of steam entering throttle valve | 164 deg. F |
| 106a Pressure of throttled steam measured between throttle valve and first row of blades | 131 3 lb. per sq.in. |
| 106b. Temperature of steam between throttle valve and first row of blades | 527 deg. F |
| 106d. Pressure of steam between 1st and 2d stages of expansion | 92 3 lb. per sq.in. |
| 106e. Temperature of steam between 1st and 2d stages of expansion | 461 deg F |
| 106g Pressure of steam between 2d and 3d stages of expansion. | 40 3 lb. per sq.in. |
| 106h Temperature of steam between 2d and 3d stages of expansion. | 374 deg. F |
| 106j Pressure of steam between 3d and 4th stages of expansion. | 17 55 lb per sq.in. |
| 106k Pressure of steam between 4th and 5th stages of expansion. | 8 3 lb. per sq.in. |
| 106i Temperature of steam between 4th and 5th stages of expansion. | 265 deg F. |
| 106n. Pressure of steam between 5th and 6th stages of expansion. | 4 3 lb. per sq.in. |
| 109. Pressure of steam at exhaust end of 6th expansion | 0 73 lb per sq.in. |
| R.p.m | 3012 |
| Weight of total steam used per hour | 8200 lb. |
| Electrical output | 459 kw. |
| Pounds of steam per kw.-hour output | 17 86 |
| Power required to drive turbine and alternator; no load | 77 kw. |
| Additional electrical losses at full load. | 4 kw. |
| Total i.h.p. $(459 + 77 + 4) \times \frac{1000}{746}$ | 722 |
| Pounds of steam per i.h.p.-hour | 11.35 |
| Efficiency ratio | 0.579 |
| Excitation | 6 kw. |
| Power absorbed in ventilating alternator | 31 kw. |
| Power required to run light and unexcited (air duct to alternator closed). | 23 kw. |
| Power absorbed in iron losses with full voltage, also friction and windage, etc | 17 kw. |

All pressures are absolute.

Tests were made by the builders before shipment to determine the turbine and generator losses, as shown in the latter portion of Table 1. From these tests the indicated horsepower was calculated.

During the test more air than was necessary for cooling was forced through the generator; consequently, the power required for blowing it was excessive and amounted to 31 kilowatts. After the completion of the test this volume of air was reduced until only 16 kilowatts was required to force it through the generator and flues. If it may be assumed that the difference of power required for this purpose, viz., 15 kilowatts, would have appeared in the test as electrical output, the steam consumption would drop to 17.26 pounds per kilowatt hour, instead of 17.86 pounds per kilowatt-hour as given.

TABLE 2

BAROMETER = 29.29 INCHES

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Steam pressure at entrance to turbine, gage, lb. per sq.in | 163 | 163 | 164 | 161 | 162 | 156 | 157 | 158 |
| Steam temperature at entrance to turbine, deg F | 524 | 526 | 530 | 530 | 533 | 512 | 528 | 530 |
| Vacuum, In of mercury | 28 29 | 27 1 | 26 0 | 25 15 | 24 05 | 23 0 | 22 0 | 21 0 |
| Kilowatts output. | 275 | 275 | 276 | 275 | 273 | 270 | 270 | 263 |
| Pounds of steam consumed per kw.-hour | 18 54 | 19 63 | 20 65 | 21 63 | 22 34 | 23 33 | 25 7 | 24 25 |
| Vacuum referred to 30-in. barometer | 29 00 | 27 81 | 26 71 | 25 86 | 24 76 | 23 71 | 22 71 | 21 71 |

After the completion of the test at 459 kilowatts, further tests were made to determine the effect of vacuum at about half load. These tests are presented in Table 2 and the results plotted in Fig. 3, after referring all vacuum readings to a 30-inch barometer.

For comparison with reciprocating engines, it is interesting to derive the mechanical efficiency of this turbine The generator efficiency is not given but may be assumed as 94 per cent for this load, voltage and frequency The electrical output is 459 kilowatts or 615 electrical horsepower. Therefore the brake horsepower due to the generator load is

$$615 \div 0.94 = 654.$$

There is also work done external to the turbine as follows. Power required to ventilate the generator, 31 kilowatts; excitation, 6 kilowatts; total 37 kilowatts = 49.7 electrical horsepower. Therefore, the total brake horsepower at the turbine coupling is

$$654 + 49.7 = 703.7.$$

The mechanical efficiency of the turbine referred to indicated horsepower, therefore, is

$$703.7 \div 722 = 97.6 \textit{ per cent.}$$

The observations of temperature and pressure made during the test were plotted on a Molher heat entropy diagram, as shown in Fig. 4. The diagram here used is that presented by Thomas in his paper, "The Specific Heat of Superheated Steam," Vol. 29, *Transactions* A. S. M. E. The points plotted were then joined. These lines represent approximately the actual expansion of the steam during its passage through the turbine. The line of ideal efficiency is an adiabatic and is plotted as a horizontal line with constant entropy, from the point representing the initial condition of the steam as it arrives before the throttle valve of the turbine. The quantities involved in calculating the efficiencies of the various expansions are given in Table 3.

TABLE 3.

| | Steam in Main. | After Throttle and Before 1st Exp'sion | Before 2d Expansion. | Before 3d Expansion. | Before 5th Expansion. | At Exhaust Nozzle. | From Initial to Final Conditions. |
|---|---|---|---|---|---|---|---|
| Observed pressure, absolute | 212 3 | 131 3 | 92 3 | 40 3 | 8 3 | 0 73 | |
| Observed temperature, degrees Fahrenheit | 550 | 527 | 461 | 374 | 265 | 92 | |
| Total heat at observed conditions from heat diagram | 1289 1 | 1283 3 | 1253 5 | 1220 7 | 1178 8 | 1059 1 | |
| Total heat at end of adiabatic expansion from initial condition to pressure at end of section | 1242 7 | 1247 5 | 1181 2 | 1100 | 1022 | | 902 |
| Heat available from this adiabatic expansion | | 35 8 | 72 3 | 120 7 | 156 8 | | 387 1 |
| Heat expended in useful work | | 29 8 | 32 8 | 41 9 | 119 7 | | 224 2 |
| Efficiency ratio, per cent | | 83 7 | 45 3 | 34 7 | 75 8 | | 57 9 |
| Reheating factors, per cent | | 16 3 | 54 7 | 65 3 | 24 2 | | 42 1 |

### Determining Available Energy for Each Expansion

The available energy for each expansion is determined as follows: The steam is assumed to expand adiabatically from the conditions noted at the beginning to the pressure observed at the end of that expansion. Then the heat available in B.t.u. from this drop in pressure is equal to the difference in the total heat contents of the steam at the beginning and the end of such an adiabatic expansion. Thus, for example, at the beginning of the first expansion, the observed conditions are: Pressure, 131.3 pounds, absolute; temperature, 527 degrees Fahrenheit. This point was plotted on the Mollier diagram and an adiabatic drawn to 92.3 pounds, absolute, which is the pressure at the beginning of the second expansion. The total heat contents per pound of steam at the beginning and end of such an adiabatic expansion are 1283.3 B.t.u. and 1247.5 B.t.u., respectively. Consequently, there are 35.8 B.t.u. available. The observed conditions at the end of the first expansion were 92.3 pounds absolute pressure and 461 degrees Fahrenheit, corresponding to the total heat contents of 1253.5 B.t.u. Therefore, the heat actually expended by this portion of the turbine in useful work was

1283.3 — 1253.5 = 29.8 *B.t.u.*

per pound of steam passing through the machine.

The efficiency of each expansion is the ratio of the heat appearing as useful work done by that portion of the turbine under consideration to the heat available, assuming adiabatic expansion as described. Therefore, the efficiency of the first expansion is

29.8 ÷ 35.8 = 83.7 *per cent.*

The results of calculations for other sections of the turbine are given in Table 3.

A second set of calculations were made by scaling the mean diameters of the blade rows on Fig. 2 and reducing the number of rows of blades on the rotor, to equivalent rows at the mean velocity of the blades in the first expansion. The equivalent rows on any given diameter are found as follows: Multiply the actual number of rows in each section by the square of their respective mean diameter and divide the product by the square of the given diameter. For example, the mean diameter of the first expansion is 0.8 inch in the figure and the mean diameter of the sixth expansion measures 2.02 inches; there are 10 rows in the sixth expansion on the rotor; the equivalent number of rows at the mean velocity of the first expansion is, therefore,

$[10 \times (2.02)^2 \div (0.8)^2] = 63.5.$

These calculations are shown in Table 4, as are also the B.t.u. available and the B.t.u. transformed into useful work per equivalent row. Fig. 5 represents the same results graphically. The drop in absolute pressure, the total heat contents and the efficiencies of the various turbine sections are also plotted in Fig. 4.

The utility from the standpoint of design, of reducing all blading to equivalent rows at the velocity of the first stage, has often been questioned. However, it illustrates graphically in an effective manner the action of the steam inside the turbine.

From Fig. 4 it would seem that the most efficient operation is obtained when there are about 1.62 B.t.u. available per equivalent row. Therefore, it is evident that the turbine was designed to operate with saturated steam at 200 pounds per square inch gage pressure at the throttle and 28 inches of vacuum at the exhaust. Under these conditions, the heat available per equivalent row for the whole turbine is exactly 1.62 B.t.u. It is also evident from Fig. 4 that where the available heat due to the use of superheated steam exceeds 1.62 B.t.u. per equivalent row, the efficiency is lowered. It would thus appear that each turbine should be designed separately for its actual conditions of operation if it is desired to obtain the heat efficiency.

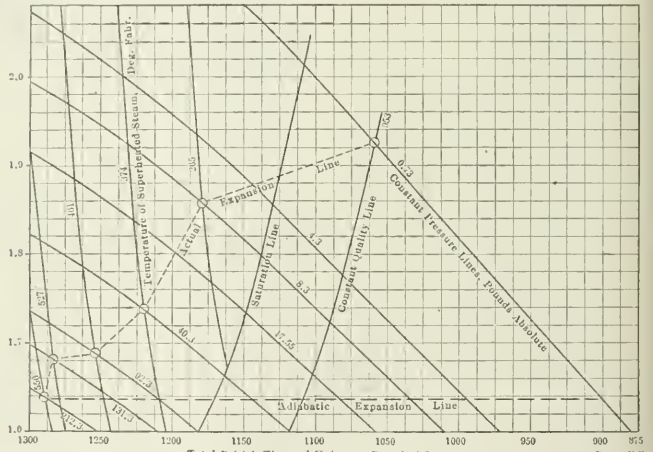

FIG. 4. SHOWING EXPANSION ON ENTROPY-HEAT DIAGRAM

### Undesirable to Add to Turbine Length

At first thought, it would seem that more rows of blades should be added when superheated steam is used. However, it is not desirable for mechanical reasons to add length to a turbine. Neither is it apparent that any thermal gain would result from adding more rows of blades. Recent tests seem to indicate that a reduction of the number of rows of blades and an increase in the B.t.u. given up per row, and consequently an increase in the velocities, produce not only more satisfactory mechanical construction but also an increased thermal efficiency at the same time.

There is more heat available per pound of steam in adiabatic expansion from the observed initial to the exhaust conditions than would be available in adiabatic expansion of dry saturated steam from the initial to the exhaust pressures. As shown in Fig. 5, the work of utilizing this extra heat seems to be limited to the second, third and fourth expansions instead of being shared equally by all sections.

A careful study of these curves and tables shows some remarkable results. Fig. 4 shows plainly that the expansion of the steam in this turbine does not follow any law in which the reheating factor is considered constant, such as is sometimes assumed in commercial designs and also by some writers on steam turbines. According to this set of results, the reheating factor which is due to friction, leakage, etc., in the blades and channels, varies as shown in Table 3 and Fig. 6. These are probably the most interesting and valuable results of the whole test and should be carefully studied. It is not believed that any other results showing this variation of reheating factor have been published.

Fig. 4 also shows that there has been considerable throttling at the governor valve. Hence the turbine was operated much below its most efficient load. Had the load been increased until the pressure at the beginning of the first expansion became about 200 pounds per square inch, absolute, the turbine would probably have operated at somewhat higher efficiency.

While it is generally believed that the blades of the first expansion work at fairly high efficiency, the results of this test show such remarkably high efficiency in this section as to be difficult to account for. The blade shapes and angles in this section have probably been carefully designed from theoretical considerations of the action of the steam since the changes from the initial condition can be closely approximated. The actual expansion evidently corresponds very closely to the assumed expansion.

It is also possible that the clearances on the copper blades used in this section were reduced to a running minimum due to the greater expansion of the copper blades than of the spindle and casing, with the temperature of the steam. This would reduce the leakage losses.

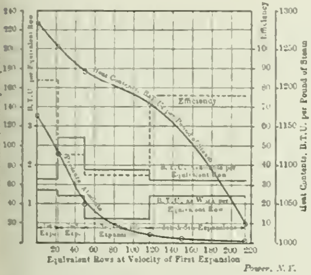

FIG. 5. VALUES REFERRED TO EQUIVALENT ROWS AT THE MEAN VELOCITY OF THE FIRST EXPANSION

The heat lost in radiation disappears from the heat-entropy diagram in the same way as heat given up in useful work. No attempt was made to measure the radiation loss in the test quoted. Therefore, the figures given in Fig. 4, as B. t. u. expended in useful work, are subject to errors to the extent of radiation loss. Consideration of this loss would reduce the efficiency of the first, second, third and fourth expansions and increase the efficiency of the low-pressure section. The average efficiency for the whole turbine would remain the same. This error due to radiation is probably very small, as turbines are usually well lagged with nonconducting material and incased in polished metal jackets. However, a complete analysis of a turbine should include a determination of this radiation loss.

The efficiencies of the second, third and fourth expansions are very low. It is to be regretted that sufficient observations were not taken to determine definitely the state of the steam at the end of the third expansion. The general appearance of the expansion curve in Fig. 4 would seem to indicate that the greatest loss in the whole turbine occurs in the third expansion.

### Cause of Low Efficiency

The question at once arises as to the cause of such low efficiencies. It cannot be definitely stated to what characteristic of the turbine these are due, without having access to the detail designs. However, the following notes suggest some of the possible causes.

In Parsons turbines, especially in those of English design with considerable length between bearings, it has been noted that the clearances are generally greater in the sections corresponding to the third and fourth expansions of the turbine shown in Fig. 2 than in any other section except the last low-pressure blade rows. This is partly due to the following causes: The distortion of the casing under heat and vacuum, if such occurs, will be a maximum at this section. The deflection due to the weight or whipping of the spindle, which is usually extremely small in well designed turbines, will also be a maximum at this section. Increase in the clearance means increased leakage and decreased efficiency.

The blade angles in the sections referred to may not be correct for the steam conditions. Attention has already been called to the fact that the turbine was evidently designed for saturated steam conditions. Under these conditions, the volume of the steam increases less rapidly during expansion than when superheated steam is used. This increased steam volume would produce higher velocities than those used in the design of the blading. Consequently, increased eddying and friction losses would occur in the succeeding portions of the turbine. These losses would naturally decrease efficiency.

TABLE 4.

Expansions.

| | 1. | 2. | 3 and 4. | 5 and 6. |
|---|---|---|---|---|
| Actual rows.. | 22 | 30 | 14<br>14 | 6<br>10 |
| Equivalent rows at diameter of 1st expansion. | 22 | 27.1 | 31.5<br>35.8 | 34.1<br>63.5 |
| B.t.u. available. | 35.8 | 72.3 | 120.7 | 156.8 |
| B.t.u. expended in useful work..... | 29.8 | 32.8 | 41.9 | 119.7 |
| B.t.u. available per equivalent row | 1.625 | 2.67 | 1.885 | 1.61 |
| B.t.u. expended in useful work per equivalent row | 1.351 | 1.21 | 0.625 | 1.22 |

A correspondent in the issue of *Engineering* for March 12, 1909, presents some similar results to those given in this article. In commenting on the tests, he gives as a possible explanation of these low efficiencies that owing to some peculiarity of superheated steam minute particles of water may be present in the steam during its passage through the third and fourth expansions and such would cause excessive friction losses. It is believed that water may exist in superheated steam under certain conditions, such as are found in pipe lines where the steam flows steadily in one direction. It does not seem probable that such would be the case where thorough intermixing takes place, such as occurs during the passage of the steam through the blade channels of a turbine. At any rate, the high efficiency of the fifth and sixth expansions seems to show that the effect of such water, if actually present, is very small.

It is quite possible that there is excessive leakage in the first and second balance pistons. A portion of this leakage may pass through the equalizing pipes and enter the blades at the beginning of the third or fifth expansions, respectively. On mixing with the steam coming from the preceding blade rows, the temperature of the mixture and consequently its apparent heat contents would probably be increased. It is hard to determine this leakage effect in a commercial test.

The efficiency of the fifth and sixth expansions comprising the low-pressure sections is high and agrees with the results of published tests on low-pressure turbines. This would indicate that the best results in steam-turbine operation may be expected with the use of low-pressure steam.

It is also interesting to note on Fig. 4 that the steam remains superheated until it reaches the first blade row of the sixth expansion.

In general, the results of this test seem to indicate, (a) that the blading of each turbine should be separately designed for maximum efficiency under its actual operating conditions; (b) that the efficiencies and corresponding reheating factors vary for each section of the turbine and follow no regular law; (c) that the efficiency of some sections is capable of improvement; (d) that the low-pressure sections are the most efficient portions. However, further tests should be made in the manner indicated, on other turbines, before definite conclusions can be drawn regarding the performance of turbines in general.

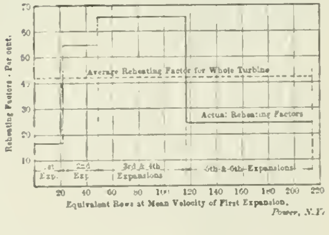

FIG. 6. VALUE OF REHEATING FACTORS

A thorough discussion and criticism of the results given herewith will be welcomed.

# Power Plant of the White Company

By Warren O. Rogers

With the development of the White steam car, it was found necessary to construct new works for the building of this class of automobiles. The site chosen is at the corner of St. Clair and East Seventy-ninth streets, Cleveland, O., and is adjacent to the Lake Shore railroad, which facilitates the handling of raw material and finished products. The plant is constructed of brick, with sawtooth design of roof, thus making a very light factory, owing to the large amount of glass provided in its construction. The power plant is located in the rear of the factory, and is constructed with brick walls, having a framework of structural steel and a cement roof.

## Boilers

In the boiler room are located four Babcock & Wilcox boilers, each of 300 horsepower, Fig. 2; each equipped with superheaters, which superheat the steam to 150 degrees. The boilers are fitted with Babcock & Wilcox stokers and are operated by two steam engines, which are located below the flooring, thus preventing them from becoming covered with dust or dirt. They are also out of the way, which prevents damage from breakage and accidents which would occur if they were placed where a careless fireman might accidentally permit some obstruction to get in the mechanism of the operating parts of the stokers.

The boilers are set in red pressed brick, which gives a very neat appearance, and the floor is constructed of cement. The smoke flues to the boilers are located in the rear, and each boiler is connected in the usual manner, the smoke flue running the entire length of the boiler settings and into the stack, which is placed at one end of the boiler room. The coal for boiler use is handled by hand, there being no coal-handling apparatus installed yet, although an overhead system for coal conveying will be put in later. The boiler pressure carried is 170 pounds per square inch.

The boilers are equipped with the necessary water columns, water glasses, steam gages and safety valves, but none of the various kinds of damper regulator and other safety devices usually found in uptodate plants have been installed. The chief engineer, W. H. Clements, while believing that they are all right, states that he pays his firemen to do such work, and under such arrangements matters are progressing very satisfactorily. The feed-pipe lines are constructed of 1½-inch brass, and the drips from the water columns, etc., are also of brass.

## Piping

The piping between the boilers and engines is of somewhat novel construction. A 12-inch header extends across the four boilers and is supported by overhead girders, which prevent excessive vibration. The pipe connections are arranged so as to obtain any combination on the steam lines between each individual boiler. For instance, each boiler steam drum is connected to the 12-inch header by means of a U-bend of 6 inch pipe, a stop valve being connected to the header and also a stop valve next to the boiler, thus providing two stop valves for each steam-drum connection. The 12-inch header over the boiler is connected to a 12-inch header in the engine room, from which a 10-inch pipe extends to the 1500-horsepower engine, and a 7-inch pipe to the 750-horsepower engine. Both engines are fitted with balance throttles of the Schutte & Koerting type, while plain valves are placed in the pipe fittings near the header.

The two engines are of the Erie City Iron Works make, and are fitted with a special design of valve. It will be noticed in Fig. 1 that the smaller engine has a novel feature, inasmuch as the frame and both cylinders are connected by studs, the object being to prevent excessive expansion due to the high superheated steam used in the cylinders. On the 750-horsepower engine both cylinders are connecte with frames by eight 3-inch studs, whic separate the cylinder and frame a distanc of 10 inches. On the 1500-horsepowe engine, the high-pressure cylinder is connected to the frame in the same manner but it was not considered necessary i the case of a low-pressure cylinder, as th steam drops sufficiently in temperature t eliminate any trouble from expansion.

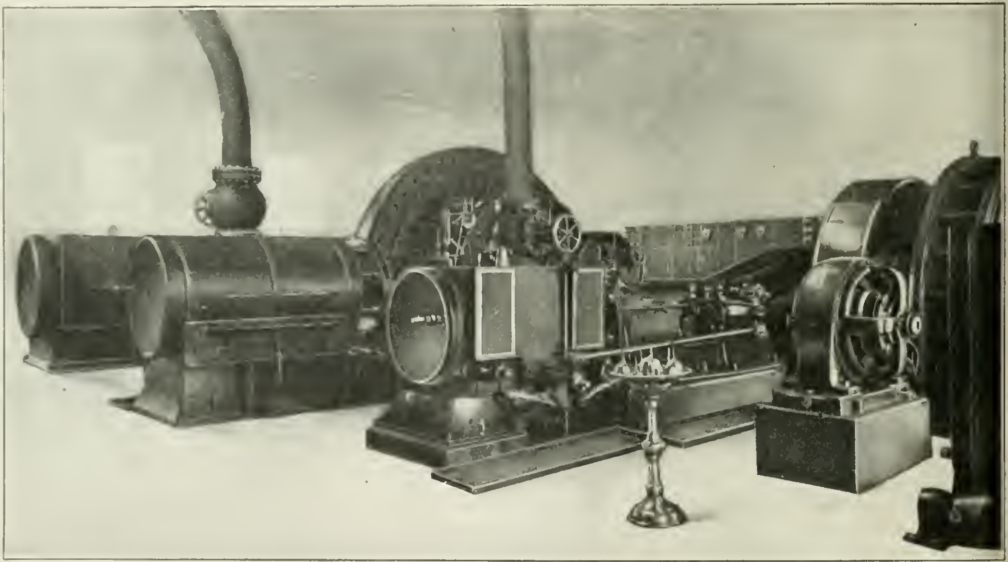

FIG. 1. ENGINE ROOM OF THE WHITE COMPANY'S PLANT

The small engine, which has cylinder 18 and 35 by 30 inches, running at 15 revolutions per minute, is direct-connecte o a 500-kilowatt generator, three-phase, o-cycle. Located between the high- and he low-pressure cylinders is the exciter et, which is belted to the engine shaft. This generator is of 128 amperes capacity, oltage 125, runs at 750 revolutions per ninute, and is of 20 kilowatts capacity.

The large engine has cylinders 26½ nd 46 by 36 inches, and is direct-conected to a three-phase 60-cycle alternator, unning at 150 revolutions per minute, nd of 1200 kilowatts capacity. Both alernators and exciters are the product of he General Electric Company. As in the ase of the small engine, the exciter is laced between the high- and the lowressure cylinders, and is belted to the aft of the engine. The exciter is of 40 kilowatts capacity, 300 amperes, 125 volts, with a speed of 650 revolutions per minute Both engines are fitted with the Nugent oiling system and reducing motion.

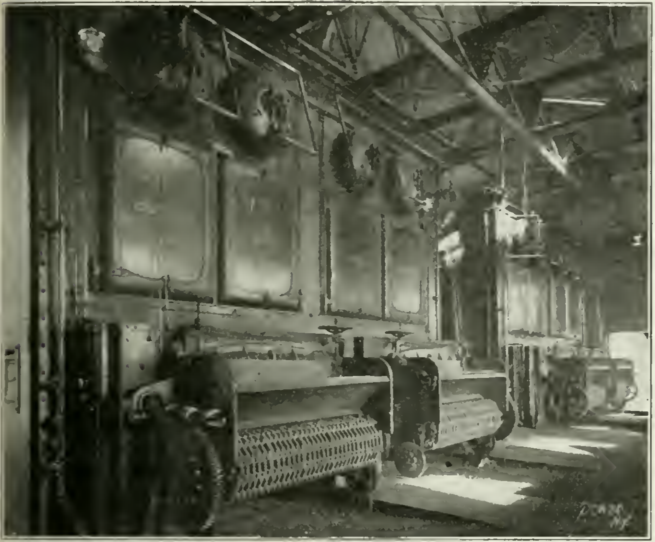

FIG. 2. BOILER ROOM OF THE WHITE COMPANY'S PLANT

### Switchboard

The switchboard is located at the rear f the engine room, midway between the two engines and generators. It is composed of 16 panels of slate slabs, divided as follows: Two being devoted to the generators, two to the exciters, three for power circuits, there being two circuits on each board. There are five panels for light, on which are placed the indicating recording meters, ammeters, voltmeters and the ordinary switchboard instruments. Owing to lack of space on the rear of the switchboard, the field resistance for the alternators are placed in the basement, and those for the exciters on the back of the board.

### Miscellaneous

Oil from the engine goes through an A B C filter and then passes into a filter designed by Chief Engineer Clements and shown in Fig. 3. The drip pipes from the engines deliver the oil to the filter on the side, which filters the oil in the usual way. The filtered oil from the A B C filter then drips into a pipe extending from the top of the homemade filter, down to within 4 inches of the bottom. This filter is made with a partition in the center, and in the first compartment are placed two pieces of perforated sheet iron, and under each is placed a piece of cheesecloth. At the top of the middle partition, between the two sections of the filter, is an overflow from the first to the second compartment.

The oil as it flows from the A B C filter passes down to the pipe in the second filter, then rises up through the cheesecloth under each plate and overflows into the second compartment, from which it is drawn off by a small oil pump and delivered to a 40-gallon oil tank placed on the wall of the engine room high above the engines. In case any obstruction should get in the pipe between this 40-gallon oil tank and the engine-lubricating system, the oil pump connecting to the filter in the basement can be connected direct to the oiling system and thus maintain the lubrication of the engines while the repairs on the overhead piping are carried on.

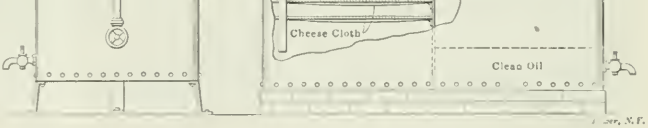

FIG. 3. ARRANGEMENT OF OIL FILTERS

In the basement is also located a 9 and 14 by 18 Snyder-Hughes vacuum pump, which is connected by its suction pipe to an 8-inch manifold, from which separate pipes run to the various departments, each pipe being equipped with a valve to allow for regulation and cutting out.

In the engine room a 15-ton crane extends from one track to the other, which permits of handling the heavy parts of the engines, when necessary.

The condensation from the steam headers and receivers is taken care of by a Squires' steam trap which returns the water to the receiving tank and uses it over again. The water in the receiving tank from the header drips is, of course, not sufficient to supply the boilers with water; therefore, water from the city main is supplied through a Seagrist water-controlling valve, thus keeping a constant supply of water in the supply tank for boiler-feeding purposes.

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## Gas Explosion in Boiler Furnace

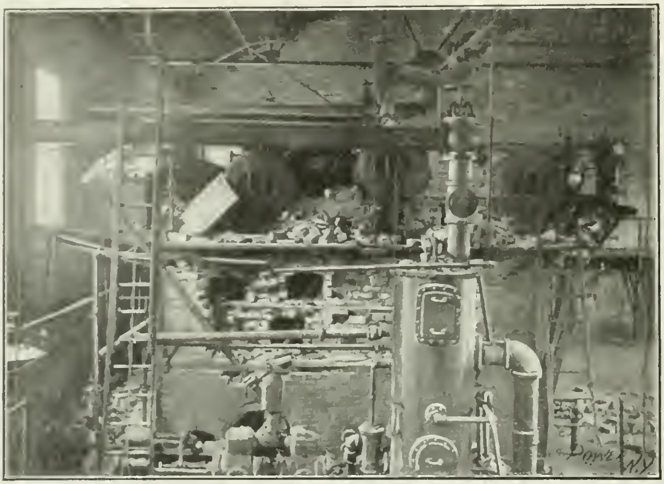
By F. W. Brady

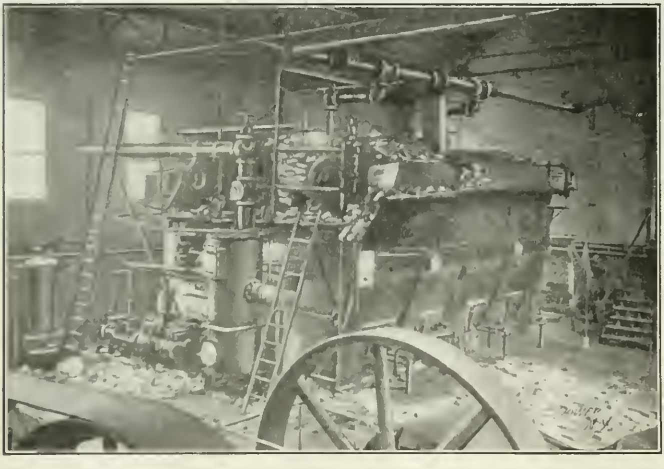
An explosion that was not on the prearranged program for the Fourth of July celebration occurred about 1 p.m. on that date in the natural-gas belt of West Virginia. The results are shown in the two views, the photographs having been taken shortly after the explosion. It was a case of being "blowed up" and illustrates the special danger that must be guarded against where natural gas is used for firing boilers.

The battery consisted of two 200-horsepower Stirling boilers located in the plant of the George Sherrard paper mill at

Wellsburg, W. Va. The boilers were fired with natural gas, which is the fuel quite generally used in this district. However, bituminous-coal prices have slumped so much the last two years that some mills have changed from natural gas to run-of-mine coal at 80 cents per ton. The plant had been closed down for about a week for making repairs. An inspection of the furnaces had been made and no leaks of gas were detected at that time, as the workmen had carried lighted torches into the furnaces.

When starting up on the Fourth the gas burners at the rear boiler had been lighted successfully, but when the torch was inserted into the furnace of the front boiler a terrific explosion followed immediately. The entire boiler setting was demolished, besides cracking the boiler front and breaking off the cast-iron column between the two boilers. The feed pipes were broken off and some other fittings injured, although there was no special damage to the boilers. The two attendants escaped serious injury from the flame and the flying bricks that knocked out the windows and made a concussion that was felt in houses quite a distance from the plant. As the accident happened fortunately when the majority of the employees were absent, the chance for injury was a minimum.





TWO VIEWS SHOWING RESULTS OF GAS EXPLOSION IN BOILER SETTING

The explosion was caused by gas leaking into the furnace after the inspection and repairs had been made. It is quite common for derangements to take place in the gas pipes and valves in the natural-gas country, because much of the erection work is done rapidly and the inspection becomes very careless. Several little explosions had already occurred in thi plant, but they had caused no seriou damage. In other plants smokestacks ha been cracked by gas explosions and employees were burned, while in domesti service houses have been blown up an the occupants killed. The pressure of th gas is 140 pounds in the mains and th regulators are supposed to reduce i to 8 ounces in the service pipes. But th pressure is variable and its presence i leaks cannot be detected as readily fro its odor as can be done with the ill-smelling manufactured illuminating gas. I many of the mills little attention is give tc economy of fuel as the price is low varying from 4 cents to 14 cents pe thousand feet for factory use, and 2 cents for domestic use. In many case the factory or mill owns its gas suppl and is independent of the Tri-State Ga Company, which controls most of th natural-gas business in northern We Virginia, eastern Ohio and western Pennsylvania. They simply "let her go" an run the risk, which means a very wasteful practice, and a carelessness of operation that causes a frequent loss of property with injury to employees and other

## Horsepower Employed in Differen Industries

G. L. Addenbrooke, in a paper on "Th Public Supply of Electric Power," in Cantor lecture delivered before the Roy Society of Arts (English), said:

The horsepower employed in differen industries varies considerably; for instance, taking the light class of trade such as builders, small mechanics' shop printers and the large class of jobbin trades, the horsepower per man employe will be between ¼ and ½. Engineerin works will usually take from ½ to horsepower per man. Mines employ o an average about 1½ horsepower per ma varying from less than 1 horsepower pe man for the smaller classes of mine to horsepower and even 3 horsepower fo modern collieries working on a large scal In the textile industries the average appears to be about 1 horsepower per employee. In industries where there is muc grinding, such as milling and cement making, the horsepower is higher, averagin 5 to 6 horsepower per man, and even mor in modern plants. Again, in rolling mill it may be very high, and in large electric power stations will amount to 200 horsepower per man or more. Taking, however, the general run of industries in district, the power used will not averag much over 1 horsepower per man employed; for instance, in London recen statistics show it is a little over ½ horsepower, while in the north, where th trades are much heavier, it will be doubl or more.

# A Practical Study of the Chain Grate*

## Results of Recent Observations, by the United States Geological Survey, at Certain Plants Where This Type of Stoker Is Used

The earliest mechanical stoker was of he treadmill type, so called because the ar- angement of the grate bars as a travel- ng belt resembled the apron of a tread- ll. It was patented in England as far ck as 1841. Improved in details of con- ruction, this type, under the name chain rate, has come into extensive use in this untry. The coal is fed from a hopper, hich extends the entire width of the rate and has a plate at the back for reg- ting the depth of the bed of coal, to continuously revolving grate, the top of hich is made to move from front to ar by power applied to the front or r sprocket shaft. As usually installed, e surface of the grate is horizontal, but casionally chain grates are given a ght incline. Back of the hopper and ex- nding over the whole width of the grate a firebrick arch. The length of this rch differs in plants equipped by differ- t makers, but the present tendency is to ngthen the arch and to proportion its gth and slope to the grade of coal to e used.

In operation, coal from the hopper be- ns to ignite as it passes under the arch nd the grates carry the burning coal to- ard the bridgewall at a rate which per- its complete combustion before the chain ses the rear sprocket and the refuse lls into the ashpit below.

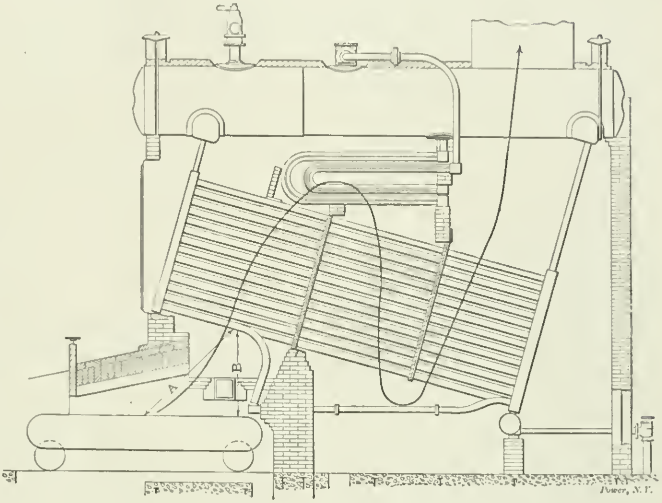


FIG. 1. WATER-TUBE BOILER WITH UPTAKE IN REAR

The majority of the stokers of this type are particularly adapted to a free-burning coal high in volatile matter, such as is mined in the central and western fields, and give less satisfaction with the higher fixed carbon coking coals of the Appalachian field. As they can burn the poorest grades of noncoking coal with complete combustion, they offer a valuable means of producing cheap power. At all the plants visited where these stokers were in use small coal was burned.

### Variations in Length of Firebrick Arch

As has been said, the chief difference at present among chain grates, as put in by the various makers, is in the length of the firebrick arch. In many water-tube boilers this arch is made short, and the gases of combustion are led to the tubes by the shortest path. A furnace and boiler with stoker thus set are shown in Fig. 1. In this setting the distance of travel for the gases from the grates to the tube-heating surface, indicated by the line *B*, is reduced to a minimum and the average distance from the fire to the first cooling surface encountered, *A*, approaches a minimum.

This type of installation is common in the Middle West, where a higher proportion of chain grates is in use than in any other section of the United States, but the short arch and the brief travel of the gases to the first tube-heating surface are features unfavorable to smokeless combustion.

A method of setting designed to lengthen the travel of the combustible gases from the bed of coal and allow them to mix and be completely burned before

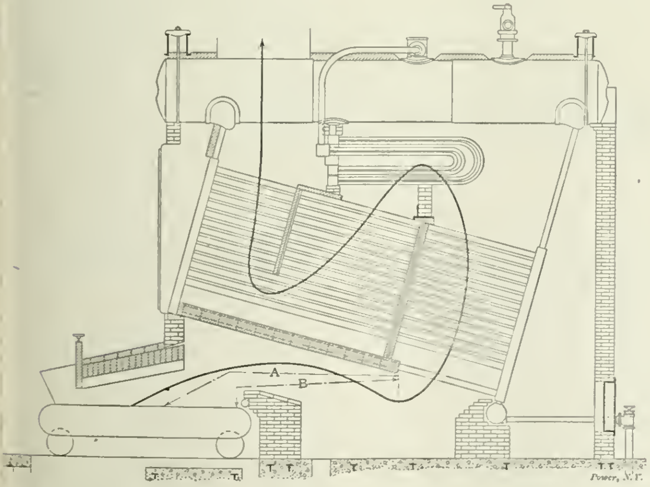


FIG. 2. UPTAKE IN FRONT

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*From *Bulletin* 373, United States Geolog- al Survey.

entering the boiler is shown by Fig. 2. Here the type of boiler illustrated by Fig. 1 is baffled so that the uptake is in front, the firebrick arch over the grates is no longer than in the other furnace, but it is supplemented by the bottom baffling made of C tile supported by the water tubes, so that the least distance from grates to tube heating surface is three times as long as in the mounting shown in Fig. 1. The bottom baffling, though it cannot, on account of its construction, become as hot as the ignition arch, has slight cooling effect, and there is ample opportunity for complete combustion before the gases reach the first cooling surface.

### Chain Grate Under Tubular Boilers

Comparatively few chain grate stokers were found under tubular boilers. An example of the usual setting is given in Fig. 3. Here, while the ignition arch is short and the shell of the boiler has a cooling effect, the average distance from the grates to the beginning of the tube-heating surface is so long that smokeless combustion can be obtained with ordinary care in operation. In the journey from the grate to the rear of the boiler the cooling effect of the boiler shell, though not negligible, is much less than it is often thought to be, inasmuch as the area exposed is not more than that of eight or nine tubes.

### Detail of Chain-grate Plants

In the course of the field investigation 57 plants were visited, ranging from 300 to 9600 rated boiler horsepower, at which chain grates were installed. The coals used, all small sizes, came from five different States and the average depth of fire in burning them ranged from 4.5 to 6 inches. The kind of coal and the depth of fire are given in Table 1, which incidentally shows that the chain grate stoker has been found to work remarkably well with Illinois coals.

TABLE 1. KIND OF COAL AND DEPTH OF FIRE AT PLANTS WITH CHAIN GRATES.

| Kind of Coal. | Number of Plants.[a] | Average Depth of Fire. Inches. |
|---|---|---|
| Illinois | 21 | 5 |
| Indiana | 8 | 5 |
| Kentucky | 8 | 4 |
| Ohio | 6 | 5 |
| Pennsylvania | 6 | 4.5 |
| Miscellaneous | 10 | 6 |

[a] Two plants burned both Indiana and Illinois coal.

Forty of these plants maintained uniform loads; the remainder had to carry variable loads. At 18 per cent. of the plants, the stokers were under boiler units of 200 horsepower or less and at 69 per cent., they were under units of 300 horsepower or less. The average boiler horsepower developed, the boiler being rated on 10 square feet of heating surface per horsepower, ranged from 23 to 158, the average being 93. The ratio of square feet of heating surface to square feet of grate surface varied from 33 to 1 to 88 to 1, the average ratio being 50 to 1.

The hight of the ignition arch at the front of the furnace ranged from 0.9 to 1.1 feet, and the hight above the grate at the rear of the arch from 1.3 to 2.2 feet. In 16 plants out of 40 the forward ends of the stokers were some distance in front of the boiler. The average hight of the ignition arches above the grates is given in Table 2.

TABLE 2. AVERAGE HIGHT OF ARCH AT FRONT AND REAR AT PLANTS WITH CHAIN GRATES.

| Type of Boiler. | At Front of Furnace. | | At Rear of Furnace. | |
|---|---|---|---|---|
| | Average Hight of Arch. | Number of Plants at Which Measured. | Average Hight of Arch. | Number of Plants at Which Measured. |
| | *Feet.* | | *Feet.* | |
| Aultman & Taylor | 1.1 | 6 | 1.7 | 6 |
| Babcock & Wilcox | 1.1 | 13 | 1.5 | 13 |
| Heine | 1.1 | 6 | 1.6 | 5 |
| Stirling | 0.9 | 16 | 1.5 | 11 |
| Miscellaneous water-tube | 1 | 3 | 1.3 | 3 |
| Return tubular | 1.1 | 5 | 2.2 | 6 |

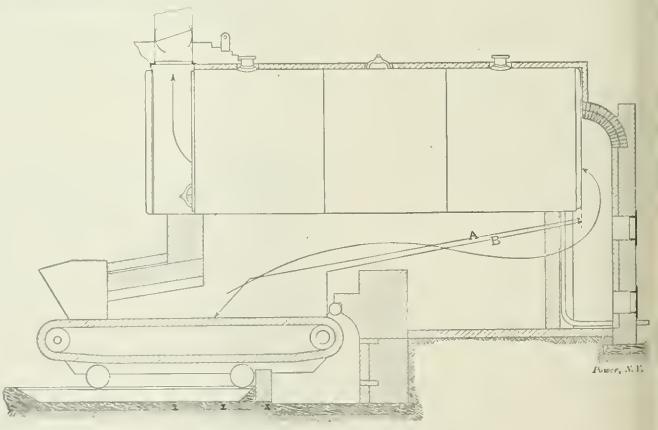


FIG. 3. CHAIN GRATE STOKER AND RETURN-TUBULAR BOILER

The coal, as received, burned per square foot of grate per hour of average heavy load ranged from 11.4 to 39 pounds, the average being 23.3 pounds.

Table 3 presents in more impressive form some of the particulars recapitulated above. It was compiled to show that with chain-grate stokers installed under 10 types of boilers (five different makes of water-tube boilers are included under "Miscellaneous") which were run at about their full capacity, at no plant was there any serious emission of smoke, combustion being practically smokeless. As bearing on the proper length of travel of the burning gases for coals from different States, the least and average distances from grates to tube-heating surface are given.

The average draft measurements at the plants were as follows: Average furnace draft, 54 plants, 0.10 inch of water; range 0.07 to 0.45 inch. Average draft at rear of boiler, 40 plants, 0.43 inch of water; range, 0.14 to 0.94 inch. Average draft at front tube sheet, four plants, 0.43 inch of water; range, 0.25 to 0.61 inch. Average draft at base of stack, 24 plants, 0.77 inch of water, range, 0.26 to 1.30 inch. These figures show approximate average drafts as follows: Furnace, 0.20 inch of water; rear of boiler, 0.45 inch; base of stack, 0.80 inch. These results give a drop in draft through the boiler of 0.25 inch of water and a drop from the boiler to the stack of 0.35 inch.

### Summary

The chain-grate stoker was found in plants carrying uniform loads and in plants where loads were extremely variable. With a uniform load and a proper setting there should never be any smoke with this equipment, but when a variable load is carried a faulty method of operation may cause the emission of dense smoke. In a chain-grate plant having a variable load, with the fire carried up to the water back, a sudden release of load will require a reduction of draft. Too often the damper is nearly closed, so that the coal on the grate and the fresh coal fed to hold the fire are burned with a limited air supply, causing the stack to smoke badly.

Plants equipped with the chain grate can be made to carry a very variable load with good results by changing the thickness of the fire, the speed of the grate, and the position of the damper to suit the load. The draft should not be reduced below a certain value, which can be determined for each plant by gradually closing the damper and watching the stack. In a plant where the maximum variations of load are nearly the same, it might be necessary to vary only the speed of the grate and the position of the damper. The damper regulator is often the cause of a smoky stack, because it is usually set to choke off the entire draft, a condition which is never necessary.

TABLE 3. SUMMARY OF VARIOUS OBSERVATIONS AT PLANTS WITH CHAIN GRATES.

| Type of Boiler | Kind of Coal. | Number of Plants. | Furnace Draft, Inch of Water. | Coal Burned per Sq. Ft. of Grate Surface per Hour, Average Heavy Load, Pounds. | Percentage of Rated Boiler Horsepower Developed, Average Heavy Load.* | Distance from Grates to Tube Heating Surface. | | Black Smoke, Per Cent. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Average, Feet. | Minimum, Feet. | |
| Aultman & Taylor. | Illinois, Ohio and Pennsylvania. | 7 | 0.23 | 19.4 | 83 | 5.2 | 3.2 | 4.4 |
| Babcock & Wilcox. | Illinois, Kentucky, Ohio and Pennsylvania. | 12 | 0.21 | 24.0 | 88 | 5.2 | 3.3 | 2.7 |
| Heine ...... | Illinois. | 7 | 0.22 | 21.2 | 113 | 8.4 | 6.4 | 6.5 |
| Stirling ...... | Illinois, Indiana, Kentucky and Ohio. | 18 | 0.19 | 23.5 | 91 | 7.0 | 4.9 | 5.4 |
| Miscellaneous water-tube | Indiana, Kentucky and Pennsylvania. | 5 | 0.20 | 26.2 | 104 | 8.3 | 5.5 | 7.5 |
| Return tubular | Illinois, Kentucky, Pennsylvania and Indiana. | 8 | 0.15 | 24.9 | 108 | 19.0 | 14.7 | 2.8 |

*Boiler rated on 10 square feet of heating surface per horsepower.

Both the speed of a chain grate and the slope of the ignition arch are important. Too often the grate is run so fast that volatile matter is being driven from the coal as far back as the center of the grate; usually in this case there is not only a loss from incomplete combustion of the gases but also losses from unconsumed carbon in the ash and from injury to the grate. Live coals in the ash-pit will not only warp a grate but gradually burn it up. The grate should not be run so fast that it will be hot when reentering the furnace. In one plant where a high draft was carried, a sloping arch was removed, and an arch built parallel to the grate. With the sloping arch the stack smoked, but with the flat arch it was entirely clean.

With chain-grate equipment a plant may run very inefficiently if the fire is carried only on the front half of the grate, as sometimes happens. When coal is burned in this way with a proper setting, it is because the fireman finds it the easiest way to carry a variable load and have a clean stack, demanding less of his attention in operation.

At some plants the boiler is forced by firing considerable coal through the inspection door. Although the desired result is accomplished by this practice, the plant becomes the equivalent of a hand-fired plant and the stack will invariably smoke badly.

## Charts to Determine Engine and Generator Capacities in Direct Connected Units

By N. A. Carle

In selecting the size of a direct-connected engine-driven generating unit for either direct or alternating current, the service for which the unit is to be provided is usually known in such terms that it can be specified as the kilowatt output capacity of the generator. This can be reduced to electrical horsepower by multiplying by 1.341, or by reference to the table on page 722 of the April 20 issue. The electrical-horsepower output capacity of the generator divided by the generator efficiency gives the brake horsepower of the engine, and this divided by the engine efficiency gives the indicated horsepower required in the engine.

The calculation by successive steps of the size of engine to be selected, starting with the volts and amperes necessary for the desired electric service, is not complicated, but it requires several operations and includes several different variables, all of which can be shown in a very convenient form by a graphical presentation.

The charts on pages 310 and 311 are for alternating-current units for single phase and three phase circuits of from 2000 to 2400 volts, delivering a maximum output of 300 kilowatts, with variables to cover steam- or gas-engine operation. These figures are intended to cover the ordinary sizes and kinds of units found in isolated plants and those supplying commercial and municipal lighting and power in small towns.

The chart on page 312 is for direct-current units to supply circuits of from 50 to 125 volts and delivering a maximum output of 150 kilowatts, with variables to cover steam- or gas-engine operation. These figures are intended to cover the ordinary sizes of exciters and units used in small direct-current lighting and power plants.

### Examples

(1) The estimated output required of a direct-connected engine-driven generating unit is 50 kilowatts. What horsepower of steam engine will be required if the generator efficiency is 95 per cent. and the engine efficiency is 95 per cent.?

Using chart No. 1 and starting with 50 kilowatts, read up to 95 per cent. generator efficiency, then across to 95 per cent. efficiency, and then down to approximately 74 indicated horsepower.

How many amperes will be furnished by this outfit if the generator is a 2400-volt, three-phase machine, with a power factor of 85 per cent.?

Using chart No. 1 and starting with 50 kilowatts, read down to 85 per cent. power factor, three-phase, then across to 2400 generator voltage, and then down to approximately 14.2 amperes.

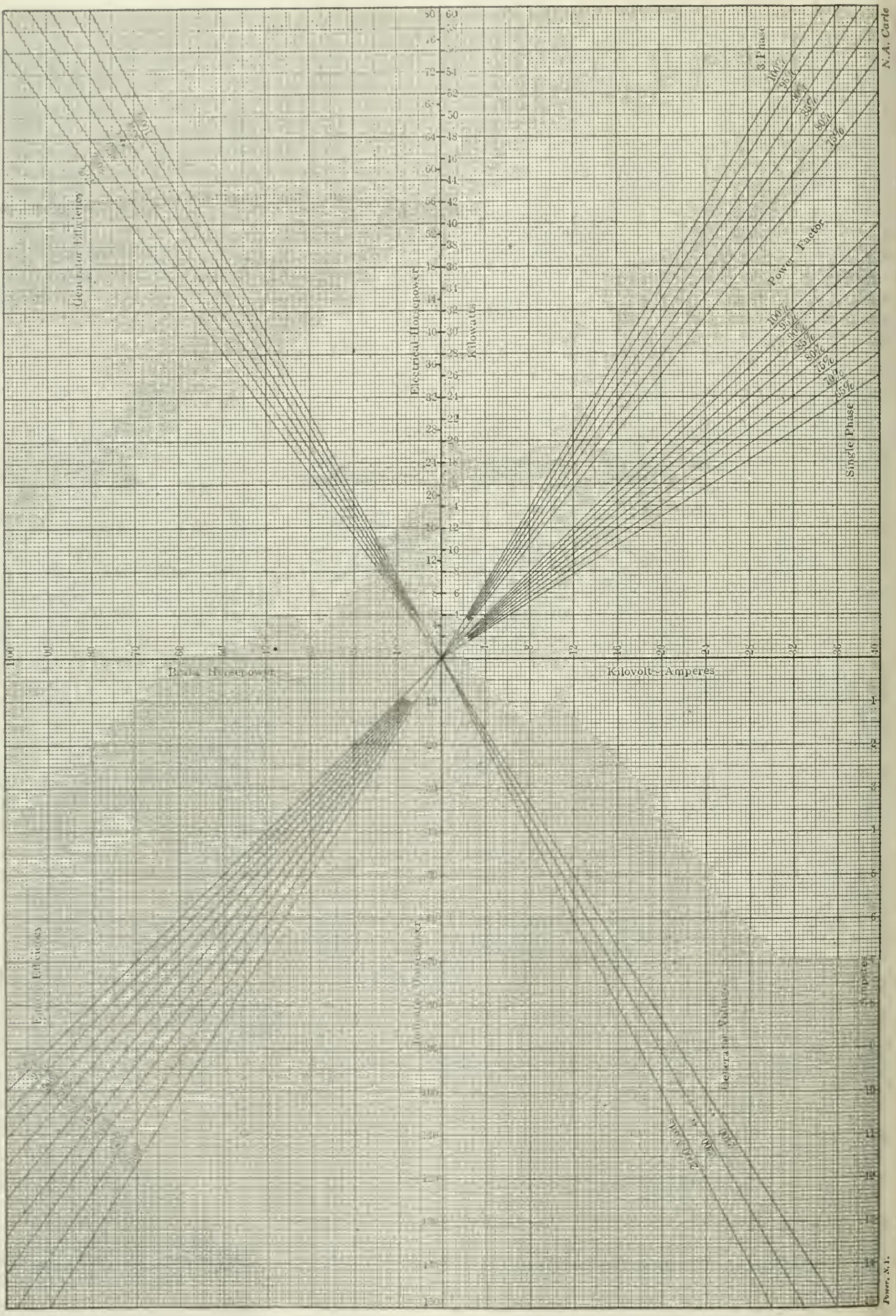
(2) The estimated service for a direct-connected gas engine and alternator outfit is 60 amperes at 2200 volts. What size of generator will be required if the system is to be three-phase and the power factor is 85 per cent.?

Using chart No. 2 and starting with 60 amperes, read up to 2200 volts, then across to 85 per cent. power factor, three-phase, and then up to approximately 194 kilowatts. A 200-kilowatt generator would be selected for this service. Reading back, it will be found that this generator would be capable of furnishing approximately 62 amperes per phase at 2200 volts, with a power factor of 85 per cent.

If the generator efficiency is taken at 90 per cent. and the gas-engine mechanical efficiency at 75 per cent., what will be the indicated horsepower of the gas engine?

Using chart No. 2 and starting with 200 kilowatts, read up to 90 per cent. efficiency then across to 75 per cent. engine efficiency, and then down to 296 indicated horsepower. A 300 horsepower gas engine would be selected for this service.

(3) The estimated excitation current for an alternating-current installation is 100 amperes at 90 volts. Assuming the



N. A. Carle

Power, N. Y.

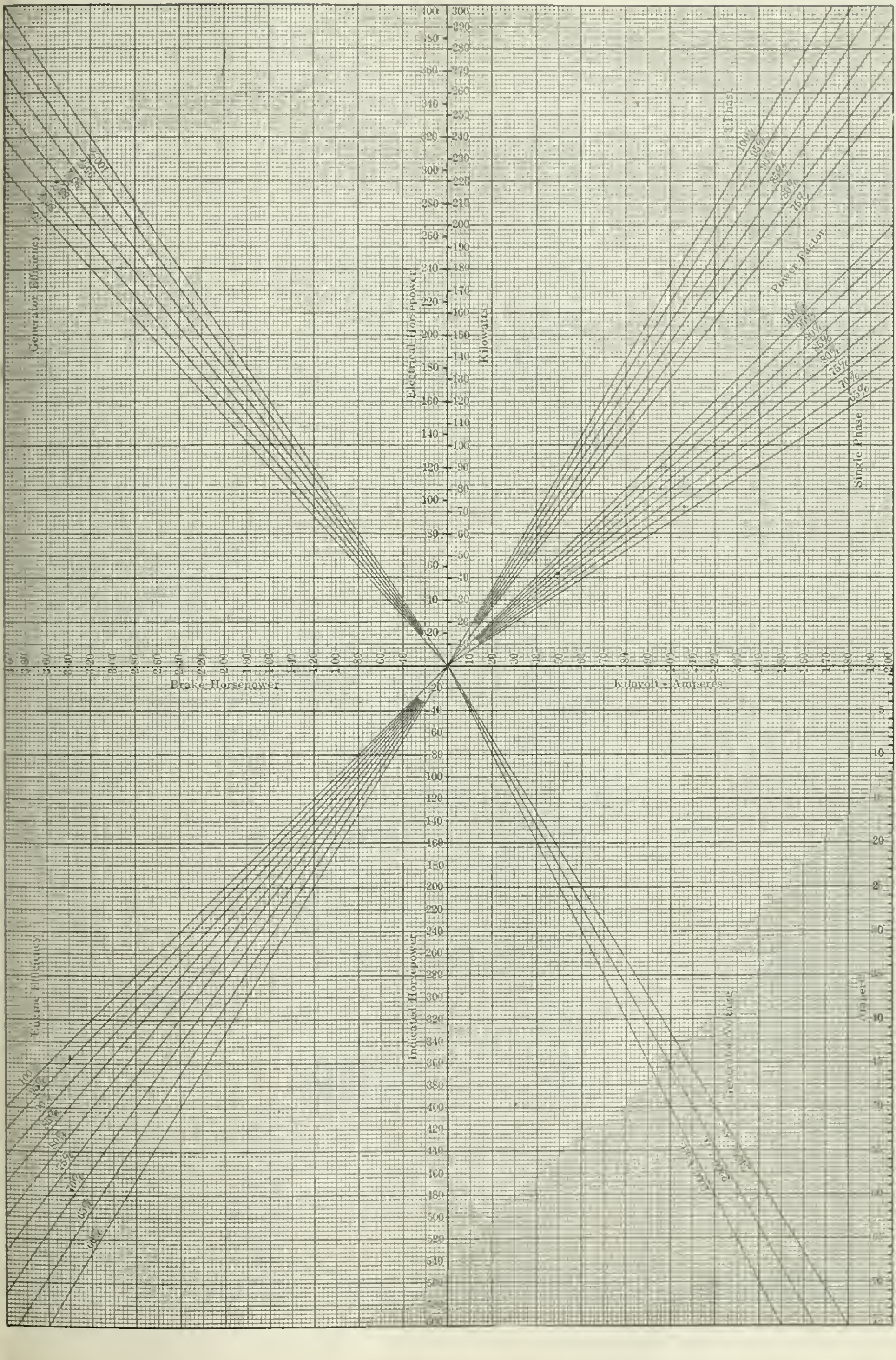


FIG. 2. DIRECT-CONNECTED ENGINE-DRIVEN ALTERNATING-CURRENT GENERATORS

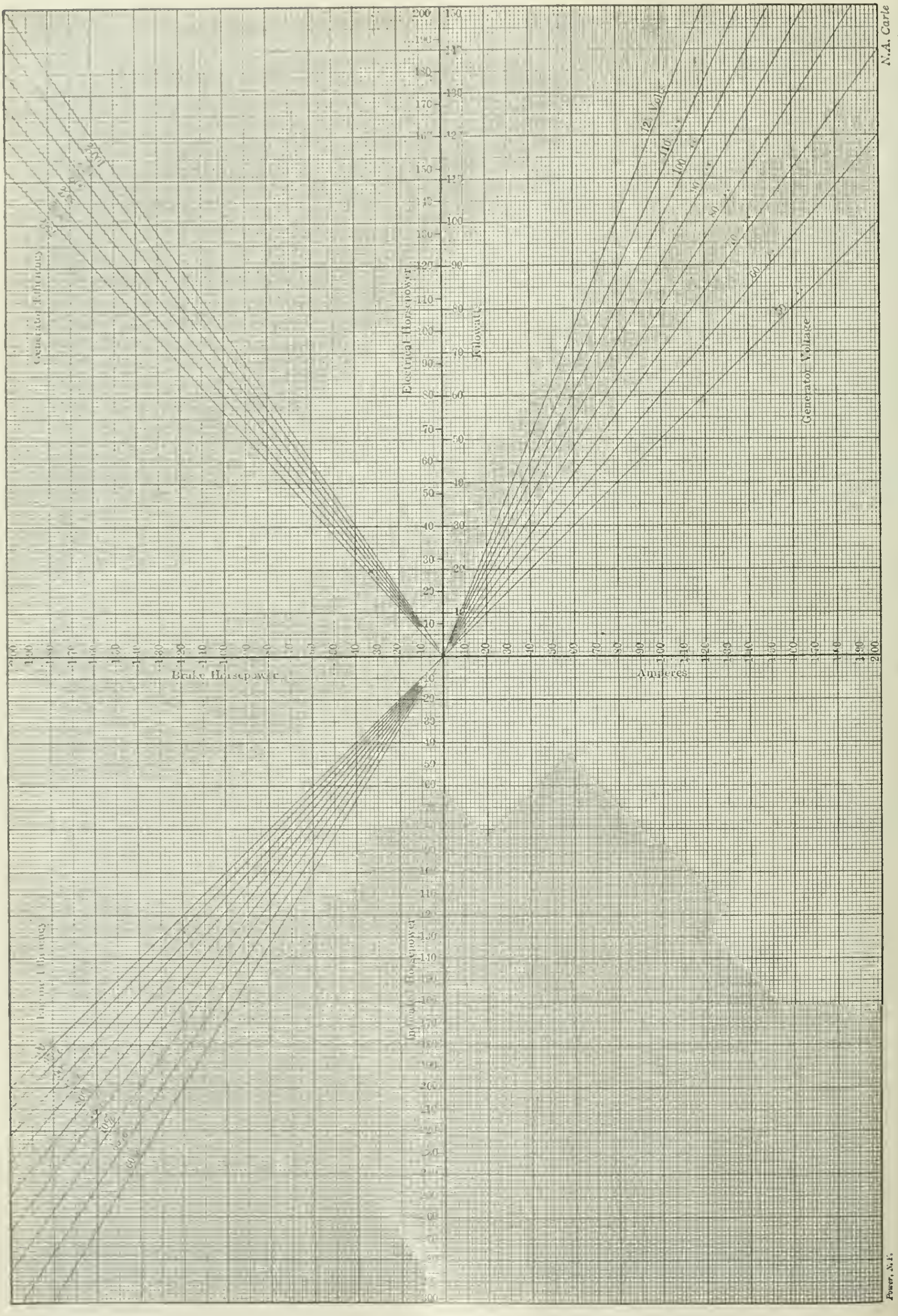


FIG. 3. DIRECT-CONNECTED ENGINE-DRIVEN DIRECT-CURRENT GENERATORS

xciter dynamo efficiency to be 90 per ent. and the exciter engine efficiency 5 per cent., what size of engine will be equired for a direct-connected exciter tfit?

Using chart No. 3 and starting with 00 amperes, read across to 90 volts, then p to 90 per cent. generator efficiency, then cross to 95 per cent. engine efficiency nd then down to approximately 140 indicated horsepower.

## Air Receiver Practice

By Frank Richards

Among the practical details of com ssed-air practice, the function of the receiver has perhaps received less than proper share of attention. Recent con ration of its use in these columns has en interesting and profitable and sug sts some further discussion.

Usually every compressor is provided th a receiver or air reservoir, and in riably it is placed quite near the com ressor. I am beginning to ask myself y the air receiver is considered such a essary adjunct, why, if used, it is ated so near the compressor, and some er questions implied by these.

As a reservoir for the storage of the air l for the maintenance of the pressure n the compressor stops, or when tem rily the demand for air exceeds the ty of the compressor, it is of little nt, since usually the total capacity the receiver does not exceed one min s output of the compressor with which is connected. When the air is being ed as fast as it is compressed, if a sud n stoppage of the compressor occurs pressure falls so quickly that it is ally too low for efficient service in lf a minute or less. The air in long lines of ample capacity will, of course, tend the time somewhat, but it is al ys found that when the air is used for stantly working tools, or other ap ratus, the storage feature is not much be counted on.

An experience which came early to the st extensive users of compressed air, rockdrill runners, was with the le and delay caused by the freezing f the exhaust passages of the drills. is freezing up was ultimately realized, a result not alone of the fall of tem ture of the air as it expanded in do g work, but was due also to the pres e of released moisture in the air, which isture could be deposited and frozen accumulating masses in the exhaust assages. The freezing temperature alone uld not make trouble of the kind that as actually encountered. If there is no ree moisture to be deposited and frozen, ere can be no choking up. This freez ng up is generally more cheaply and ef ectively prevented by the elimination of the moisture than by maintaining the temperature of the air above the freezing point. This is not in any way belittling the value or importance of air reheating. The desirability of having dry compressed air is generally realized, and it is commonly understood that the real and most important service of the air receiver is to give the air an opportunity to drop its superfluous moisture before it is delivered to its work, it being assumed that the air will most accomodatingly do this in the receiver, which is, therefore, provided with a drip cock, from which it is expected that the water is to be drawn. Generally speaking, it may be said that the air which passes through an air receiver as ordinarily installed does not emerge in a very dry state. In Fig. 1 is shown a horizontal air receiver connected to a motor-driven compressor used on one of the New York State barge canal contracts. It may be said incidently that, from a mechanical engineering point of view, everything connected with this compressed air installation is excellent. The piping and all accessories are perfect. Air leakage and such troubles are impossible here, and the cost of maintenance of the plant is at a minimum.

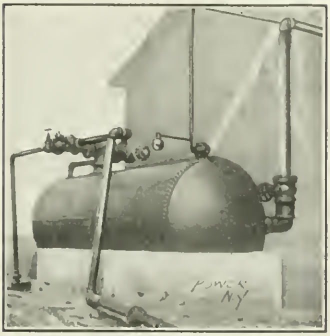


FIG. 1

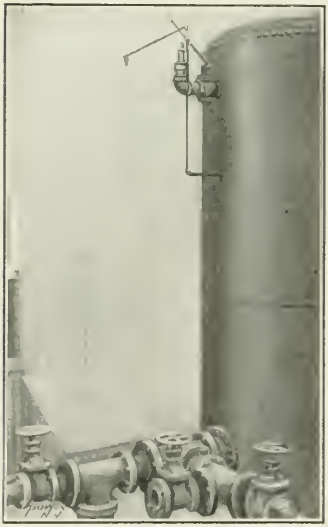


FIG. 2

The air from the compressor passes into the receiver at the side near one end, and out at the top, near the other end. As the air enters the receiver with the heat of the final compression, and as, after the receiver once gets as hot as the air, there is nothing in the receiver to cool the air and it passes out at about the same temperature as when it enters. From the location of the inlet and outlet pipes we may well assume that when the compressor is running, the entire contents of the receiver are in motion, and it would be rather absurd to assume, as correspondents do (page 1064), that the air is appreciably cooler at one point of the receiver than at another. With a temperature above 300 degrees Fahrenheit, there would be no apparent reason why there should be a difference of a single degree, or why, so far as temperature was concerned, the air might not be taken from one part of the receiver as well as from any other.

Nor would it make any difference, so far as the deposition of moisture in the receiver was concerned, where the outlet was located, because practically all the moisture in the air would be carried along with it, and out of the receiver in any case. It is a fact that there is a drain cock provided at the farther end of this receiver, and also while the man in charge perfunctorily opens the cock every few days there is no water there to be drawn off.

In Fig. 2 is shown a vertical air receiver connected to two steam driven air compressors at lock 7, on the barge canal. The air enters near the top of the receiver and passes out to the distributing pipes near the bottom. There is little practical advantage shown by this arrangement over that of the horizontal receiver connected as in Fig. 1, and if the connections were reversed or otherwise arranged very little water would accumulate in the receiver in any case.

That there is moisture in the air, and carried along with it when leaving the receiver, is evident, as in case the air has passed through a quarter of a mile of pipe and has become cooled to normal temperature while still under full pressure in the pipes, water will be found; and with any suitable opportunity here provided for the water to collect, and with means for drawing it off, considerable quantities may be obtained.

When compressed air is at its highest pressure, and at its lowest temperature, its capacity for moisture is at the minimum, and cold compressed air, which is at the point of saturation, would then pass for dry air when expanded to atmospheric pressure and repeated. It is for securing this desired condition of low temperature with high pressure that the aftercooler has its value in connection with the air receiver. While there is little or no deposition of moisture in the air receiver as generally used, with only hot air passing through it, the case is very different if the air is thoroughly cooled before the receiver is reached, the receiver then becoming a water collector.

An interesting and uptodate compressor plant, the designers of which have given evidence of recognizing and appreciating the things which are worth while in compressed-air practice, is that which is being installed at High Falls, Ulster county, N. Y., for the work of construction of the Rondout siphon in the Catskill extension of the New York City water supply. In the power house there are ten compressors, with a combined capacity of 24,000 cubic feet of free air per minute. One feature of this plant is the employment of aftercoolers for the entire system. For each pair of compressors there is the usual air receiver. Conveniently near, but close to each vertical-air receiver there is also a vertical aftercooler, through which the air from the compressors must first pass and be thoroughly cooled before entering the receiver. In this case we can fully understand that the air in the receivers will be in condition to drop its superfluous moisture, and there can be little doubt that considerable quantities of water will be drawn from those receivers, and that the air when it comes to be used will be so "dry" that no inconveniences will later accompany its use.

I have to confess, however, that even the arrangement of the aftercoolers thus combined with and preceding the receivers does not promise complete success in the drying of the air. In the receivers here spoken of there would certainly be opportunity for discussion as to the best points of location for both inlet and outlet, but more than that is required to be considered.

To induce the air to drop as much of its moisture as possible, not only must we have the highest pressure and the lowest temperature occurring simultaneously, but we must also give the air *time* for the completion of the deposition of the released moisture.

I was at one time foreman of a shop extensively manufacturing pulleys, shafting, hangers, etc., especially pulleys, and I introduced a machine for grinding the faces of the pulleys instead of turning them. Of course the grinder made lots of dust which was effectively taken care of, so far as the machine was concerned, by an exhaust fan which was an integral part of the apparatus, but the disposal of the dust-laden air was the question.

It happened that the proprietor of the works was often afflicted with novel and brilliant ideas, and one of them struck him in this connection. The tall brick boiler stack of the works was only a few feet from the grinder, and a pipe carrying the discharge from the fan was led into it, sending all the dust up into the sky with the smoke. Could anything be simpler? Unfortunately many people lived in the immediate neighborhood and on the first washday the dust was heard from. The white clothes on the lines were covered with yellow spots of iron rust, and the exhaust into the stack had to be suddenly abandoned.

We then went through a course of experimenting to find some way of getting the dust out of the air so that it would not make trouble. The exhaust pipe of the fan was only 3 inches in diameter, and we made a vertical box a foot square and of considerable hight with shelves occupying half the area, about a foot apart vertically and placed alternately on opposite sides of the box so that the air could zig-zag back and forth and deposit the dust on the shelves, which it didn't do to any extent. The same box was tried in a horizontal position with no better results, and other trials, of which these may be taken as typical, were no better.

The ultimate solution was simple enough. We finally realized that if the air moved slowly enough, the dust, or most of it, would drop through the air of its own weight and settle along the way. The air was discharged into one end of a horizontal box or chamber 4 feet square, and here it dropped the dust so that it could be shoveled out at openings provided while the air passed out through a large opening near the top at the other end and was never after heard of.

The moisture in air, being always present, is, we might say, a part of the air, and until the point of saturation is reached the air remains transparent and it is more ready to absorb more moisture as it finds the opportunity than it is to give it off. When its moisture capacity is so reduced by changes of pressure or temperature, especially the latter, as to cause it to be oversaturated, then the excess of moisture is condensed into water and forms a cloud distributed through the air, the cloud consisting of minute drops or particles of actual water, those portions of water being then heavier than the air and being sustained in the air just as dust is by friction, and with always a tendency to descend through the body of air by the action of gravity. Give the water in the air sufficient time, and it will drop to the bottom of the channel where the air flows, when it can be drawn off.

In the air receiver as usually installed, even if all the other conditions for drying the air are secured, there usually is not enough time allowed for the released water to drop out. It would seem that if the cost of the receiver, the aftercooler being assumed, was all put instead into the enlargement of sufficient lengths of horizontal pipe, thus forming a long hor zontal receiver through which the ai could flow with the requisite slownes drier air would be delivered.

## Elimination of Oil from Condense Steam

By George H. Gibson

Oil is usually present in exhaust fror reciprocating engines and from pumps an other apparatus in the steam cylinders o which lubricants are employed. Befor the steam or the water condensed from i can be applied to many purposes, thi oil or grease must be removed. Eve where the steam is condensed in a je condenser the oil should be removed i the tail water of the condenser is to b used for boiler feed or other purpose especially if the same water is circulate again and again over a cooling towe Where such tail water has been discharge into a cooling pond holding four or mor times the total amount of circulating wate used per day, it has been found tha trouble from oil did not become seriou but this well serves to show how greatl diluted unpurified condensed steam mus be, if trouble from oil is not to be encountered. Only about one-thirtieth o less of the jet-condenser circulating wate is condensed steam. Where the exhaus steam from reciprocating engines condensed in surface condensers is to be use as boiler feed, the removal of the oil i imperative, although the condensate otherwise is composed only of pure distille water. It is desirable not only to remov the oil from the condensate, but als to prevent the entrance of oil into th surface condensers themselves, since i will soon so thickly coat the heat-transmitting surfaces as greatly to reduce th effective capacity of the condenser.

Similar considerations apply in the cas of exhaust-steam heating systems, bu even with greater economical significance If all of the exhaust from reciprocatin engines is utilized for heating or drying the fuel cost of the power produced becomes very little, and if all the return condensed from the exhaust can be use again for boiler feeding, nearly all of th expense for feed water is likewise cut off Oil should not be allowed to enter steam piping systems and radiators, as its removal therefrom is most difficult. It wa formerly customary to dissolve grease ou of surface condensers, closed heaters, heating coils, etc., by means of a strong solution of caustic soda, caustic potash, or lye but modern cylinder lubricants are composed largely of mineral oils and minera oils are not saponified or otherwise affected by alkaline bases.

Closed heaters come under the same classification, as regards oil, as surface condensers, that is, unless protected by a efficient oil separator the condensate must be rejected as unfit for boiler-feed purposes.

### Methods for Removing Oil

The earliest methods for removing oil were probably by allowing condensate to stand, and by skimming. A certain portion of the oil, that is, the part that remains as free oil, will come to the surface because its specific gravity is less than that of water and then it can be removed in this manner from open hot wells or skimming tanks. With the high steam pressures and temperatures now employed this method does not prove satisfactory, for even after all the free, visible oil has been removed, the condensate will still have a bluish, opalescent or milky appearance due to the presence of particles of oil in suspension, which condition persists after days and even weeks. When such condensate is brought to a high temperature in the boiler, however, free oil invariably makes its appearance. The explanation of this is found in the fact that the oil is present in the water in an emulsified condition, that is, it is subdivided into minute globules, each of which appears to be protected by an oxidized coating that prevents coalescence of the separate particles. Under a high-power microscope the globules of oil can be seen and measured. Some are as small as even $\frac{1}{100{,}000}$ inch in diameter.

The small size of the oil particles and their nonadhesive character explain why all attempts to remove emulsified oil from condensation by means of filters have proved futile. To these minute oil particles the meshes of any type of feed-water filter, even the finest terry cloth, are in comparison about as large as the trees of the woods are to the birds. Experiments in the laboratory show that these oily particles entirely escape the finest experimental filter employed by the analytical chemist. In other words, it is impossible to strain the oil particles from the water by means of the difference in size between them and the water molecules. It is true, of course, that some oil will appear on filter cloths, but this is the free oil. When it is considered that a 1000-horsepower engine will use, say, three gallons of oil during six days of ten hours each, it will be seen also that quite a considerable amount of filtering cloth would be required if all the oil were present in the free state. As a matter of practical experience, it is poor engineering to depend upon any kind of filter to remove the oil from the water, since the emulsified oil escapes the filter.

It has also been attempted to remove oil from condensate by chemical treatment. Some years ago the Detroit Edison Company conducted a series of experiments with the purpose of finding some commercially practicable method of removing oil from condensed steam. The only effective methods of treating condensate containing oil in suspension or emulsion discovered were either to heat the emulsion to a temperature well above 350 degrees Fahrenheit, or to precipitate the oil particles with sulphate of alumina, fuller's earth, powdered chalk, or other similar coagulent. Cochrane vacuum-oil separators were installed in the exhaust lines to the surface condensers and the intention was to remove the oil from the drips from these separators so that all of the condensed exhaust could be returned to the boilers. The following conclusions are taken from the report of the experiments:

"With the low water rate of the city of Detroit, 2¼ cents per thousand gallons, it is doubtful if the system would be a profitable investment, unless, as before mentioned, it is desired to operate on a pure water cycle entirely. The separator on exhaust mains should, however, be retained in any case, thereby enabling a large percentage of condensation to be saved irrespective of the drips. With higher water rates for large condensing systems, where waste from drips would be considerable, it is probable that the system could be employed to great advantage, both from the standpoint of saving in water bills and boiler maintenance."

The practical inference from the foregoing is that oil particles can be removed from exhaust steam successfully only before the steam is condensed. The following considerations will make clear why this is more feasible than filtration: A filter must depend upon differences in size in order to secure separation. The oil in water is a mechanical mixture, but it is of the most intimate nature, so complete as to appear like a chemical mixture, the microscopic globules of oil being distributed evenly throughout the water and remaining in suspension for an indefinite time.

Before the steam is condensed, the situation is different, as the oil then exists as particles of liquid blown along in a current of gas. The oil separator takes advantage, not of the size of the oily particles, but of their weight, that is, of the difference in specific gravity between the oil and the steam. The specific gravity of oil as referred to water is about 0.9, while that of saturated steam at 212 degrees Fahrenheit, referred to water, is about 0.0006. Therefore, a particle of oil is around 1500 times as heavy as the same volume of steam, and it is a case of a light gas carrying heavy particles in suspension, as air carries sand in a sand blast. When the gas is compelled to change the direction of flow suddenly, the heavier particles shoot on ahead against the obstruction.

In industries where hot water is required for washing, dyeing, etc., it is highly economical to use hot condensed returns or to heat the water in an open heater by means of exhaust steam, but it is absolutely necessary that such steam be entirely purified of oil.

In order to secure satisfactory results with an oil separator the engine-cylinder oil should be purchased under a rigid specification as to flash point, since oil which is vaporized or burned into a gas by the temperature of the live steam performs no service in the cylinder as a lubricant, and if it remains as a gas in the exhaust cannot afterward be removed. A better oil may cost more per gallon, but it will generally be found that the final cost of a good oil will be less, while the loss of power and a damage from friction in engines will be greatly reduced. Recently a chemical company experienced some trouble with the cylinder lubricant, and upon testing it found that the flash point was less than 200 degrees Fahrenheit, that is, less than the temperature of exhaust steam. The price of this oil was 23 cents per gallon, and upon substituting a better grade, costing 60 cents a gallon, it was found that about only one-fourth as much was required in the engines.

The following specification for cylinder oil is used by a large ice manufacturer and may be of service to others:

High-grade filtered cylinder oil is desired.

The oil must be of uniform quality, clear and clean and free from foreign matter. The flashing point must not be below 553 degrees Fahrenheit, and the burning point not below 623 degrees Fahrenheit. The test will be made in an open cup by heating the oil not less than 20 degrees per minute, and applying the test flame every 7 degrees, beginning at 539 degrees. Gravity to be about 24 degrees Baumé at 60 degrees Fahrenheit.

The oil must flow readily at 70 degrees Fahrenheit and at 350 degrees Fahrenheit the viscosity must not be less than that of a pure sugar solution containing 62 grams of sugar in 100 cubic centimeters of the syrup, the viscosity of the sugar solution being taken at 80 degrees Fahrenheit.

The viscosity tests will be made upon the torsion viscosimeter.

A sample will be taken at random from each shipment upon receipt and tested, and the entire shipment will be accepted or rejected on the result of this sample.

In case of rejection, freight both ways must be paid by the shipper.

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A new pyrometer for the measurement of high temperatures, known as the Féry spiral pyrometer, has been brought out. The instrument is simple in principle and construction. Instead of the heat rays being concentrated on a thermoelectric couple, as in earlier instruments, they are focused on a small bimetallic strip made of two metals rolled into the form of a spiral, which unrolls when heated, owing to a difference in their coefficients of expansion.

# Practical Points on the Water Colum

## Some Excellent Advice for Boiler Attendants about the Location and Care of One of the Most Important Devices in the Plant

BY J. R. EARLY

The device which shows the water level within a steam boiler is equally as important as the safety valve and should receive the same care and attention. In stationary work it is usually a fixture termed the "water column," and consists mainly of a closed cast-iron cylinder connected at the top by suitable piping to the steam space of the boiler and at the bottom to the water space. At the extreme top and bottom of this cylinder are openings for glass gage connections, with a drip-cock connection on the lower one. At different levels on the cylinder are located openings for try gages, usually three in number, which are almost useless adjuncts in that position on 90 per cent. of the stationary boilers in operation, and are of use only when the glass gage is out of order. As a rule they are of so little account when attached to the water column that they are never kept in repair and soon become entirely useless, many times their vents being plugged up with small sticks of wood driven into them.

Try gages should be connected directly to the boiler, for then they would serve as a check on the entire water column; as usually connected, to the column itself, they serve only to check the glass gage with the water column, and the water in the boiler may be at a different and unsafe level. It requires only a slight knowledge of mechanics to tap and fit a try gage directly to a boiler, and there is no reason why at least one cannot be run to the point of lowest working water level in every boiler installation, and two or three would be of great assistance to the careful attendant in preventing dangerous water levels. Two tests for safety in this respect are as essential as two feed lines, two pumps or duplicates in any part of the power plant.

### Best Locality for a Water Column

In view of the fact that a very large per cent. of stationary engineers consider conditions safe when water can be seen in the glass gage, or it can at least be blown out at the drip cock, regardless of the location of those parts with reference to the highest heating surface, it is good policy to set the column at a level which will bring the lower glass-gage connection up to a point not less than 2½ inches above the very highest surface exposed to the direct heat of the furnaces.

Glass gages which show water at a level below exposed heating surfaces are positively dangerous in the hands of a majority of steam-boiler attendants. It is surprising how many blindly assume safety when they can see water. For the same reason if it is possible, when installing a water column, have the length of the glass such that maximum high water will be at the extreme top of the glass. The highest level permissible is not as readily determined as the lowest and is largely found by experience, but the amount of water evaporated and the degree of dirt saturation are the main factors which limit the rise of water level in any boiler, although in return-tube locomotives and other types having domes, or water-tube boilers with auxiliary steam drums, the water level may be carried higher than in like boilers without these features, and still deliver dry steam.

### Piping and Connections

In piping a water column as few turns as possible should be made and in every turn a tee or cross should be used in order to facilitate thorough cleaning. While the steam pipe should be as short and direct as possible, a place for connection to the boiler should be selected which will always insure full boiler pressure against the steam side of the water column, as it requires only 0.036 pound pressure to raise water one inch, and it is readily seen that only a very slight difference in pressure on the two sides of a water column may serve to cause a dangerous difference between the actual water level and that shown. That is one of the many conditions in which try gages connected directly to the boiler would be of great advantage. Steam connection should never be made to domes, auxiliary drums or pipes leading away from a boiler, but always to the main shell or drum, for many times there is a slight expansion of the steam, under heavy loads, after it leaves the main part of the boiler, due to too small passages to the dome, drum or pipe, and while it may not cause a continued fictitious level, it will cause undue and fictitious fluctuations upward, which may cause the attendant to think he has too much water and slow down the feed pump. Such a condition is very liable to become annoying where there are water alarms attached to the water column, by causing needless blowing of the alarm whistle.

The water connection should be given a liberal depth on fire-tube boilers, any boiler having the main part of t water in one large body, or any wat tube boiler in which conditions not hereafter will warrant. So doing will gi better results when blowing off t column by having a greater head of wat and by taking water below the light d which floats near the surface. On t other hand, the connection should not low enough to come into the region heavy dirt at the bottom of the boil Experience will best determine the exa location for best results.

In connecting columns to water-tu boilers there is the additional necessi of guarding against getting either t steam or the water opening in line wi the heavy currents which are set up them, especially water currents.

Pockets in the piping must be avoide for they will collect dirt in the wat pipes, which will hasten choking up, a water in the steam pipe, which will cau a continued incorrect water level, whi is always higher than that in the boil and may be sufficient to be dangerou especially in boilers of the fire-box ty wherein a very slight exposure of t crown sheet brings about extreme dang

Any part of the water pipe which is the path of the hot gases should covered with some nonconducting m terial; it will greatly assist to delay cho ing with hard scale.

### Importance of the Blowoff

The blowoff of a water column is very essential feature and should alwa blow from the lowest point in the wat connection. In many instances provisi is made for blowoff connection at t bottom of cast cylinders, but anoth should be connected as stated, unless, in some types of water-tube boiler, t connections are such that the bottom the cast cylinder is the lowest part the entire water column. The lower co nection of the blowoff will materially a sist in keeping the passages clear b cause of the greatest head of water t wash through them. It may be of i terest to know that when the blowoff opened far, the full boiler pressure is d rected toward it, driving water out unle the steam passage is closed, and in cas where the blowoff is much smaller tha the steam connection, or has great lengt or numerous turns, there is but littl aside from the actual head of water b tween the point of the blowoff connection and the water level to drive the water out. This may be explained as a back pressure of the steam against the water, which a little study will make clear. Also, a little study will make clear how much more difficulty will be experienced in cleaning the water connection when the blowoff has to raise the obstructing filter through a piece of vertical pipe than when it comes straight out.

In regard to valves in the pipe connections, with the exception of the "freezing" of the water column when the boiler is out of service, they are unnecessary in an ideal installation looked after in a careful manner, and in cases of carelessness or a desire to cause an injury to the boiler, valves may become sources of danger. A valve may be permissible in the steam connection to produce forced blowing out of the water pipe which may have become choked through neglect, but a valve should never be placed in the water connection except for the purpose of "freezing," as noted, and in every instance it should be an angle valve in full view of the boiler attendant.

### Causes of Failures

Of the numerous failures of the water column, the bursting of the glass gage is perhaps the most frequent. This failure is caused mainly by a breaking of the glass near the top, due to the trickling of the water of condensation down the inside. The corroding effect is due to the great capacity of condensed steam for absorption and it will attack anything with which it comes in touch to satisfy that capacity. But whatever the cause of a broken glass, many times the blowoff valve can readily be opened to draw the hot water away from the break, and then the valves cutting off the glass gage may be shut without danger of the attendant being scalded. When trying to insert the new glass it is a very aggravating situation to find it a trifle too long with no glass cutter on hand, but a makeshift can be had in a small file, round, square or three-cornered. Break a piece off of it, insert a broken end at an angle in the glass and with one of the sharp corners a short piece of the glass may be cut off by marking around it as with a regular gage-glass cutter. Of course, only a short piece can be cut off at a time in this manner but enough can be cut to reduce any glass, however long, to the required length.

The next most frequent failure of the water column is due to closure of the pipe connections. If there is a complete stopping of the water pipe, either by a closed valve or a deposit of sediment, and there is no leakage at any point between the place of stoppage and the steam end of the column, it is very evident that the water will stand steady in the glass gage and gradually rise by condensation from above. This is one of the most dangerous conditions of the water column, because the attendant is very liable to think the feed pumps are running too fast and slow them up, especially if the water stands without much fluctuation. It would be a difficult matter to have a leakage which would just balance the incoming condensation and hold the water at a constant level, but the danger would remain almost as great as before, depending upon whether the water was above or below the working level; if it is above, the feed pump is liable to be slowed up, creating a very dangerous condition to bring about low water, while if the column shows a level below the regular working level, the pumps are liable to be increased in speed, even to the extent of overflowing the boilers. In event of any considerable leakage, such as might occur at the blowoff valve, it follows that the water will fall in the column with a rapidity depending upon the amount of leakage and completeness of pipe closure; thus the greater the leakage at the blowoff valve, or the nearer the pipe is entirely closed, the faster the water will fall in the water column, and in the case of a gradual choking there may be a difference in water level between the boiler and water column covering a considerable period, with the ever-present danger of the water being raised too high within the boilers, which may be sufficient to cause damage to the engines, knocking out a cylinder head or causing some other break which would permit a great rush of steam, with its attending danger to the boilers and employees. But the condition is one of very delicate balance and is not liable to remain very long. Any small thing, such as a piece of scale lodging in the restricted water passage, will destroy the balance and in a moment the water may all disappear from the water column while there is still an ample supply in the boiler.

As soon as the attendant notices the absence of water he may at once "take to the woods," or he may take what he considers a safe course and cover his fires; but if he is really a good man he will not let his column get into such a condition and will have try gages run directly to the boiler. It is possible this condition is not quite as dangerous as those mentioned before, for the attendant is more apt to notice the entire absence of water in the glass before any serious change takes place in the boiler-water level.

### Other Conditions

Only three other conditions have ever come to the writer's notice to cause the water to leave the column and still have ample water within the boiler, nor can the writer conceive of any others, although there may be other causes. First, a large area of heating surface acting on a small body of water will cause it to swell with the steam in it, especially if the water is very dirty. If in that condition the load is suddenly thrown off the pressure will rise a little, which will materially stop the boiling, the heat going to raise the water to a temperature for the higher pressure as it increases. This is frequently the condition in water-tube boilers and in view of the fact that their working water level embraces a very limited surface area a great drop in water level may occur, it even becoming a real case of low water if previously it was close to the danger line.

Second, this same condition may be brought about on boilers which use cold feed water by excessively increasing the feed on a hard-worked boiler. The drop of water level will be made greater by throwing in a fresh fire at the same time, which has a temporary cooling effect, no matter what its previous condition may have been. This also may cause real low water if it has been close to the danger line, but the probability is that before the fireman or attendant has time to think much about it, the steam will drop a little, the water begins to boil again, swell and rise in the glass gage as mysteriously as it went down.

The third condition is a very usual one, and is due to a dirty condition of the water through neglected cleaning, having to feed dirty water, or the use of too much chemical for scale reduction. In this case the attendant will sometimes open the blowoff suddenly and, notwithstanding that there was plenty of water before, none returns. Again, it is sometimes a "case for the woods" or covered fires. The failure of water to return is caused by the plugging of the water passage by the sediment which has lodged and jammed in it, due to the sudden opening of the blowoff. It is always best to open the blowoff slowly the first time to avoid this occurrence, and then make a second opening rapidly, if it is desired to test the column for speed in blowing down. This trouble is more liable to occur where there are many turns in the water pipe and restricted passages due to an accumulation of hard scale. A leaky blowoff valve will hasten this trouble, also, for the water slowly flowing through the passages soon deposits enough sediment completely to stop them up, and many times causes continued and untold annoyance in that way, as well as danger.

The writer has seen many instances of this sort of failure of the water column and many instances in pipes of feedwater and other water systems. It is about the only condition wherein a valve in the steam connection is of any service when closed, by directing the full boiler pressure against the obstructing sediment jammed in the water passage. Full boiler pressure does not always relieve the situation, however, and the choked condition is made worse rather than better.

### Pounding the Pipes Dangerous

To pound the pipes is a dangerous practice, to be considered only as a last resort where cooling down the boiler would entail great loss or damage to property. It is good judgment to cool a boiler down when the water column becomes in this condition, unless there are try gages direct to the boilers, and in case there are more than one boiler with their water-column blowoffs connected to a common pipe, after the pressure on the boiler in trouble has been reduced below that of the other boilers by opening its blowoff and another on a boiler having full pressure, many times a few pounds blown back will relieve what the full pressure blown ahead will not. It is always better to give each column a separate blowoff pipe because of greater freedom of passages, fewer turns and better ability to inspect for leaks in individual columns; but in event of connection to a common pipe, advantage can be taken of it sometimes, as stated.

In the case of a valve in the steam connection the dangerous condition is when it is closed or so nearly closed that it causes the water to rise out of sight in the glass gage. In that condition the average boiler attendant will take it for granted that there is too much water, slow down or stop the feed water and perhaps blow down the boiler, doing the very thing he should not do. If the steam pipe is closed only enough to cause a slight rise of the water level in the glass gage, it will be known by violent surging of the water in it; the violence depending upon the freedom of the water passage. In the ideal installation properly cared for, wherein the pipe connections are cleaned with a frequency sufficient to insure a clear passage through them and the water within the boiler is not permitted to become seriously charged with filth, a valve in the steam pipe is a superfluous fixture, but as stated it has some benefits which come into use, as we diverge from the perfect care of a boiler and its accessories.

A little attention to the action of the water in the glass when blowing down many times will locate an approaching trouble before it becomes serious, and the peculiarities of water columns should be studied like those of people.

### Points to be Remembered

The lowest safe water level should be determined to within a fraction of an inch and marked in plain view on the water column or boiler front. The attendant should make himself perfectly familiar with how fast the water drops in the glass gage when the blowoff valve is opened and how quick is the return when the valve is closed. If at any time the drop becomes quicker and the return slower it indicates that the water connection is obstructed, but if the water drops slowly and returns at normal speed it indicates a restriction in the blowoff pipe, which may be due to scaling up on account of a leaky blowoff valve, or the valve itself may be out of order. The disk may be partly unscrewed from the stem, and if the pressure is on the stem side of the valve it will take the slack up toward the seat, thereby reducing the opening. Eventually it will come entirely off of the stem, if not fixed, and it may cause a dangerous condition to exist by not properly closing the blowoff. Sometimes through neglect the cross passage from the cast cylinder to the glass gage becomes clogged, which will be indicated by a slow drop and return of the water in the glass when blowing off the column. This test may be checked by leaving a try gage open when blowing off, and if the slow movement of the water in the glass is due to a choked cross passage, water will appear at the try gage before it rises that high in the glass. This is a condition which is very liable to be brought about by a leaky or inoperative drip cock.

Also, attention should be given to the sound made when blowing off. A change in it many times will give warning of a partial closure of the water connection.

### Fluctuations in the Glass Gage

The fluctuation of the water level in the glass gage is a point which is an interesting and instructive study within itself. Large columns and small or choked water connections tend to reduce the amplitude of fluctuation while the reverse is true of small columns with large and clear water passages. The water level will stand quietest on boilers having a large body of water in proportion of the area of the heating surface, such as the old style of two-flue boilers; and the opposite is true of most water-tube boilers. Also, heavy loads tend to increase and light loads to reduce the amplitude of water variation in the glass gage. The writer believes this fluctuation or running of the water in the glass is a good thing if it does not go to excess, and for that reason the cast cylinder should be made small and the pipe connections large, which also will help to avoid choking.

By attention to the running of the water in the glass gage, the attendant can tell when the pipe connections are becoming choked with sediment, which will be indicated by a quieting of the water in the glass. Also, it is a good indicator of the load and will show a change, especially an increase, long before it is shown by any other means in the boiler room, and many times will give ample warning to increase the fires before there is any fall of pressure.

In return-tubular, fire-box or any type of boiler in which the water consists of one body with a large surface area, the running of the water in the gage glass is due to the waves which roll from one end of the boiler to the other, and the water within the boiler near the water column rises and falls almost in unison with that in the column; but in the case of water-tube boilers, in which the body of water forms loops, a different condition exists and the fluctuations inside the boiler may be opposite those in the glass gage. As a rule the steam from several or all the tubes of a water-tube boiler is delivered to one passage leading up to the steam space and if the water column is connected to this passage, the level in the glass gage will fall with heavy loads, due to the balancing column of water inside the boiler becoming lighter on account of the steam filling it, which is a principle many engineers will recognize in the pumping of deep wells by forcing air to considerable depth in them. If the water column is connected to the opposite end of the water loop, when it goes down, the fluctuation or running in the glass gage will be in unison with that inside the boiler. Should the fluctuations go to an extreme, causing too great a difficulty in determining the actual water level or an unreasonable blowing of the alarm whistle, they should be reduced in amplitude in boilers of the return-tube, fire-box, and other types having large surface area of the water, by a large cast cylinder and never by smaller or throttled water connections. On most water-tube boilers amplitude of fluctuation can be reduced by connecting the water end of the column higher upon the boiler more readily than any other way. Connecting higher up reduces the unbalancing effect of the steam-filled water within the boiler and can go to any length in that respect, but in no event should the water end be connected to the boiler above the level of the water connection in the cast cylinder. Boilers are made in a multitude of shapes and types but as far as the water column is concerned they may be considered as one of the twq foregoing classes.

Is it not safe to say that some time in his experience every engineer has been misled by a spot on a dirty glass gage, believing it to be the water level? Keep the pipe connections clean, keep the glass gage clean, to avoid error in finding the true water level, keep the try gages open and ground tight, keep the blowoff valve tight, blow off with a frequency that experience teaches is reqired to keep any particular column clear, and for the sake of pride in your work keep all the parts bright and clean.

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The seventh annual convention of the Colorado Electric Light, Power and Railway Association will be held at Denver, Colo., October 7, 8 and 9, the same week of the conventions of the American Street and Interurban Railway Association and allied organizations.

# Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think,
Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

## A Broken Center Crank

In Fig. 1 is shown a diagram of a broken crank on a 10x12-inch center-crank hoisting engine, also the machinery which caused the break. At the left-hand end of the crank shaft are two paper frictions, next to which are two pulleys on the same shaft with the spools. These pulleys can be thrown either against the friction or against the rub block, by means of the eccentric bearing shown in the diagram. The flywheel is at the extreme end of the crank shaft.

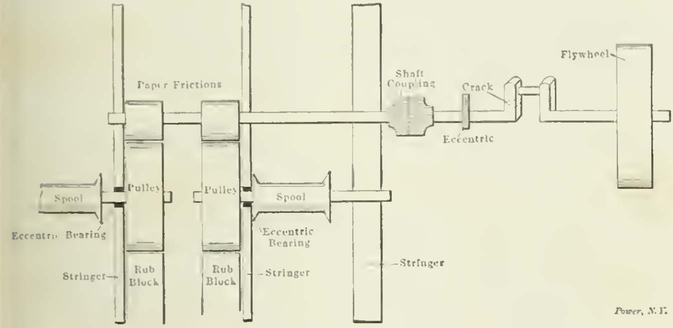


FIG. 1 THE BROKEN CRANK, AND HOW THE ENGINE WAS CONNECTED, CAUSING THE BREAK

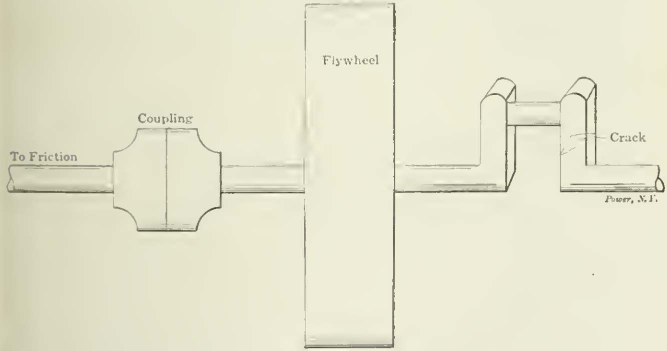


FIG. 2 POSITION OF THE FLYWHEEL, CRANK AND ECCENTRIC AFTER THE REPAIR WAS MADE

It is often necessary to raise loads ranging from five to ten tons already suspended. The engine is speeded up so that it cannot stop on the center, when the load is thrown against the friction This allows the flywheel to gain considerable energy, and when the load is thrown on the engine it has a tendency to stop the crank shaft at one end, while the flywheel tends to turn the shaft at the other and twists or breaks it; in this case it was the crank.

This could happen only when the crank was on either center at the moment the load was received by the crank shaft, or when the operator had just throttled the steam. I disconnected the crank shaft at the coupling, and stripped the shaft of its half of the coupling and also the eccentric. The crank end of the connecting rod was also disconnected and the caps taken from the main bearings. A piece of iron, ¾ inch thick by 2½ inches wide, was shrunk on to the broken crank. Then the shaft was replaced in the bearings, but instead of placing it as it was originally, we turned it end for end as shown in Fig. 2. The flywheel is now where it will catch the jar instead of the crank.

LOUIS T. WATRY.

Colorado City, Colo.

## Don't Stand in Your Own Light

I think the editorial, "Don't Stand in Your Own Light," in the July 20 number, a good one. If you have a suggestion to make for the improvement of your plant, make it, and if it is not acted upon at once make it again and, as long as you know you are right, keep on making it until action is taken.

I have in mind a case where it took an engineer two years to convince his employers that a certain change would save the price of improvement in three months, and the amount saved would be about one and a half times the engineer's salary. The engineer finally got what he asked for, and proved that he was right. There is no doubt that this man stands higher with his employers than if he had given up and thought: "Well, if they don't want to save money they can let it alone!"

Sometimes you may make a mistake; but have you ever noticed that the man who does not make mistakes is the man who does not do enough to amount to much anyway? If you are the man in charge, have you found it best to judge your help by the week or month to see how they average up? We are not any of us at our best every day.

If you are one of the assistants, and the "old man" comes in looking crosser than ever, don't get "sore," too; try and do something to please him; shine up that dirty lubricator, or get that pile of sweepings out of the corner where you have been pushing it the past week. You will both feel better over it.

If you are the fellow who comes around with something to sell, don't think the engineer is a "queer sort of a guy" if he doesn't give an order for everything you have. If we did this our engines and boilers would look more like Christmas trees than anything else

W. C. SCHUELER.

East St. Louis, Ill

## Remedying Air Leakage

A few months ago, C. B. King, manager of the London Street Railway Company, London, Ont., assisted by R. H. Welburn, mechanical superintendent, decided to dig down into the working of the power plant with the idea of locating defects by the removal of which the present plant could be made more economical.

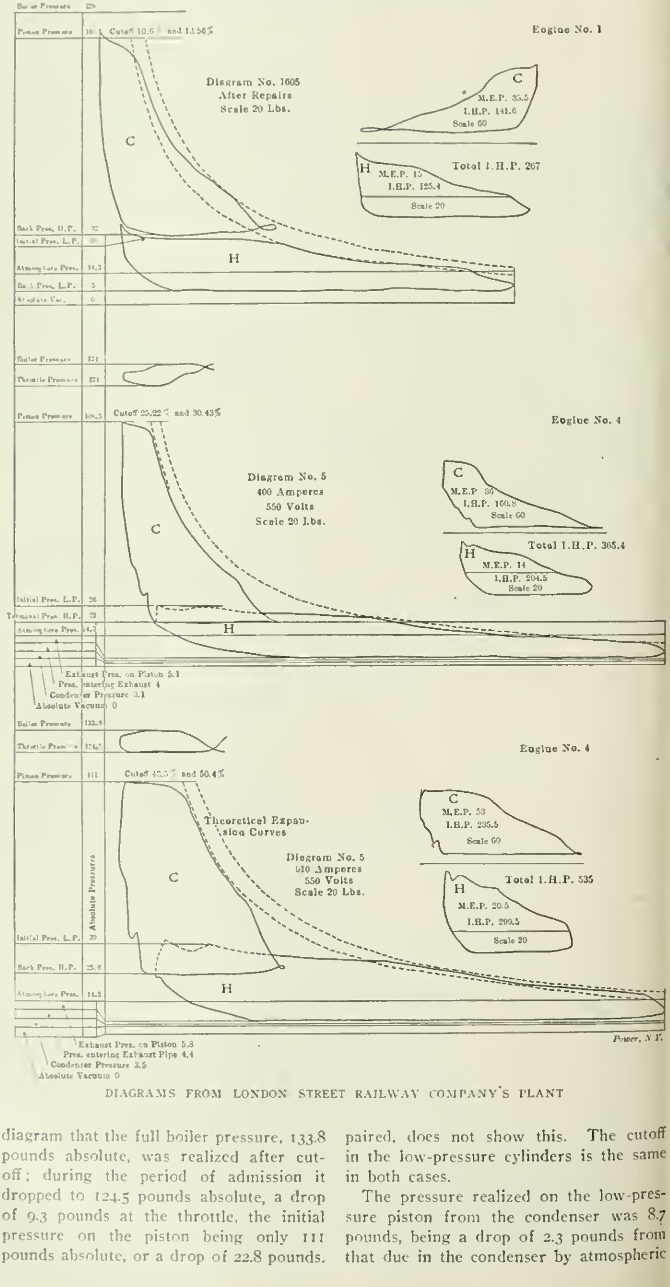
It was decided to find the losses of pressure of steam in passing through the different stages of piping and cylinders to the condenser. All instruments used were known to be correct. All the engines are Armington-Sims piston-valve type, with flywheel governors, and in excellent running condition. The cylinders and valve chests of No. 1 were rebored, with the corresponding work on the piston and valves. No. 4 had been running several months without any work being done to the valves or pistons. The different diagrams were obtained by connecting the instruments as follows: An indicator was placed on the steam pipe immediately above the throttle valve. The motion for this indicator was direct from the indicator on the crank end of the high-pressure cylinder. On the low-pressure cylinder the indicator was on the head end. As the cranks are at 180 degrees, this end received the steam that the indicator on the high-pressure cylinder accounted for. A fourth indicator was connected to the low-pressure exhaust pipe, as close to the cylinder as possible. This indicator received its motion direct from the one on the low-pressure cylinder. A fifth indicator was placed directly on the condenser where the manufacturer (Davidson, Brooklyn), had provided an opening for the vacuum gage.

The assistance of a timekeeper assured that all diagrams would be taken at one time. The absolute line is the one due to the barometer on that date. The altitude of the locality is 800 feet above sea level. There were about 26 sets taken, two for each condition of load. A throttling calorimeter at the throttle showed 1.7 per cent. moisture. The boilers are 6 feet in diameter and 18 feet long, of the dry-pipe type. They are very close to the engines. There is a 7-inch riser from the boiler leading to a 10-inch header. The condensation from the header is led to a trap which discharges into the open heater. The pipes leading to the engine are 7-inch, connected to the top of the header with gate valves. The pipes lead down to the engines by bends of 4-foot radius. There are no separators. All piping is well covered right to the steam chests. The clearance on all the engines is 9 per cent. for the high-pressure cylinders and 10 per cent. for the low-pressure cylinders. The "Davidson" jet condenser, with a steam horizontal direct-acting air pump, takes care of the four engines and is below the engine-room floor level. The exhaust pipe, about 25 feet long, is 12 inches with two elbows and one angle valve. The cutoff on the high-pressure cylinders is controlled by the flywheel governor, that on the low-pressure is fixed at 7/16 of the stroke.

It will be noticed by the steam pipe diagram that the full boiler pressure, 133.8 pounds absolute, was realized after cutoff; during the period of admission it dropped to 124.5 pounds absolute, a drop of 9.3 pounds at the throttle, the initial pressure on the piston being only 111 pounds absolute, or a drop of 22.8 pounds.

The next period is one of considerable interest. The release pressure from the high-pressure cylinder is 25.6 pounds absolute; while the initial pressure on the low-pressure is 38 pounds, or 13.4 pounds more, caused by excessive leakage from the high-pressure to the low-pressure cylinder. Engine No. 4, which had been repaired, does not show this. The cutoff in the low-pressure cylinders is the same in both cases.

The pressure realized on the low-pressure piston from the condenser was 8.7 pounds, being a drop of 2.3 pounds from that due in the condenser by atmospheric



DIAGRAMS FROM LONDON STREET RAILWAY COMPANY'S PLANT pressure. This 2.3 pounds is lost: through the exhaust port, 1.4 pounds and through the length of the exhaust pipe, 0.9 pound. The effects of clearance are demonstrated through the different periods. The lead, assisted by compression, has to fill the clearance as well as overcome condensation and leakage losses in 0.15 of a second. The clearance alone is equal to 400 cubic inches in the high pressure, probably the condensation with the leakage as found where engines are well looked after, will amount to as much or more than this. The lead on the piston stroke shown by the pipe diagram on card No. 5 is about $\frac{5}{8}$ inch and still the drop to initial pressure on piston from the boiler pressure is 22.8 pounds. The velocity of the steam to supply the displacement of the high-pressure cylinder is 3969 per minute, or 66.15 feet per second. This represents only the velocity required to fill the displacement made by the piston. To this must be added leakage, clearance and condensation. All of these are assisted by compression. It has been demonstrated that the actual quantity is about one-third more than this. We therefore have a velocity of 5292 feet per minute. If this velocity was constant the size of pipes could even be reduced, but in this case it is brought to a state of rest 400 times per minute, as well as brought to its maximum velocity the same number of times. A large receiver close to the steam chest is the only solution as far as concerns the steam pipe. The drop between the throttle and the piston can be reduced only by reducing the clearance.

The losses of pressure in the exhaust pipe and ports are a large percentage of the gain by the condenser. In this case the pipes are large, the velocity due to piston displacement being 4248 feet per minute. The increase of volume due to the lowering of pressure has considerable to do with preventing the drop of pressure to the lowest point. Another point was to discover why the condenser would not maintain the vacuum it originally did doing the same work. Naturally the reply must be "air leakage." In most cases of this kind there is someone that requires a more explicit reply, which comes down to "where?"

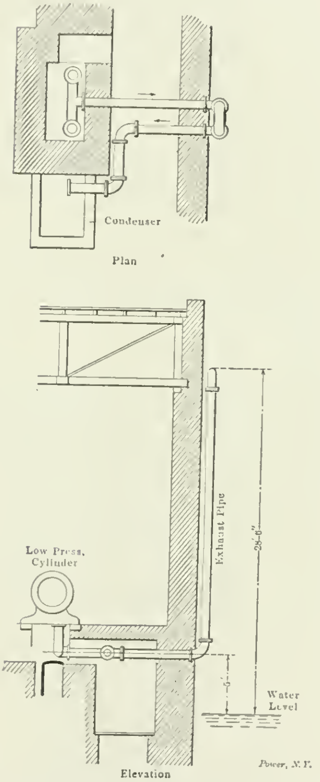
The pump was in good condition. The exhaust piping and all packed boxes and valves were found to be in good condition. There was no easy method of closing the inlet of the injection pipe. The feed pump and its connections to the open heater were ascertained to be correct as far as air leakage was concerned. Then it must be with the injection pipe somewhere. This pipe, owing to changes and extension of buildings, is entirely inaccessible. The temperature of the condenser relative to the vacuum was the only proof. A thermometer well was provided with connections extending to the center of the condensing chamber. The results were from several readings: Average vacuum, 19 inches; temperature due to this vacuum, 105 degrees Fahrenheit; that actually in the condenser, 87 degrees Fahrenheit; injection or condensation water, initial, 50 degrees Fahrenheit; hot well, 96 degrees Fahrenheit. It was decided from this to leave the old pipe where it was, a new one in an accessible course to be put in. The trouble is now over.

J. O. B. Latour.

Toronto, Ont.

## Water Wrecked Compound Engine

About a year ago I witnessed the breakdown of a steam engine under peculiar circumstances, and as the actual reason for this accident was not investigated sufficiently at the time, it occurred a second time with a more serious result. The engine had cylinders 22 and 34 by 40 inches, and ran at 100 revolutions per minute. It had been run for several weeks, after having been put in operation, without giving any trouble.



SHOWING REPAIR TO COMPOUND ENGINE

One evening while the engineer was stopping the engine for the day, knocking of water was heard in the low-pressure cylinder, the tailrod of which worked the air pump of the condenser. The resulting shocks were so violent as to bend the connecting rod and the crank pin.

At this time it was assumed that the accident, caused by the accumulation of water in the low pressure cylinder, was due to the negligence of the engineer in not closing the valve of the water-supply pipe of the condenser when he stopped the engine. As the low-pressure cylinder, after closing the steam valve, created a greater vacuum than the air pump, the water consequently rushed into the condenser and from there through the exhaust pipe into the cylinder, damaging the engine as mentioned.

After straightening the connecting rod and making a new crank pin, the engine was again started. But after having made only about 20 revolutions, water again found its way into the low-pressure cylinder and damaged the engine to a far greater extent than the first time. The engineer stated that the finger of the vacuum meter had already risen to the 21-inch mark, but quick as lightning fell back to zero, and with a cracking sound the bedplate of the low-pressure cylinder broke near the main bearing. The cotter connecting the piston rod and crosshead was sheared off, the connecting rod and crank pin were bent again, and the crank was somewhat twisted and bent. The firm from which the engine was purchased was notified, and sent an expert to look into the matter. His investigation showed the accident to be due to the insufficient distance of the level of the low-pressure cylinder from the water level in the tank supplying the condenser. In starting the engine, the exhaust steam created a vacuum in the condenser, lifting the water from the tank into it. As the engine, in starting, had but a slow speed, the air pump was not capable of discharging all the water and it flowed through the exhaust pipe into the low-pressure cylinder. To avoid a similar occurrence, the exhaust pipe leading from the low-pressure cylinder to the condenser was replaced by a ∩-formed section, as shown in the illustration. Since this change was made the engine has been running without giving the least trouble.

Charles A. Schranz.

Camden, N. J.

## Throttling Steam to the Engine

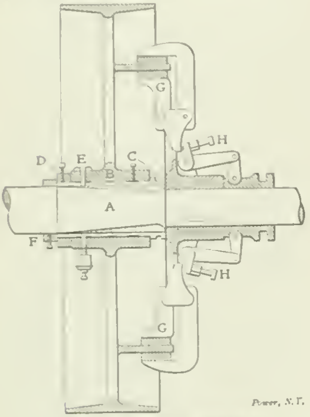
There is a 14x22-inch engine in a certain engine room, running at 156 revolutions per minute, and carrying about 35 pounds pressure in the steam chest. The boiler pressure is 100 pounds and is cut down by a throttling governor. The question is, will the engine run more economical at a higher rate of speed than at a low speed, when operating with the same load?

A. A. Blanchard.

Oak Harbor, O.

## A Clutch Repair

The sleeve of a 75-horsepower clutch pulley was badly worn and the grease would ooze out at F without lubricating the end C. There were several other pulleys keyed and fastened to the same shaft, so, renewing the shaft or moving the clutch was out of the question. I repaired it in the following manner.



HOW A CLUTCH WAS REPAIRED

The removable split sleeve was taken from the hub, and after all the old babbitt was removed a layer of manila paper was wound around it and then replaced in the hub *B*. The collar *F* was put tight against it, and the clutch thrown in so that the wooden shoes *G G* held everything in its place, and by a slight adjustment of the screws *H H* the sleeve was centered.

A set screw was removed at *E* and a paper tube, also a ring of putty, put in its place for pouring the babbitt. All leaks were stopped with putty, and a vent was left at *C*. The space shown by the dotted portion of the drawing was filled with babbitt, the set screw at *C* was removed and a collar was placed at *D*. The pulley now revolves on the sleeve when the clutch is out, as the sleeve was made secure to the shaft by the babbitt.

Charles Haeusser.

Albany, N. Y.

## Natural Gas for Fuel

Some time ago Edward H. Lane took exception to my article on "Natural Gas for Fuel," with which I obtained a boiler horsepower on 27.05 cubic feet of gas, Mr. Lane assuming that my figures must be wrong. As my figures were obtained from a carefully kept record of almost three years and a daily load of about 1000 horsepower, I believe they are nearly correct.

Theoretically, it requires about 12 pounds of air per pound of combustible if coal is used, but in practice it is nearer 24 pounds, and on that basis I accomplished the results stated with natural gas and a homemade burner, as explained.

Because of improper combustion or an imperfect air distribution, I attribute the failure of most gas burners from an economical standpoint, because their efficiency is based upon 966 B.t.u., which is very misleading.

For Mr. Lane's information I will refer him to the very interesting and instructive article by Prof. W. D. Ennis in the July 14, 1908, number of Power, on the "Heat of Fuels and Furnace Efficiency," from which I beg to quote to make my point clear:

"Calculated heat values are not always accurate—and the heating value of a fuel is the quantity of heat evolved by the fuel in uniting with oxygen and the temperature obtained from the combustion of a fuel depends upon its heating value and other factors.

"In present practice, successful combustion means the evolving of the largest quantity of heat and the commingling of just sufficient air to furnish the necessary oxygen for complete burning.

"If the air supply is below the amount necessary for complete combustion, it decreases the evolution of heat and lowers the resulting temperature, causing a loss.

"If the air supply is in excess of that necessary, loss again occurs."

The professor concludes his article by saying as to high furnace temperature, "the condition which produces this result is that of proper air supply, and since this condition also leads to minimum loss at the stack, adjustment of air supply is the overwhelming factor in economical combustion to steam generation."

As Professor Ennis has described the conditions necessary for perfect combustion so nicely, I only wish to say that the results I obtained were from vertical water-tube boilers, each having 108 four-inch tubes, 22 feet long, with 2494 square feet of heating surface each, all gases from the furnace passing through the center of the steam drum to the stack.

With a furnace temperature of 1600 degrees and a stack temperature just above the steam drum of 545 degrees, a uniform furnace temperature was maintained with the walls and top of the furnace a bright cherry red. The ashpit doors were entirely removed and the damper to each boiler was wide open all the time, so the stack draft was constant.

As explained in a former article, if the amount of gas burned exceeded 8 ounces on the mercury gage attached to each burner (a pressure of 4½ pounds being on the 6-inch main line), an additional air supply through a 1/32-inch hole opposite the opening to each burner from an air line of 100 pounds pressure was blown into the furnace along with the gas, which would maintain a steady flow of gas and air to the furnace and stop the rolling of the flames, an impossibility with most gas burners and which could be observed through the necessary peepholes, the stack draft not being sufficient under those conditions.

Natural gas was the most economical and satisfactory fuel we ever burned, but because of the domestic rate being raised to 30 cents per thousand cubic feet, an industrial rate could not be obtained during the winter from the gas company and we have burned coal for almost one year.

We never had any clogging of gas passages or burned nozzles while using this burner and only had to renew the brickwork once in two years.

W. D. Ranney.

Columbus, O.

## A Tube Jack

Supporting new tubes, especially in the Stirling boiler when the weight of the tube has to be overcome, is a tedious task on the part of the helper.

In Fig. 1 is shown a homemade jack which holds the tubes in place and serves its purpose in every respect. The body is made from a piece of old 13/16-inch shafting, cut 1 inch longer than the diameter of the drum, with a suitable base having a socket in which the shaft sets. This allows for turning the shaft without its running sidewise on the side of the drum.

The nut is made from an old end of shafting turned a little larger than the diameter of the tube. The bar is rounded off to enter the tube easily and serve as a guide, while a shoulder is left to sit square against the end of the tube.

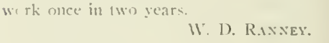


FIG. 1. TUBE JACK

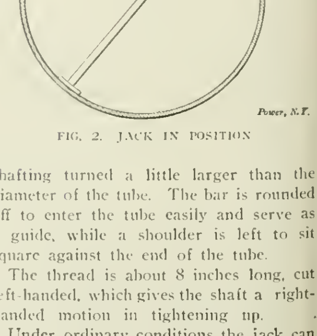


FIG. 2. JACK IN POSITION

The thread is about 8 inches long, cut left-handed, which gives the shaft a right-handed motion in tightening up.

Under ordinary conditions the jack can be operated by hand, otherwise a small pipe wrench is sufficient. It cost less than $1 complete, and has saved its cost several times. Fig. 2 shows the jack in position supporting a tube.

John Wells.

Ottumwa, Iowa.

## Corliss Engine Detaching Device

Our two 700-horsepower vertical cross-compound condensing Corliss engines, running in parallel in the power house where I work, used to regulate badly with a friction load on, the governor hunting up and down. When the load changed from heavy to light, the governor would go up so high that the engine would make six or seven revolutions without a valve opening.

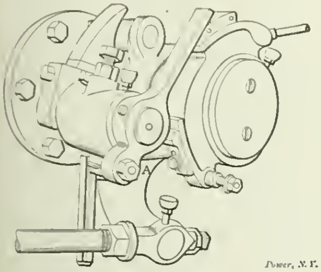


FIG. 1

The trouble was due to excessive tension on the spring at *A*, Fig. 1; so much so, that the knockoff cams had to be renewed after about two years' service, and a spring would break every once in a while. I gave the springs the proper tension, and the governors regulate now as well as could be expected.

The detaching mechanisms through which the steam and exhaust valves get their motion, Fig. 2, made considerable noise at each reversal of the wristplates, the teeth in block *D* being the only connection to the hook rod *B*. The handle *E* did not have the clamping effect, when thrown into the running position, and had to be tied down when running to prevent it from becoming detached from the hook rod. I removed the cap *N*, and inserted a liner at *T*, which was sufficient to bring the two halves of the hook *L* together and clamp the rod *B* tightly, when handle *E* was thrown into the running position. This stopped the noise.

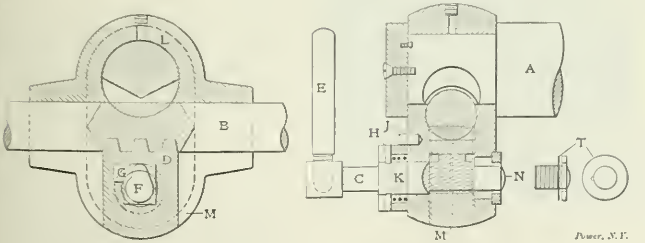


FIG. 2. DETACHING MECHANISM

In the illustration *A* is the wristplate pin, *B* the hook rod, *C* the pin which throws the locking block *D*, in and out. This locking block is a rectangular piece with teeth on the upper edge meshing with corresponding teeth in the hook rod. The block *D* is operated by turning the handle *E* sufficient to bring the cam portion of the pin *C*, into contact with the surface *G*. When the motion is continued, the block *D* is forced down and out of mesh with the hook rod. The block *D* is held in its unlocked position by the collar *H* coming into frictional contact with the pin *J*.

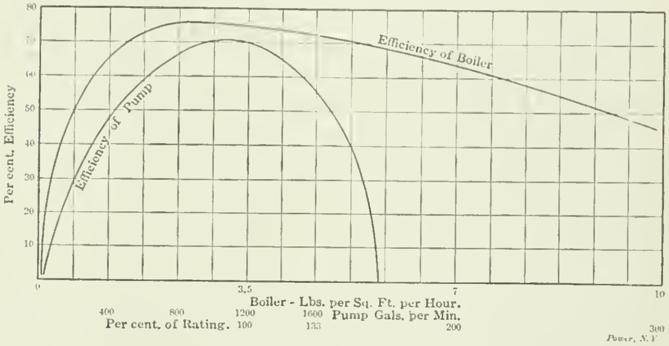
The spring *K* tends to throw the block into its locked position so that when the engineer wishes to lock the block in place, he simply throws the handle over, and when the hook rod comes into its proper position, the teeth in the block engages with those in the rod; after this engagement takes place the motion of the handle *E* is continued, clamping the block and hook rod firmly together. The hook *L* is split at *M* so that it is free to clamp tightly on the hook rod *B*; the pin *C* being threaded at *N*, for the purpose of bringing the two halves of the hook *L* together.

There is a slight clearance between the block *D* and the casting *L*, so that when the clamping action takes place, it is on the rod *B* and not on the block *D*. This clamping action is almost sufficient to hold the hook *L* and hook rod *B* together without the aid of the teeth. Notwithstanding this the three teeth give a much greater bearing surface than is afforded by the single pin sometimes used. The cam *F* also holds the stock *D* into contact with the hook rod *B*, so it is impossible for it to back out, and the frictional contact of the casting *L* materially helps to hold the rod firmly in place.

Thomas Sheehan.

Pittsfield, Mass.

## Efficiency of Boilers and Pumps



EFFICIENCY CURVES

In his letter on page 1165 of the June 29 number, Mr. Bement seems surprised to learn that the efficiency of a boiler is not a constant quantity, but is necessarily variable, depending on the rate of driving and other things. He understands the facts perfectly, but he desires to give a new meaning to the old and well known term "efficiency of the boiler," and attempts to coin a new term, "efficiency of operation," to represent what has hitherto been called by the old name. It is to be hoped that no subsequent writer will follow his example, which only tends to introduce confusion into the language of engineering.

For the last forty years the term "efficiency of the boiler" has been used to express a definite idea, and the term has been rigidly defined in the reports of the boiler committees of the A. S. M. E. in 1885 and 1890, in textbooks, and in the catalogs of boiler manufacturers. It would be as hopeless now to change its meaning as to change the meaning of the terms "moment of inertia" and "specific heat," both of which are sometimes objected to as illogical. If the term efficiency of a boiler is thus to be changed, we would have to change the meaning of efficiency of a pump, or of any other apparatus. The curves show that the efficiency of a certain turbine pump varies from 0 at maximum head and no delivery up to 70 per cent. at a lower head and a delivery of 1200 gallons per minute, from which point it rapidly falls to 0 at maximum delivery and no load. In like manner, a boiler which may have an efficiency of 0 when the rate of combustion is sufficient only to supply the radiation and chimney losses, may go to 75 per cent at a rate of driving of 3.5 pounds evaporation per square foot of heating surface per hour, and fall to 50 per cent at a rate of 10 pounds. With these data, what would Mr. Bement say was the efficiency of the pump and of the boiler?

WILLIAM KENT.

Sandusky, O.

## Valves Require Setting

In regard to Hugh Conway's Buckeye-engine diagrams in the August 3 number, I should say that they show late admission, late compression, late release and late and unequal cutoff. I should advise Mr. Conway first to advance the eccentric which operates the main valve, taking diagrams all the time, until the admission lines are perpendicular. This will give an earlier compression and earlier release. Both diagrams show unequal cutoff.

As Mr. Conway has not designated which is the head end, we cannot tell whether to lengthen or shorten the valve rod connected to the rider valve and shaft governor, but if the head end shows the longest cutoff he should lengthen the valve rod or the corresponding eccentric rod to balance up the cutoff. One cannot do better than to study the principle of the old riding cutoff-valve gear to become familiar with the Buckeye engine, which has made wonderful improvement in the way of design and economy. As a final adjustment Mr. Conway should take hold of the shaft-governor weights and block them out beyond their running position and see if the rider valve admits steam through the main valve to the cylinder, which it should not do; because with the weights out beyond their running position the engine would be racing. As the rider eccentric is attached to the governor wheel it would be necessary to turn the governor ahead in the direction the engine is to run until the rider valve closes the port in the main valve, after which fasten the governor wheel to the main shaft.

A. C. WALDRON.

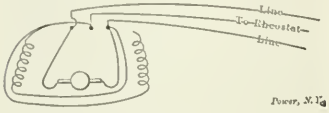
Lynn, Mass.

## An Exciter Trouble

In our plant we have but one alternating-current generator and exciter. The exciter had been running a good many years without repair, and the commutator was worn out. In a plant with but one unit, repairs must be done in a day, so early one morning I started and put on a new commutator.

When the machine was started up, it would not generate. I had tested the coils by the telephone-receiver method and they all showed up clear with the exception of a few. I did everything I could, but of no avail. It was 4 o'clock in the afternoon, and I was expected to have the lights on at 6 o'clock.

I knew where there was a 220-volt shunt-wound motor, and I set it up, but of course I could not use 220 volts on a 110-volt alternating-current field. The 220-volt motor was bipolar, so I connected the fields in parallel, instead of series, as illustrated, and ran the motor at about half speed, thereby getting 110 volts.



EXCITER CONNECTIONS

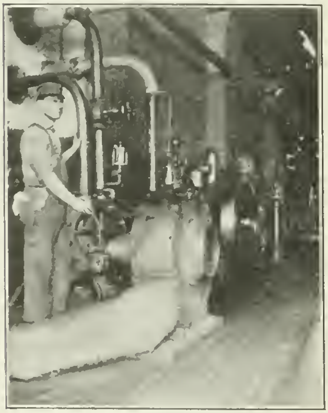
The next morning I connected my exciter up as a motor and it started on the spot. The exciter had lost its residual magnetism, that's all.

A. J. ALTHOUSE.

Birdsboro, Penn.

## Improvised Ventilation

Recently it became necessary to reset some boilers during the hot weather. The proximity of the boilers being repaired to those being fired rendered the temperature so high that the workmen could work only with great discomfort. To render conditions more tolerable, a ventilating outfit was improvised. The outfit consists of an old blower, to the discharge of which was connected a long flexible canvas tube, made of duck and coated with linseed oil to render it air tight. When in use the blower was belted to various auxiliaries about the station and the air directed to the place needed by means of the canvas tube.



IMPROVISED VENTILATION

C. L. GREER.

Handley, Tex.

## An Engine Wreck

Under the heading "An Engine Wreck," in the July 20 issue, Mr. Carl lays the blame on a careless fireman. This may be right in this case, but I believe the engineer in charge is the one to receive the blame. Anyone who has tried to regulate the water level in an open heater by hand knows it is a difficult proposition.

The real cause of the wreck was in not having a drain in the lowest point of the exhaust pipe. This drain can be connected to a trap if one is in use, or through a siphon into the sewer.

A. B. SUMMERS.

Lindsborg, Kan.

## Effect of Scale in Boilers

In a recent issue, F. H. Williams says he understands that 1/16 of an inch of scale in a boiler will cause a loss of from 12 to 15 per cent. in fuel, depending upon the character of the scale. He then asks what becomes of the corresponding amount of heat, whether it is absorbed by the boiler setting or is carried off by the escaping gases. In a more recent issue, J. L. Bradshaw replies that the greater part of the lost heat is absorbed by the boiler plates. It would be interesting to take a specific case and figure out what would happen if such were the fact.

A 100-horsepower boiler will evaporate 3450 pounds of water per hour, from and at 212 degrees Fahrenheit. In doing so, it will utilize 3,331,665 B.t.u. per hour. If this amount of heat is taken as a basis, instead of the larger amount contained in the coal, and if 12 per cent. of it were lost, then 399,800 B.t.u. per hour would be the amount of heat to be accounted for. It has been stated that the greater part of this would be absorbed by the boiler plates. Half of it would amount to 199,900 B.t.u. per hour.

The catalog of a reputable builder gives 11,500 pounds as the weight of a 100-horsepower boiler, including shell, tubes and braces and built for a working pressure of 125 pounds. Not more than half of the boiler, however, would be coated with scale so as to allow its temperature to rise above that of the inclosed water and steam, so the weight to be considered would be not more than 5750 pounds. Such a boiler would be built of steel having a specific heat of about 0.1165, so it would require only 670 B.t.u. to raise the temperature of the part protected by scale one degree Fahrenheit. If, therefore, the boiler plates and tubes absorbed 199,900 B.t.u. per hour, the temperature of the overheated parts would rise

$$199{,}900 \div 670 = 298$$

degrees per hour. If its temperature were 352 degrees to start with (which is the temperature of steam at 125 pounds gage pressure), at the end of the first hour it would be 650 degrees; at the end of the second hour, 948 degrees; at the end of the third hour, 1246 degrees, and so on until the boiler exploded.

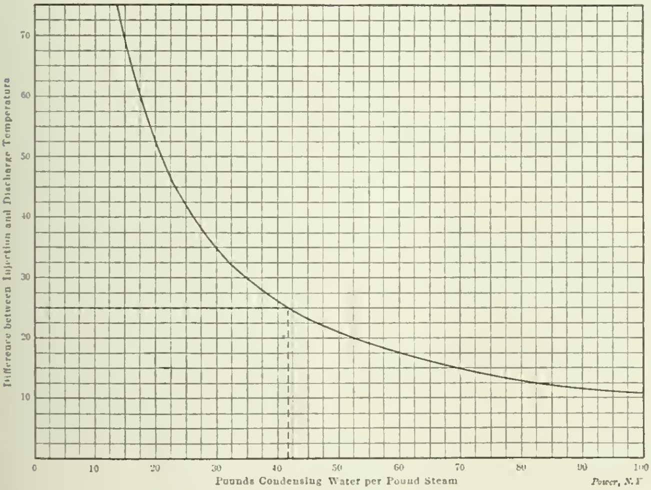
The truth of the matter is that the plates of the boiler would absorb a small part of the lost heat for a short length of time. Their temperature would rise and, at the same time, the temperature of the escaping gases would rise. The bulk of the lost heat would go up the chimney

C. W. Stevens

Boston, Mass.

## Circulating Water for Condensers

It is often necessary to know the amount of circulating water being used in any particular case; also the amount of water to be allowed for in any proposed condenser installation. Theoretical calculations must largely be relied upon, and are so used in practice in determining the amount of water required.



CURVE FOR DETERMINING CIRCULATING WATER

If the conditions of temperature and vacuum remain stationary, the amount of heat gained by the circulating water must equal the heat lost by the steam which is condensed. This neglects the slight loss through radiation; and the small amount of heat taken away by the vacuum pump, if the dry vacuum system is used. In general any practical case follows very closely this equation:

$$Q(t_d - t_i) = (H + 32) - t_d,$$

$Q$ = Pounds of circulating water per pound of steam,

$t_d$ = Temperature of discharge water,

$t_i$ = Temperature of injection water,

$H$ = Total heat in steam above 32 degrees (taken from steam tables).

In determining the amount of water needed, certain assumptions must be made, aside from the steam to be condensed and the vacuum to be maintained. These assumptions differ with different builders, and also according to the particular design of condenser. These are the amount of surface (which will not be taken up here), the rise and temperature of the injection water and the temperature of the discharge. The rise, or temperature range, depends upon the supply; or if the water is used over again, upon the cooling effect produced by cooling towers, or other methods of cooling water. The usual temperature range, if cooling towers are used, is from 20 to 30 degrees. In regard to the temperature of the water leaving the condenser, different builders claim to discharge the condensing water at from 15 to within 3 degrees of the temperature of the steam corresponding to the given vacuum. It does not pay, as a rule, to try to carry the discharge temperature too high, and a usual practice for best results is to have the discharge water 10 degrees below the steam temperature.

The accompanying curve is plotted from the above equation, considering a 27-inch vacuum and the water discharged at 105 degrees, which is 10 degrees below the temperature of the steam for a vacuum of 27 inches. It is sufficiently accurate, however, for other temperatures and ordinary degrees of vacuum. It is seen from the curve that the rise in temperature is the determining factor. The temperature at which the water is discharged makes very little difference; also any other vacuum within the range ordinarily carried, changes the amount of water required very little.

The variation from the curve is less than 2 per cent. for a vacuum as low as 24 inches, and for discharge temperatures from 5 to 20 degrees below the steam temperature.

As an example, assume the conditions to be as follows: Vacuum, 27 inches; discharge temperature, 105 degrees; injection temperature, 80 degrees (giving temperature range of 25 degrees); the load, 300 kilowatts, and 20 pounds of steam used per kilowatt per hour, which gives 6000 pounds of steam per hour to be condensed

Referring to the curve and following the dotted line, we see that 41.7 pounds of water are necessary per pound of steam, or

$$41.7 \times 6000 = 250{,}000$$

pounds per hour. To change from pounds per hour to gallons per minute, divide by 500 and we get,

$$\frac{250{,}000}{500} = 500$$

gallons per minute required.

The above applies alike to the surface and barometric condenser. In a surface condenser the quantity of water for a given amount of steam, and temperature range, depends upon the amount of condensing surface. If the temperature range is doubled, the same vacuum can be maintained, even if we had much less surface. A barometric condenser has to be designed more for the particular conditions under which it is to operate; especially the temperature of injection. If the temperature of injection were lowered we could decrease the amount of water somewhat and still maintain the same vacuum. But there must be sufficient water to spray, or spread out in the condenser in order to give the same condensing action. Also the quantity must be sufficient to fill the tail pipe and have velocity enough to carry out the entrained air. This is especially true of the "centrifugal" type of barometric condenser; which instead of being elevated the barometric hight, with the tail pipe discharging into a hotwell, discharges directly into the suction of a centrifugal pump. Even though a great temperature range could be secured, enough water would have to be used to enable the pump to give uniform and satisfactory operation.

If too little water is used, the air and water may separate in the suction passages of the pump and give an intermittent action, as a volume of air and then a gulp of water being discharged. This action could be seen by a gage on the discharge of the pump, or better yet by watching the ammeter, if the pump should be motor-driven. This irregular action may also be noticed if the pump is called upon to deliver greater than the normal quantity of water, or if the design is such as to create friction in the suction passages of the pump.

L. Corwin.

Newburgh, N. Y.

## A Left Handed Valve

Engineers will generally agree that it is highly unsafe to assume that instructions given to subordinates will be correctly interpreted and carried out. In many cases it seems that no matter how plain and concise the instructions are, errors are bound to creep in, usually where least expected.

I was given charge of the power end of a brick and tile factory at an early age, and although the plant was not of large capacity, I felt the responsibility deeply and put forth every effort to keep the "power coming." The engine was of 50 horsepower capacity, running at 310 revolutions per minute. It was unsuited to the work and was a cast off article from an electric-light plant, and was bought for a song. Two boilers were in service, both of the horizontal tubular type. One was of 60 horsepower and the other of 40 horsepower capacity. The surplus steam was used for drying the product preparatory for burning. These boilers were installed together with the feed pump and piping as shown in the illustration. The valve *A* controlled the feed to boiler No. 1 and the valve *B* to boiler No. 2. The boilers were run day and night, as is usual in plants of this character.

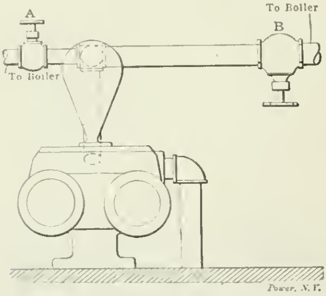
For some weeks everything went well, but after a time the night fireman was discharged for going to sleep and allowing the drying rooms to cool off. I was informed that a new man would be sent in during a certain afternoon and that I should be expected to show him "around," and give him such information as might be necessary. Accordingly, at the specified time he arrived, and proved to be no less than a worthy relative of the superintendent, a plasterer and bricklayer by trade, temporarily out of a job. He brought a note from the superintendent, pertaining to the items he was to be instructed in particularly. Among them were the spreading of coal, the cleaning of fires, importance of keeping plenty of water in the boilers, what to do in case the feed pump should fail, etc.

This fireman-to-be explained that he had never fired much and knew very little about a steam plant. Therefore, I set out to inform him thoroughly on every detail and did not realize until later that I was overdoing this part of the program. Beginning at the bottom, the evaporation of water into steam, steam pressure and use of steam gage, water glass, piping, opening and closing of valves, action of the feed pump, how the steam dried the brick, and a multitude of other things too numerous to mention, were explained to him. I wished to make a good impression with the boss so I postponed my supper and stayed with the embryonic fireman until after ten o'clock that night, leaving him with the water glasses full, the fires clean and a good head of steam on. My final instructions were for him to call in case anything went wrong.

My home was about a mile and a half from the works and on the way I chuckled to myself over the fact that in seven hours I had developed a first-class fireman. I could think of nothing that would mar the prospective "first night" for him.

After a late supper I turned in, but hadn't slept long before there was violent rapping at the door downstairs. I answered, only to learn that there was trouble at the plant and that the new man needed me right away. The messenger (the brick-kiln fireman) explained that it was impossible to get any water into the big boiler and that when he left the glass was almost empty and "Joe" was drawing the fire.

We made good time going that mile and a half, he to save a kiln of half-burned brick, and I to prevent a possible boiler explosion. When we arrived at the yards we met "Joe" looking for us in anxious expectancy. He said he hadn't been in for about 20 minutes and had made up his mind not to go back until he knew that everything was safe. Upon inquiry it developed that he had pulled the fire under the big boiler, but hadn't shut its steam valve at the top. He further explained that the little boiler was nearly full of water, nothing at all being visible in the glass.



SHOWING LOCATION OF LEFT-HANDED VALVE

Sure enough the water was below the glass in the big boiler and the fires were out. The steam pressure was down so that the feed pump would barely run, although he had a good fire under the small boiler. The steam had fallen since he had not pinched off the drier and the load was too much for one boiler. I examined the pump and found it in good condition. It would throw as good a stream as ever, so I looked farther, and behold the valve *B*, controlling the feed to the large boiler, was shut tight and jammed so that a good pull on a medium-sized pipe wrench was necessary to open it.

Being somewhat vexed at this, I spoke my mind freely, after which I listened to his argument. It was simply this: "You told me yesterday that if I always turned a valve to the right I would shut it, and if I turned it to the left I would open it. Now I have turned that valve to the left as far as I can get it with a wrench, and yet you say I am wrong."

By noting the position of the valves his trouble is at once apparent.

C. R. Moore.

La Fayette, Ind.

## Graphite for Lubrication

In the July sixth number is an article on "Graphite for Lubrication," which calls for special comment. It seems odd to the writer that there can be engineers and millwrights who are as yet unfamiliar with the many uses that graphite can be put to, and how much work and worry the judicious use of it will save them. I have been using graphite for fifteen years: In rolling-mill work, on shipboard (lake and ocean), in refrigerating and cold-storage and ice plants, on heavy air compressors during the construction of the Chicago drainage canal, in gas-engine plants, around gaskets, tube plates and nuts, etc., on many kinds of boilers—in fact, every piece of machinery I have handled, I have always had to use graphite at some time or other. While my experience has been more with flake graphite than with the finely pulverized or amorphous form, owing no doubt to the great faith I have always had in the flake or pulverized flake, and being a little shy of trying the amorphous kind until recently, say a year ago, when I gave the amorphous kind a good trial; and although it is almost an impossibility to determine whether the flake or the amorphous (if used to cool a warm bearing of any size) does its work quicker, still my personal opinion is that the flake manages to stay on the wearing surfaces longer and thus accomplishes more in the nature of reducing friction than the amorphous form, as the latter promptly passes through the bearing with the oil, while the flake is held and rubbed into the wearing surfaces.

For 90 per cent. of my work I use the powdered or pulverized flake. While I am not positive, still I have an idea that the amorphous form contains more impurities than the flake. In this comment I have not included the product known as "Oildag," as this is the smoothest graphite it has ever been my privilege to test, but owing to its high cost at present it cannot be used as freely as the commercial graphite. As to an air compressor, I consider powdered flake graphite superior to oil for internal lubrication. Valves will not stick, nor will one get an explosion in the receiver or pipe lines. A few teaspoonfuls inhaled through the intake is all a good-sized compressor needs once an hour or so. Another place and time where graphite is practically a safety valve is in an ammonia compressor, when testing out new condensers or additions to the high-pressure end of a system where 300 pounds air pressure must be pumped on an old oil-saturated system. The oil used previously being of low cold test and not being able to withstand a very high temperature, an explosion is a possibility at any moment, as the oil is liable to vaporize and form an explosive mixture and serious results can easily follow. This is avoided by using graphite, and, besides, getting better compression, as the piston rings are in more intimate contact with the cylinder walls and air pressure is got up to the top notch sooner.

As to gas-engine work: I find that powdered flake graphite will keep the cylinders, valves, etc., in better shape than by using oil alone. I allowed each of my five gas engines to inhale a teaspoonful of graphite once every three hours during a 12-hour run and during three years I had no occasion to take the pistons out because of loss of compression. In taking apart the hardest-worked of my 100-horsepower engines (3-cylinder verticals), I found the cylinders with a mirror glaze on them and the rings neatly polished and easily moved in their grooves—no sticking anywhere. I used 3 pounds of powdered flake graphite in each crank case with ½ barrel of oil. I found I got good results and very little wear on the bearings with splash lubrication.

I now have a twin-tandem horizontal gas engine of 180 horsepower, operating an alterating-current generator, which has given a remarkably large amount of trouble due to heating of bearings since its installation three years ago. I took a position where this engine is, a few months ago, and so far have overcome the heating of the piston pins and am gradually overcoming the heating of the main bearings. The pressure on the piston pins is about 1500 pounds per square inch, too high for good results. That on the main bearing is about 1050 pounds. The chain-oiling system is used on the main bearings. I mix graphite with Twentieth Century gas-engine oil and find that even a good filter will not remove much of the graphite from the oil, and hence I get good results. The main bearings operate at a temperature of about 155 degrees and attain this temperature in two hours after starting. Then, of course, radiation equals the production of heat and a stationary temperature results. I let this engine inhale coal oil and powdered flake graphite through the intake when running and have fine compression. The engine starts easily, and the valves never stick. There is metallic packing between the cylinders and the rods are like mirrors, and I consider graphite my best ally.

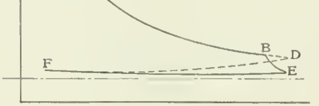
I have mentioned powdered flake graphite each time, as that is the kind I mostly use, from force of habit, probably. I know what it will accomplish and don't know what the other will. I use flake for heavy slow-speed bearings (when heated) and the powdered flake for high-speed bearings, and where oil and graphite must be fed through the ordinary small oil cups. The enormous number of uses to which graphite is put nowadays would take a long time to record. I personally must have graphite in my engine room.

D. L. Fagnan.

Cleveland, O.

## Setting Gas-engine Valves

Mr. Tilden, in his letter in the June 15 number, seems to think that the gas engines mentioned by Mr. Abegg and myself were single engines. As for myself, I will say that during my six years of gas-engine experience on the road, repairing and erecting, in the shop, the drafting room and at the Case School of Applied Science, I have yet to note an engine with valves set as indicated by Mr. Tilden, and I have set valves on engines of from 1½ to 600 horsepower, and of many different makes. All textbooks on the design of the gas engine will give the timing of valves as stated by the other writer and myself. By "gas engine," I mean any internal combustion engine, regardless of the fuel used. If Mr. Tilden will investigate a little and examine other engines, he will find that it was his engine designer who had "the peculiar ideas."



Power, N.Y.

GAS-ENGINE INDICATOR DIAGRAM

With any certain cam and valve motion, shifting the gears so that the valve will open later will certainly result in its closing later. If it is desired to change the time of opening without affecting the closing, a new cam must be designed. Thus, with the cam as laid out on any engine, very little change can be made in the timing. This is the point Mr. Hollman brought out in his letter, evidently misunderstood by Mr. Tilden.

In regard to the opening of the exhaust valve before dead center, the accompanying indicator diagram shows that the pressure at the end of the expansion stroke is from 30 to 50 pounds. This pressure does not drop to atmospheric the instant the valve is opened. If it remains closed until the dead center, the piston must work against this pressure stroke. This takes power from the flywheel which otherwise would be available for outside work. This may be illustrated by means of the indicator diagram. The line *A B* shows the expansion carried to the end of the stroke, and *D F* the greater back pressure against the piston during the exhaust stroke. If the valve opens before the dead center is reached, the pressure will drop to within 2 or 3 pounds of atmospheric by the end of the expansion stroke, and there will be only this pressure against the returning piston. The greater back pressure during the exhaust stroke will easily wipe out the slight gain due to the further expansion of the mixture.

Now as to a definition of inertia, the Century dictionary, and all books on mechanics define it as follows: "Inertia is that property of matter by virtue of which it maintains its state of rest or of uniform rectilinear motion so long as no foreign cause changes that state."

If the exhaut passage has easy curves there will be little to oppose the outflow of the burnt mixture. A number of experimenters have shown that if the length of the exhaust pipe is made about 65 feet, there will be a partial vacuum formed in the cylinder at the end of the exhaust stroke. If the inlet valve is opened at the same time, air or a fresh mixture will rush in and displace a portion of the burnt mixture usually left in the clearance volume.

As early as 1894 a Crossley engine was operated under these conditions. The indicator diagram taken with a light spring showed a pressure of 2 pounds less than atmospheric at the end of the exhaust stroke.

An automobile-engine designer, in a recent article, told of designing a two-stroke-cycle engine along these lines. He hoped in so doing to displace a larger proportion of the burnt mixture than in the ordinary two-stroke-cycle engine.

The example cited of an air compressor is an altogether different proposition. The air is forced into a chamber against pressure and is not free to expand, while during both the inlet and exhaust strokes of a gas engine the gas is flowing from a higher to a lower pressure.

The maximum explosion pressure depends partly on the compression pressure, as Mr Tilden says, but it is the volume occupied by the gases at the instant the flame has passed *entirely* through the mixture, or, as I expressed it, when the entire mass is ignited, that determines the maximum explosion pressure. The clearance volume of a gas engine may be designed to give a high compression pressure.

If the spark is retarded so that the flame has not passed entirely through the mixture by the time the piston starts on the power stroke, the maximum explosion pressure will not be as high as on an engine with a lower compression pressure, but with the spark properly advanced.

Louis J. Buschman.

E. Cleveland, O.

## Saving by Throttling Steam

In the July 20 issue W. E. Crane says: "The question arises, how much superheat is there added to the steam, say at a reduction of 20 pounds? Why does steam superheat, and all other gases cool by reducing pressure?"

The first of these can be answered by referring to the steam tables. Suppose that before throttling, the pressure is 100 pounds absolute, and afterward it is 80 pounds. Then the total heat in a pound of steam before throttling is 1181.8 heat units (assuming it to be perfectly dry and saturated). The total heat in a pound of dry saturated steam at 80 pounds pressure is 1177 heat units, which means that 4.8 heat units are expended in superheating. Taking the specific heat of steam at constant pressure as 0.48, which is a fair average value, one pound of steam would increase in temperature 4.8 ÷ 0.48 or 10 degrees. That is, by throttling from 100 to 80 pounds absolute, the steam is superheated 10 degrees.

Suppose the original pressure were 200 pounds and final pressure 180 pounds absolute. The superheat is found by subtracting 1195.7 from 1198.3 and dividing by 0.48, which gives 5.4 degrees.

If the original pressure were 300 pounds and it were reduced to 280 pounds, the superheat would be (1209.2 − 1207.3) ÷ 0.48 or 4 degrees.

The answer to question No. 1 is, then, that if you throttle dry saturated steam so that the pressure is reduced 20 pounds, the superheating will vary from two to four degrees, according to whether your initial pressure is 100 or 300 pounds absolute.

I think that Mr. Crane asks the second question because he confuses superheating with increase of temperature. In superheating by throttling the temperature is actually lowered, so that the action of steam is not different in this regard from that of the (other) gases. This may be shown as follows: The steam tables give the temperature of saturated steam at 100 pounds (absolute) pressure as 327.6 degrees Fahrenheit, and at 80 pounds as 311.8 degrees, a difference of 15.8 degrees. The steam at 80 pounds pressure is superheated 10 degrees, as was shown previously, and therefore the final temperature is 321.8 degrees, which is 5.8 degrees lower than the initial temperature. If the original pressure were 300 pounds, the temperature before throttling would be 417.4 degrees, and afterward 411 degrees + 4 degrees of superheat, or 415 degrees Fahrenheit.

All the figures used have been obtained from the steam tables in an old edition of Kent, published in 1898, so that they perhaps may disagree a little with more modern tables, but they will serve just as well to illustrate the principle of the thing.

H. H. Bliss.

Visalia, Cal.

## An Engine Accident

In answer to Mr. Sheehan's article on an engine accident, Mr. Baker, on page 1026 of the June 8 number, says that he considers the diagram fairly good, only the cutoff on the head end of the low-pressure side could be made a little shorter. Will Mr. Baker please tell us if shortening the cutoff on the head end of the low-pressure side of a compound engine makes any difference in the amount of steam used; that is, would one save anything by equalizing the cutoff on the low-pressure side?

He also says that the receiver will be governed by the load. The engine that I am running is governed differently than anything I ever saw. It is an 18 and 30 by 42 cross-compound condensing engine and when its load goes off the receiver, pressure goes up, and *vice versa*. This engine has a 3½-inch high-pressure piston and a 4½-inch low-pressure piston, but I don't see how that makes the low-pressure side the stronger, as the wristpin, connecting rod and crank pin are the same size on the low- as on the high-, but then perhaps those are built with a large factor for safety; if not, I don't see how we are any better off than Mr. Sheehan with his small low-pressure piston rod.

A. W. Griswold.

Adams, Mass.

## Expert Advice

I should like to answer A. T. Samuels, who has an article in the August 3 issue, where he answers my article of June 22.

Unquestionably a man who has charge of a plant, and who is there 365 days in the year, knows that plant well, if he is a careful engineer and adapted to the place. This, however, does not mean that he knows that plant so well that he can improve it. His knowledge is likely to be confined to that one plant, and he has not by experience in other plants learned what can be done to improve his plant. Neither has he the opportunity to make the extended study and investigation into new devices and the applications of old devices that the so-called expert has, so that he is not as well fitted to suggest and improve as a well trained expert. The question as to whether or not he is well posted on the machinery in the plant of which he has charge, has little bearing on the matter. The principal point is: Has he sufficient experience and a wide enough knowledge of all types of plant to adapt various machines or devices to improve his plant?

It is not uncommon to find that the men in an individual plant assume that everything has been done by them to bring the plant up to its best possible condition, and it may be fair to assume that so far as their knowledge extends, such is true. The expert, however, may, through his knowledge of what has been done in other plants, be able greatly to improve this plant.

I do not class an expert according to Mr. Samuels. An expert in engineering work, according to my classification, is one who has had experience in many plants and under many conditions, and knows well what can be gained by combinations and changes, which an expert according to Mr. Samuels' ideas would never have the opportunity to gain. A man may be exceedingly expert in operating a certain type of automobile, but be a most dangerous character when operating some other type. It is not always safe to take the dictionary classifications as applicable to engineering services, and it is not always safe to employ every man who considers himself as an expert. A license law is needed in every State, and it is a great misfortune that such does not exist in many States. The license law is a protection against a poor man being put in charge of a good plant, and assures the plant owner that his engineer knows enough about his machinery to run it well and keep it in good working order; but does not assure the plant owner that the engineer is capable of giving him such advice as may be necessary about new machinery and new devices, which will improve materially the operating economy of the plant.

I am glad to see Mr. Samuels' reply, because it expresses very clearly the lack of coöperation, and willingness to assist in all ways, by the operating engineer with the consulting engineer, and shows to my mind a decided lack of appreciation of the opportunities to learn of new things and new methods, of which, were it not for the consulting engineer, many operating engineers would know nothing. This is no reflection on the operating engineer, because he is often too busy keeping the plant in thorough working order to have the opportunity to look into new devices and to study new conditions. This, however, is the business of the consulting engineer, and he makes a point to learn what has been done in all the plants with which he can come in contact, and to study the application, the advantages and disadvantages of various pieces of machinery which are within the range of his calling.

Both the operating engineer and the consulting engineer can learn a lot by coöperation, and I do not believe any consulting engineer would say that he had not learned a lot from various operating engineers, nor do I believe there are any broad-minded operating engineers who could not say they had learned a lot through the advice of consulting engineers.

The putting of a plant in the charge of an engineering-supervision company is to my mind unwise, but I do believe that many plants can be materially assisted through the cordial coöperation of consulting and operating engineers, particularly those plants of moderate size. In large-sized plants, the chief usually has an opportunity to make investigations. If he does not, it is a grave mistake of the owners, and they should take every opportunity to see that he does visit other plants and have the opportunity to study new devices for their own protection.

HENRY D. JACKSON.
Boston, Mass.

## Cylinder Lubrication

Referring to the editorial, "Cylinder Lubrication," in the August 10 number, your reference to the value of a separator would likely be more quickly comprehended if qualified in some such way as this: "If a steam separator were used, it would probably dry the steam, before entering the cylinder, to such an extent that a less quantity of lubricating oil would be needed."

JAMES L. ROBERTSON & SONS, INC.
New York City.

We note that you have not touched upon that phase of the subject which relates to the effects of the oil in the steam after it has passed through the engine. Frequently it is highly important to be able to remove the oil from the exhaust so that the latter will not foul heating systems or surface condensers, and so that the returns condensed from the steam will be suitable for use as boiler feed. The character of the lubricant has a very important bearing on this subject, since lubricants which are gasified by the heat of the steam cannot be removed from the steam with any degree of success, and removal from the condensation is practically impossible.

GEORGE H. GIBSON.
New York City.

We note particularly that portion of the article which reads as follows: "If a separator were of no other use it might earn its keep in the possible saving of oil and cylinder wear." While this is quite true, yet you must admit that a good steam separator has many other uses than the one you mention.

D. T. WILLIAMS VALVE COMPANY.
Cincinnati, O.

If suggestions are in order, I should add one more question, namely: Which oil gives the most trouble in the exhaust steam, especially when the exhaust is used in heating systems and when the condensation is used as boiler feed water?

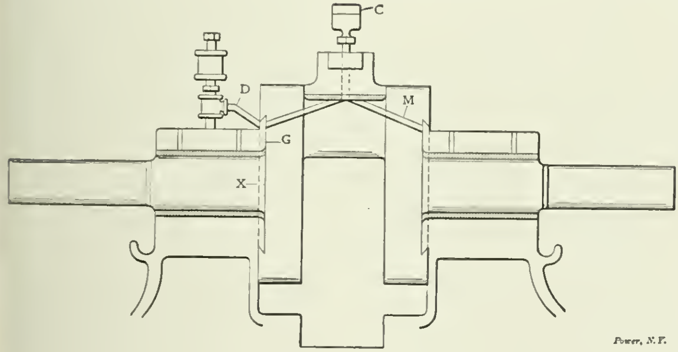
A. E. MICHEL.
New York City.

## Improving the Lubrication

The accompanying drawing shows how a troublesome engine was arranged for a better lubrication. This engine had been giving trouble by the crank pin running hot and melting the babbitt out, which had filled up the oil holes *M*. As no oil could be got from this source, the lubrication was dependent upon the wiper cup *C*. The bearing shells at the end *G* had become badly worn, so that the shaft had considerable end play.

We drove out the babbitt at *M*, and took some ¼-inch pipe nipples and fitted them as shown at *D*. Then, taking some brass tubing from the old gas fixtures we made some small leads to carry the oil to the recess plates. These small brass tubes come close into the crank plate, so the oil would necessarily flow to the cavity and be carried out into the ducts intended to oil the crank pin. When the engine was started again there was no further trouble.

C. R. McGAHEY.
Richmond, Va.



IMPROVING THE LUBRICATION

## Changing Centigrade Readings to Fahrenheit

In POWER, of July 20, John E. Sweet gives a method for converting Centigrade readings to Fahrenheit. His method is to add 8/10 the reading to reading and then add 32. A method which will cut out one addition and make the process that much simpler is as follows: Centigrade to Fahrenheit—9/5 (Centigrade reading) + 32 = Fahrenheit; Fahrenheit to Centigrade—5/9 (Fahrenheit reading — 32) = Centigrade.

G. A. GLICK.
Norwood, Ohio.

## Engine Control

In a great many plants, in all parts of the country, engines are being operated under conditions which make good economy almost impossible, on account of having a widely fluctuating load, and the necessity of keeping a high-boiler pressure in order to handle the heaviest load, which probably only lasts for a few minutes, while the greater part of the time the cutoff takes place so early as to expand below atmospheric pressure.

With this condition, the engine is noisy, on account of the exhaust valves being lifted at the end of each stroke, and the economy very low, on account of excessive cylinder condensation, due to the wide range of temperature between the initial and terminal pressure.

This is especially true in the case of engines driving railway generators, rolling mills, etc., where the load fluctuates over a very wide range, and probably requires a cutoff of less than one-fifth stroke, more than half of the time.

Suppose that a Corliss engine is running under these conditions and, in addition to the regular cutoff governor, a throttling governor is put in the steam main. Then set the collar on the cutoff governor down so that the cutoff cannot take place earlier than, say, one-third stroke, and adjust the throttling governor so that it remains wide open and just begins to operate to control the pressure when the cutoff governor has reached the stop.

With this arrangement the engine would operate in the usual way with full-boiler pressure and a variable cutoff at all loads above its rated capacity, while on lighter loads the cutoff would never take place earlier than one-third stroke, and the speed would be controlled by the throttling governor. In other words, the throttling governor controls with a fixed cutoff at the most economical point on light loads, while the regular variable cutoff controls at all loads above this point. The same arrangement could be applied to any of the riding-cutoff engines, using shaft governors, by adjusting the stops to allow the weight to move the way to the point which gave the required point of cutoff, to give the best economy.

S. Kirlin.

Harrisburg, Penn

## Location of Blowoff

I should not advise a check valve. I have charge of a battery of three return-tubular boilers, one equipped with a 2-inch pipe while the other two are equipped with 1½-inch pipe.

Our layout is the same as Mr Sheehan's, only we feed our boilers through the blowoff pipes. Before I had any experience feeding through the blowoff, I thought it was not the proper way, but have changed my mind and want to say that I fully believe it the most satisfactory way to feed a boiler.

Mr Sheehan should see that there is plenty of room in the brickwork around the blowoff pipes, then fill the space with asbestos. This asbestos will yield to the pipe as the boiler expands and contracts, and will save trouble. All blowoff valves should be opened and closed very slowly. The boilers I have charge of are run seven days a week, twenty-four hours a day. Our water is bad. The boilers are blown down every twelve hours. Repairs for the three blowoff valves, in nearly four years, have amounted to about 25 cents, and not one of the valves leaks a drop.

M. C. Reynolds.

Carey, Ohio

## Kerosene in Boilers

Twenty years ago I was assistant engineer at the fertilizer works on Barren island, N. Y. Water for the boilers was taken from a well about 15 feet in diameter and 6 feet deep, point-driven in the center; if the point were driven any deeper we would get salt water. When the tide was very high we had plenty of water (the salt water filtered through the sand), and I punched the upper part of the pipe with ½-inch holes to facilitate pumping.

I was always partial toward kerosene, because it was always on hand, required no mixing, and was cheap and safe to use, if handled intelligently. There were ten boilers, six of the cylinder type, 36 inches in diameter by 36 feet long, and four horizontal multitubular boilers, 66 inches by 16 feet. The boilers scaled so badly that a set of tubes would last about one year and I was pulling out and putting in tubes until I was regarded as an expert at it.

I started using kerosene, but the boilers still continued to scale, and the men we employed to clean them could not get the scale off from between the tubes.

Finally I took a barrel and sawed it in two, making a tub. I then sawed one of the boiler tubes off that I took out, put it in the tub and kept it covered with kerosene for a whole year, and at the end of that period the scale was just as hard as ever. I next took a galvanized pail, the inside covered with grease, filled the pail with boiling water to within 3 inches of the top, and then took a condensed-milk can of kerosene oil, put it in the pail, took some hot coals out of the fire and kept the pail boiling continuously for about three hours, with the result that I had hardly any kerosene left, but the pail was clean as a whistle where the kerosene had floated on the surface of the water.

The lesson I deducted from this was that kerosene will neutralize grease or oil but the very thing I used it for, namely, boiler scale, it would not touch.

Where an engineer is under the impression that the kerosene is doing the work, he could probably trace the result to the fact that after he started to use kerosene he opened his blowoff more frequently. The one fact that kerosene stays in the boiler, on the water line, ought to condemn it.

James C. Mellen.

Brooklyn, N. Y.

## Pound in an Engine Stopped

I had an experience once with a pound in a 28½x36-inch slide-valve engine, running condensing at 85 revolutions per minute, with 90 pounds of steam, with a very uneven load.

The first time it was just one heavy thump. I was immediately all attention, but the engine was still turning over and, not hearing any pieces fly, I let her run, concluding that a wrench or something must have fallen on the floor.

About 10 days afterward I heard the noise again, just once, and came to the conclusion it was in the engine. About a week later I heard it again and in the course of another week twice more. I found that it occurred in passing the head-end center as near as I could locate it. The following Sunday I took the cylinder head off and examined everything, but found nothing wrong. The following week I heard it more often, on Monday twice, Tuesday not any, Wednesday four times and the rest of the week from two to six times each day. On Sunday I took the piston and rod out and looked everything over very carefully. Monday my old friend the pound was still there, and acted about the same as the week before. I studied the engine that week and solved the pound. On the next Sunday I took the head off and put two springs in place of one in four places at the bottom of the piston, between the bull ring and the steam ring, and when I started Monday the pound had deserted me.

I figured it out that, as the steam carries the piston along just clear of the cylinder, with certain variation of loads when the piston was at the end of the stroke, it dropped down on the cylinder and caused the pound, and by reinforcing the springs it eased it down gently and saved the knock.

John Chamberlain.

Chicago, Ill.

## Iron and Steel Pipe

In the August 3 issue there is an article on iron and steel pipe by Lewis C. Reynolds, of Willard, N. Y. He is quite correct in his statement that the greater proportion of the pipe today is steel pipe, and that steel is very frequently substituted for wrought-iron in orders, although specifications plainly call for wrought-iron. I am glad to be able to back Mr. Reynolds up in this statement.

I note, however, that he speaks of cutting steel pipe and wrought-iron pipe with the same dies, and that steel pipe threaded with a die which will cut a perfect thread on wrought iron is very badly cut up and gives a great deal of trouble in threading. This is no more than natural, as a die which is satisfactory for wrought iron is by no means satisfactory for steel. The clearance should be very different, and the die made for cutting steel. This is found to be true quite as much in the ordinary tools used in machine work, as in cutting threads. It is always advisable to adapt your cutting machinery to the material which is to be cut.

Henry D. Jackson.

Boston, Mass.

## Dashpot Trouble

I have frequently experienced dashpot troubles with Corliss engines running under light loads, which were usually caused by insufficient valve lubrication, owing to short travel of the valve; also by poor vacuum under the plunger, owing to short-stroke and the packing not being tight.

This is very often the case with plungers having leather cups on the bottom as the leather becomes hard and smooth and is not tight in the dashpot. When the plunger rises, the pressure of air on top has to set out the packing before the vacuum begins to form and allows a small amount of air to enter under the plunger, which expands and tends to destroy what little vacuum is formed. I have frequently remedied this defect by taking out the leather cup and rubbing the sides with sandpaper; then trimming the edges of leathers on a bevel at the top from the inside, and giving them a dose of neatsfoot oil, making them soft and pliable. If the leathers have been allowed to get so hard and dry that this will do no good, I get new ones in as soon as possible. I have always received good results from using neatsfoot oil in dashpots having leather packing.

W. E. King, Jr.

Memphis, Tenn.

## Corliss Engines versus Steam Turbines

We have received from its author a copy of the following letter, sent by him to the General Electric Company. We do not wish to open our columns to salesmen's talk and manufacturers' claims unsupported by facts and engineering argument, but there is an important engineering question involved here, and we shall be glad to see the contention of each side backed up with real evidence:

General Electric Company,
Schenectady, N. Y.

Gentlemen:

On page 161 of the issue of Power and The Engineer of August 3, 1909, we note an advertisement over your name which makes some astounding comparisons between the "steam consumption of any good engine" and the "steam consumption of Curtis steam turbines." Your statement is directly contrary to the accumulated evidence of years which proves that a properly designed and built reciprocating engine does not become wasteful of steam in from five to ten times the period of the nine months shown in the advertisement, whereas, you can base your claim for the performance of the steam turbine on no such evidence.

The fact that the advertisement shows the turbine performance for but nine months prompts us to ask why any such narrow time limit was set? The curves shown are almost humorous and, our curiosity excited, we turned over the page to see where those curves got to in the next nine months. Finding nothing, we beg to ask from what data these curves were plotted; why the rate of increase in steam consumption for the engine is so great in the first three months; why after eight months there is practically no further increase in steam consumption of the engine; and if wear is the general cause of this increase, why does it practically stop at the end of nine months?

For the purpose of bringing this particular instance to a focus, we will assume an engine which will approximately agree with the average power-plant conditions and fulfil the initial condition shown by your curve. With steam pressure at 125 pounds gage, one of our Corliss engines will develop an indicated horsepower on 25 pounds of steam per hour, noncondensing. That this engine will deteriorate so rapidly as to require 38 pounds, as shown by your curve, or 54 per cent. more in nine months, is a little more than absurd. On the contrary, we will guarantee that not only will the engine show this economy after it has been in service a short time, but that it will actually maintain it over a period of at least five years. If you doubt our sincerity in making this statement or doubt the ability of the engine to fulfil the guarantee we will go under bond to fulfil it.

Now as to the performance of the small steam turbines, we challenge you to demonstrate two things under impartial supervision. First, that under the same conditions they will show a steam economy even approximately as good as can be obtained from one of our engines. Second, that over a period of two years or more the turbines will retain their initial steam economy. We will go further and challenge you to demonstrate with any steam turbine you have ever built in size up to 2000 kilowatts, and which has been in service for at least two years, that it can produce a kilowatt hour under the same conditions on as little fuel as one of our compound engines, no matter how long the engine has been in service.

For several years the engineering world has listened to and read articles extolling steam turbines, recommending them for every possible set of operating conditions, and claiming great advantages of many kinds over the reliable and economical reciprocating engine. For years engine builders have had to accept these statements without question, because they were led to believe that really the steam turbine was vastly superior to the engine, if not in reliability and length of life, at least in steam economy; and because they had no chance to get reliable information on the station performance of the steam turbine. There were (and are still) able and straightforward engineers devoting their lives to the development and manufacture of reciprocating engines. However, just so long as they had reason to believe, or at least no good reason to doubt, the impression created as to the efficiency of the steam turbine, they have made no attempt to discredit what they thought they recognized as an engineering achievement; but we have had statements from many reputable engineers which confirm the opinion firmly established in our own minds, that over-enthusiastic (to say the least) statements have been made as to the life, economy and dependability of the steam turbine.

As you are the largest builders of steam turbines, we have taken this opportunity to ask proof (which cannot be questioned by anyone) of your contentions. We cannot accept shop tests for comparison, nor can we find reliable service records of steam turbines which equal advertised performances; and until these are universally obtainable, everyone will have good reason to question the extravagant statements which have been made in the exploitation of the turbine.

Yours very truly,
Wisconsin Engine Company,
Cornelius T. Myers,
Assistant Treasurer.

Asso. Mem. A. S. M. E.
Mem. A. W. W. A.

## The Water Power Trust

During the National Irrigation Congress, which was held in Spokane, Wash., during the week beginning August 9, considerable agitation was fomented by an address by United States Chief Forester Gifford Pinchot, in which he directly criticized the policy of Richard A. Ballinger, secretary of the interior, in dealing with public lands. Mr. Pinchot declared that a great water-power trust was being formed in the West, and that it is helped and not hindered by Mr. Ballinger's methods.

It is claimed that when Mr. Ballinger had released from the reserve into which Mr. Roosevelt had segregated about one million acres of land containing water-power sites, the so-called water-power trust secured in Montana 15,868 acres.

It is pointed out in this connection that Mr. Taft had directed Mr. Ballinger, on April 30, to put the land back in the Roosevelt reserve, and that this was done on June 26, but that in the interval the trust had done its work. Secretary Ballinger and his friends denied this.

Another charge against the secretary is that he has favored, by inaction, applicants (for whom he was once attorney) for concession of 5280 acres of coal land near Katalla, Alaska, and that they are likely to get it, in spite of the fact that Congress has passed a law restricting contiguous coal-land holdings and forbidding combinations.

## National Association of State and Municipal Boiler Inspection Departments

Delegates from the State and municipal boiler-inspection departments of Detroit, Mich., Nashville, Tenn., Providence, R. I., Omaha, Neb., Los Angeles, Cal., Denver, Colo., and Minneapolis, Minn., met in Detroit, August 12, and perfected an organization of boiler-inspection departments.

The primary objects of this organization are for the promotion of uniform inspection methods and boiler construction and for the facilitation of exchange of ideas and experiences. This movement has the hearty approval of the American Boiler Manufacturers' Association.

The organization will be known as the National Association of State and Municipal Boiler Inspection Departments.

The officers chosen are as follows: J. C. McCabe, Detroit, president; Charles F. Doyle, Providence, first vice-president; Philip McCarthy, Denver, second vice-president; M. J. Close, Minneapolis, third vice-president; M. N. Brien, Nashville, secretary; Robert Wolfe, Omaha, treasurer; F. E. Griesmer, Los Angeles, chairman of committee on rules.

POWER
AND THE ENGINEER

DEVOTED TO THE GENERATION AND TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

John A. Hill, Pres. and Treas. Robert McKean, Sec'y.

505 Pearl Street, New York
355 Dearborn Street, Chicago.
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of Power solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "Powpub," N. Y.
Business Telegraph Code.

### *CIRCULATION STATEMENT*

*During 1908 we printed and circulated 1,836,000 copies of* Power.

*Our circulation for July, 1909, was (weekly and monthly)* 141,000.

*August* 3.............. 42,000
*August* 10.............. 33,000
*August* 17.............. 33,000
*August* 24.............. 33,000

*This paper reaches 42,000 separate readers each month and 33,000 each week.*

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*

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## Valve Setting

Valve setting is one branch of knowledge in the engineer's vocation the importance of which cannot be overestimated. If a man knows how to set the valves on an engine he understands how the steam will be distributed in the cylinder under all conditions of load and steam pressure, as well as the effect of apparently minor and unimportant departures from correct practice.

Standard engines are expected under ordinary working conditions to give the best results as to steam economy when the cutoff takes place at or near one-fourth stroke and, with the valve setting recommended by the builder, will operate satisfactorily carrying the load for which the engine was designed. But engines are frequently called upon to carry either continuously or intermittently much heavier loads than those for which they were designed and it is under such conditions that an intelligent departure from standard or conventional practice often allows the carrying of double or more the load for which the engine was designed, if not with a fair degree of economy certainly without decrease of economy at the average rated load.

In one instance a one-hundred-fifty-kilowatt generator was coupled directly to the shaft of a 16x36-inch Corliss engine running at one hundred revolutions per minute. The average load on the generator was seventy-five kilowatts, at which load the operation of the engine was satisfactory and the speeds regular, but at times an increase of fifty kilowatts was suddenly thrown on, with the result that the regulation was poor and the operation highly unsatisfactory. When the facts in the case were laid before the builders of the engine and advice asked for as to the best course to pursue, the owner was promply told that the engine was too small for such a load and that only a larger engine would operate satisfactorily under such conditions.

One evening the question of the unsatisfactory operation of this engine was discussed at the meeting of the engineers' association and an engineer present suggested a change in the valve setting, and after some discussion volunteered to improve the condition. The following Sunday was selected for the attempt. On removing the valve-chamber covers the steam valves were found to have three-eighths of an inch lap and the exhaust valves one-eighth. It was also discovered that the collar on the governor shaft must rise fully one inch before the releasing cams became operative.

In resetting the valves one-eighth-inch lap only was given to the steam valves, while the exhaust valves were left "line and line," as the expression is, or with neither lap nor lead. Then the regulator was blocked up three-sixteenths of an inch from the stop and the releasing-cam rods so adjusted that the head-end valve would trip at the extreme travel of the motion plate and the crank end-valve hook would touch the cam but not release. On the next day the valve setting, after the slight adjustment suggested by the indicator diagram, was tried out, with the result that the engine carried with apparent ease all of the load that could be put on it, and the fact that the regulation was not all that could be desired was due to a rather light flywheel and to the fact that the governor ran much slower than the engine, instead of faster than the engine as it should.

An intimate understanding of the principles of valve setting is not beyond the attainment of the commonest engineer and none should be satisfied with less than a complete mastery of the subject.

## Vibration

One element of danger to the operators in the steam plant is that of vibration of steam pipes. When there are frequent and comparatively great changes of pressure at one end of a steam pipe, as is not unusual with the pipe leading to a Corliss engine, with the steam valve wide open steam is rushing through the pipes at a high rate of speed and is instantly checked as the steam valve closes, and the momentum of the moving steam is expended on the pipe. When the valve to the cylinder opens, the pressure in the end of the pipe next to the cylinder drops, according to the length and size of the pipe, from two to twenty pounds, and the higher-pressure steam in the boiler starts toward the region of lower pressure at the other end of the pipe. It is only fairly started when it is stopped. As long as the pressure in both ends of the pipe is equal there can be no flow, but when the pressure at one end is reduced the steam in the pipe pushes toward this end, and as it must have something to push against it pushes against the other end of the pipe and tends to move it in the direction of its length.

If a length of pipe with closed ends could be imagined as lying on the ground filled with steam at any pressure, and if one end of the pipe should be instantly opened to the atmosphere, the steam would rush out with a velocity due to its pressure, but the unbalanced pressure at the closed end of the pipe would tend to drive the pipe in a direction opposite to that of the escaping steam. This is a simple principle of physics, or natura philosophy, which is used in some forms of water wheel and steam turbine, and which when understood makes the necessity for the proper anchoring or bracing of steam pipes apparent.

Vibration produces its effect in th weakest parts, in the threads, the joint and, sometimes, in the fittings. Several failures of angle throttle valves on steam-engine cylinders have been traced directly to the vibration of the pipes connected to them, examination tests and calculations showing that they were amply strong to withstand several times the pressure at which they were used, but failed because of the repeated bendings to which they were subjected by the vibration of the pipe to which they were attached.

In some instances serious scalding of operatives has resulted from these failures, but whether hurt to human beings or merely inconvenience and delay is the result of such failures, all steam pipes should be so secured that vibration is impossible.

## The Steam Jacket and Reheating Receiver

Recent discussions of the value of the steam jacket have failed to bring out the object sought by its use, which is not to prevent radiation from the cylinder, but to prevent the transfer of heat from the high- to the low-temperature level without the performance of work upon the piston.

Be it said in commencing that this writing is no argument for the use of the steam jacket. Many tests have shown that it was not of any large benefit, but it is well to understand the loss which it attempts to avoid and its relation thereto.

It is essential to the highest efficiency that the heat supplied to an engine should go into it at the high-temperature level and leave it at the low-temperature level, and that the entire fall of all the heat between these levels should be utilized for the production of useful work. If some of the heat is allowed to leak or filter down to a lower head or level before it becomes effective in the operation, there will be a loss of power-producing potency such as there would be in a water power if some of the water, instead of being introduced upon the wheel under its full initial head, were allowed to leak into the system after the fall were partially completed.

The steam-engine cylinder receives its supply of heat in the steam from the boiler, and should be at the temperature of that steam when it is admitted, so that all of the working fluid may come to it at the high-temperature level, and be reduced in temperature only by doing useful work upon the piston after the supply has been cut off. That is, the only cooling (except that done at the lower-temperature level as by a condenser) should be done by expansion, by the conversion of heat into work. If any heat is taken from the high-temperature level and introduced into the cycle after expansion has commenced, its power of producing work between the high level and that at which it is introduced will be, in part at least, sacrificed.

But with cast-iron cylinders it is practically impossible to have the containing surfaces at the temperature of the incoming steam. For the greater part of the preceding forward and return stroke they have been bathed in steam which, due to expansion and to the exhaust pressure, is at a lower temperature. Even if they were initially dry and the steam were dry-saturated at the point of cutoff, there would be condensation due to the conversion of some of the heat into mechanical energy, and the water thus produced, being above the boiling temperature at the exhaust pressure, is all ready to evaporate and make steam to send to the condenser, after it is too late for it to do useful work. It is in the same condition with relation to its environment that ammonia or ether is at atmospheric pressure and temperature, volatile, ready to evaporate and to draw the heat for its evaporation from objects with which it is in contact. Just as evaporating ether or ammonia abstracts heat from the hand, producing a sense of coldness, the evaporating water abstracts heat from the cylinder walls, piston and port surfaces. When, therefore, steam is admitted to the cylinder, it finds the surfaces below its own temperature, and is condensed upon them, and the water thus produced is reëvaporated, partly during expansion, doing some work on the receding piston, but mostly during exhaust, when it only puts extra work on the condenser. Much of the heat drawn from the boiler to warm up the cylinder at the commencement of the stroke is thus used simply to make steam for the condenser after the exhaust port has been opened, and thus gets through the engine without doing any useful work. That portion of the heat which is applied to reëvaporation during the expansion helps some, but not as much as though it came into the operation at the highest-temperature level. The same argument applies to the reheating receiver which takes heat from the high level and introduces it at a reduced temperature.

If the steam furnished to an engine is measured, as by weighing the feed water, it will be found to exceed by some twenty per cent. in favorable cases, and more in cases which are less favorable, the weight required to fill the cylinder up to cutoff the number of times that it has been filled for weighing. The difference, if it is in the cylinder at the point of cutoff, is there as water and does not affect the indicator diagram. It is quite likely, however, that some of the difference is due to leakage.

The intention of the steam jacket is to keep the interior surfaces of the cylinder hot, so as to reduce or prevent this heat-trapping action, not to put a hot blanket around the cylinder for the purpose of preventing escape of heat by radiation.

## Cast Iron Crosshead Pins

When rollers or balls are used to reduce the friction between two moving surfaces, the surfaces upon which they are to be used are especially prepared for this service, but when oil or grease is to be used little attention is given by the designer to the character of material of which the rubbing surfaces are to be made, or to their fitness for the lubricant that may be possibly used; nor, indeed, beyond the expectation that the parts shall have the necessary strength and be accurately machined, does the matter seem to interest him at all.

It is well known that all metals do not move with equal freedom upon metals other than themselves and that the interposition of a film of oil or grease does not always entirely separate the moving parts of machines where much pressure is applied; that more or less wear takes place, according to the material of which the moving parts are made and the pressure to which they are subjected. It has been demonstrated that cast iron slides upon itself and upon other metals with less resistance and with less wear for the same pressure than any other combination of metals or alloys. There are many places in steam-engine construction where the use of cast iron, on account of its low tensile strength and want of elasticity, would be considered unsafe, while there are other places where it would not be thought to be an unsafe metal to use.

Where one surface moves upon another slowly and under a heavy pressure, lubrication is difficult and the wear is relatively rapid. Such parts should be made of those metals which are or may be proved to be best adapted to run together. In the crosshead bearing of a steam engine will be found the conditions of slow motion and heavy pressure and a place where cast iron may be used with safety and the certainty that at one point at least friction will be reduced to a minimum. Cast iron may not be a safe metal to use for crank shafts and crank pins of modern steam engines, but there are many engines in this country that have for a half century or more operated satisfactorily with shafts and crank pins of cast iron, and that are using steam at much higher pressures than those for which they were designed. However, if cast iron is not considered safe to be used in crank shafts and crank pins, the crosshead pin offers opportunity for the use of that metal; there it would appreciably reduce the friction of the engine and prolong the life of and minimize the attention that must at the present time be given to one of the most troublesome and annoying details of steam-engine operation.

# Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

## Westinghouse Leblanc Condenser

Within the last year this new type of condenser has been put on the market by the Westinghouse Machine Company and up to date has made a good showing. The most striking features of the condenser, its compactness and simplicity, will be evident from Fig. 1. The condensing chamber is of small diameter, being but slightly larger than the exhaust opening of the engine, and another excellent feature is the provision for separate removal of water and air. This is performed by a pair of small turbine-type rotors on a common shaft, inclosed by a single-unit casing which is integral with the lower portion of the condensing chamber. A general sectional view of the standard Westinghouse-Leblanc condenser is shown in Fig. 2. The exhaust steam enters the chamber *D*, and cooling water entering through pipe *A* is projected downward through spray nozzles *B*. The injection water and condensed steam flow to the centrifugal discharge pump *M* under a head of 2 or 3 feet, which insures positive filling of the pump. The exhaust steam is drawn downward and condensed by the water spray. The space *E* above the water is occupied by water vapor plus the air released from the injection water and from the exhaust steam. This space communicates with the air pump *N* through pipe *K*. A detail of this pump is shown at the right in this illustration.

The principle of the air pump is entirely new. The pump projects a series of water pistons through the discharge nozzles, each one of which forces ahead of it a small pocket of air. The air mingles with the water in the lower portion of the nozzles, but the speed is such that no part of it ever finds its way back toward the condenser, in other words, there is no leakage past the pistons. The initial pocketing of the air between the successive layers of water is positive, so that the neutralizing effect of clearance is eliminated. The water supply for the air pump may be taken from the main water inlet, or a supply may be placed in a tank and used over and over. Since the air-pump water is in communication with the condenser, it is drawn by suction into an annular chamber *G*, which is overhung by the buckets of the pump rotor. The water passes out of the chamber through the port *H* and is projected downward in a rapid succession of water pistons. At the lower end of the air-pump nozzle is placed an auxiliary ejector nozzle *L* to which is connected a steam pipe. In starting up the condenser, steam is turned into this auxiliary nozzle for a few moments, thus creating sufficient vacuum to start the regular flow of water through the air pump. Where the level of the cold well is 3 or 4 feet above the basement floor, the air pump may be started without the use of steam. As will be noted in Fig. 2, the air-pump rotor and the main-pump runner are inclosed in a common casing and mounted on the same shaft. There are only two bearings and the shaft glands are made airtight by the water seals. The air and centrifugal pump impellers are shown to advantage in Fig. 3.

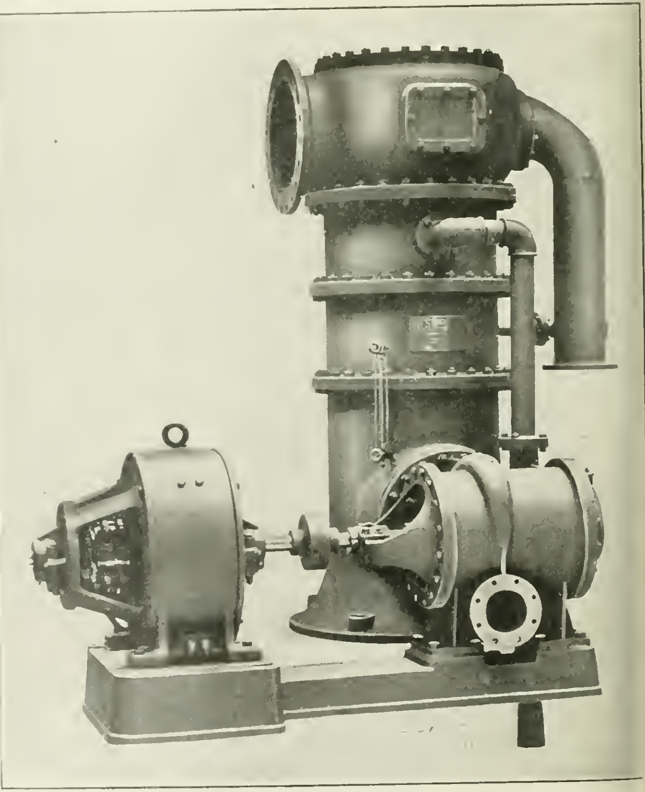


FIG. 1 WESTINGHOUSE LEBLANC CONDENSER, MOTOR-DRIVEN

Usually the pumps are driven by a Westinghouse steam turbine, and under ordinary conditions require from 2 to 3 per cent. of the power generated by the main engine. The exhaust from the condenser turbine is utilized for heating feed water. In cases where economizers used, or where there may be extra sourc of exhaust steam, it is advisable to erate either the condenser pump or t exciter by means of an electric motor. T main pump is commonly designed to d charge against only a few feet head su cient to overcome friction in the charge line. If it is desired to elevate water to the top of cooling towers or other moderate elevations, the pump can be modified to meet the additional duty.

For units smaller than 300 horsepower, it is customary to eliminate the main condensing chamber and pass all the exhaust steam as well as the air through the air pump only. For this service the air pump is slightly modified, a relatively greater amount of water being used, which serves both to expel the air and condense the steam in one operation.

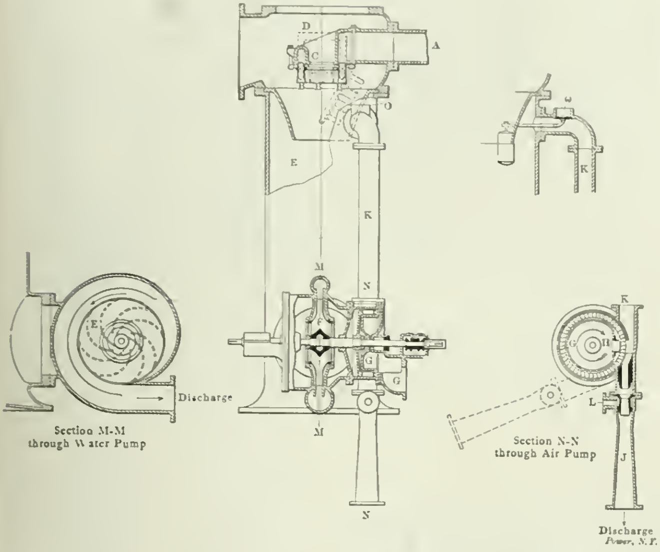


FIG. 2. SECTIONS OF CONDENSER AND AIR AND CIRCULATING PUMPS

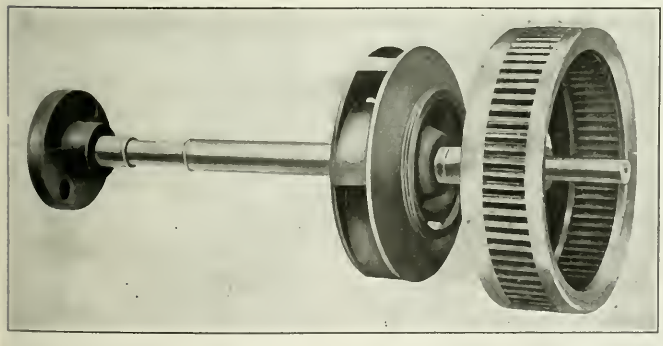


FIG. 3. AIR AND CENTRIFUGAL-PUMP IMPELLERS

For use with surface condensers, both stationary and marine and for application to barometric and other types of jet condensers, evaporating pans, etc., the air pump is furnished separately. In the case of new installations of surface condenser, the air pump and the circulating pump may be combined in a single compact unit substantially as shown in Fig. 2.

At the present writing a number of these condensers have been put in service, and most of them serve turbines of various types, while a few, especially in small sizes, are used with reciprocating engines. The results obtained from a shop test of the No. 12 condenser are set forth in the accompanying table. Efficiency is here expressed by the percentage of an ideally perfect vacuum actually obtained. For instance, if the discharge temperature is 100 degrees Fahrenheit, the corresponding ideal vacuum would be 28.08 inches. If, however, the observed vacuum is 27.75 inches, the efficiency percentage would be,

$$\frac{27.75}{28.08} = 98.8 \textit{ per cent.}$$

CAPACITY AND EFFICIENCY TEST OF NO. 12 CONDENSER.

| Steam Condensed Lb. per Hour. | Temperatures. | | Vacuum Referred to a 30" Barometer. | Per Cent. of Ideal Vacuum. |
|---|---|---|---|---|
| | Injecti'n. | Discharge. | | |
| 11,400 | 65 | 79 | 28 76 | 99 5 |
| 18,300 | 70 | 92 | 28 09 | 98 8 |
| 25,000 | 71 | 97 | 27 96 | 99 3 |
| 32,100 | 70 | 104 | 27 59 | 99 3 |
| 38,600 | 70 | 112 | 26 81 | 98 8 |
| 11,300 | 55 3 | 72 | 29 06 | 99 5 |
| 18,400 | 56 5 | 86 3 | 28 44 | 99.4 |
| 25,000 | 62 3 | 94 | 28 21 | 99 7 |
| 32,100 | 65 5 | 103 | 27 51 | 99 0 |
| 37,500 | 54.0 | 102 | 27 56 | 99 0 |

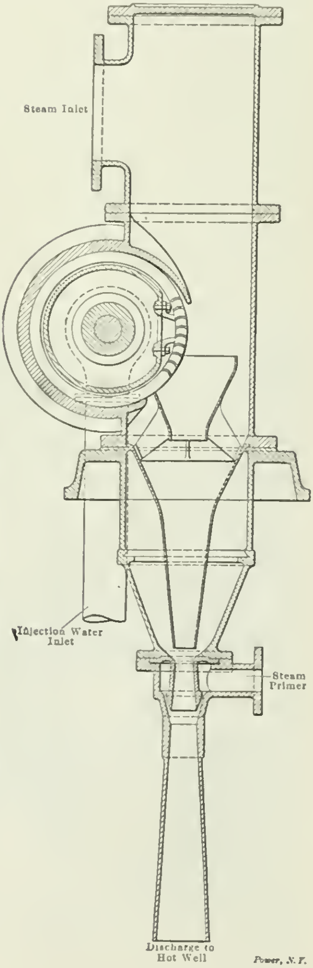


FIG. 4. VERTICAL SECTION THROUGH CONDENSER

# Trill Continuous Diagram Indicator

A type of indicator, known as the Trill continuous-diagram indicator, is illustrated in Figs. 1 and 2. The instrument is of the outside spring type, as shown, but instead of having one drum on which the paper is wound two drums are provided which, in connection with a takeup cylinder, keep the paper tight as it winds and unwinds on the second cylinder. This is accomplished by placing a roll of paper on which the indicator diagrams are to be made on the larger drum of the two, or what would be the paper drum of the ordinary type of indicator. The takeup cylinder is then moved around about one turn in order to get proper tension on the paper, the other end of the paper being wound on the second and smaller cylinder, which revolves in unison with the larger drum and in the same direction, and at the same time. With the indicator in place on the engine and the paper properly placed on the drum, the cord is attached to the connection on the crosshead and the indicator operates the same as with the ordinary type. A diagram is drawn on the paper for each stroke of the engine, but on the next stroke the admission line, for, say, an engine with a 30-inch stroke, will be about 1¾ inches in advance of the former one on the paper, that is, the admission lines will be about 1¾ inches apart. This feature allows of the engineer taking any number of diagrams and enables him to note the changing load and also the conditions the valves operate under at different loads. It also enables him to take a larger number of diagrams for a shorter period than could otherwise be accomplished.

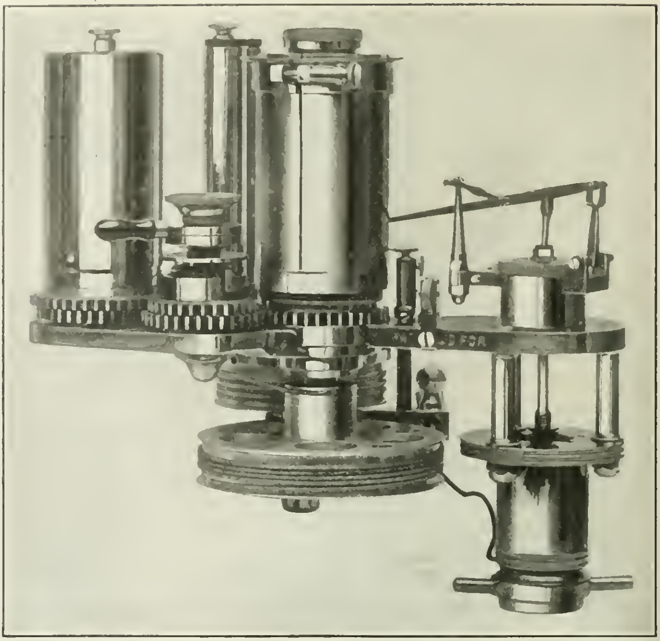


FIG. 1. TRILL CONTINUOUS-DIAGRAM INDICATOR

A detent device is also provided. When the handle is turned in one direction, that is, toward the smaller drum, the paper is being fed from the larger drum to the smaller one. When the handle is turned toward the larger drum the feeding is stopped. A feature of this instrument is the fact that after the atmospheric line has once been determined, a separate pencil is arranged, whereby it may be set, and no further attention need be paid to it, which eliminates the bother of taking the atmospheric line for each successive card. Another feature is the fact that a weight is supplied with the indicator, which is attached to a cord, which in turn is attached to the pencil-arm stand, thereby always obtaining the same pressure on the pencil point, which insures that there will be no excessive friction on the pencil point, due to a misjudgment in the pressure applied, as can easily occur if the operator does not use judgment.

The instrument is well made, is highly nickeled and is of a very substantial build. It is also fitted with a second piston for high pressures, also a spring and the usual paraphernalia that go with an indicator set of this kind. This indicator is manufactured by the Trill Indicator Company, Corry, Penn.

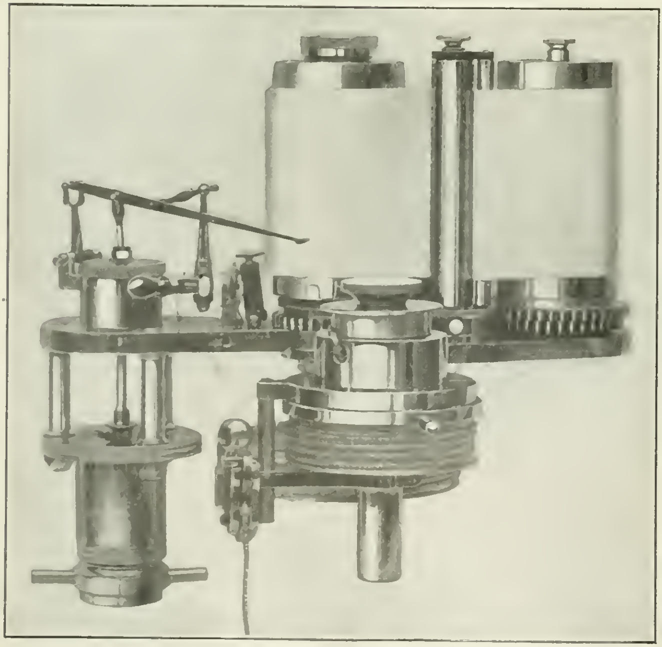


FIG. 2. PAPER ON DRUMS

## Mica Flake Lubricant

Mica flake lubricant, which is manufactured by the United States Mica Company, 238 and 240 La Salle street, Chicago, Ill., is made from white mica and ground to certain degrees of fineness, according to various manufacturing needs.

It is what its name implies, a flake mica, and is a lubricant to be used in connection with lubricating oils. It is mixed with lubricating oil and applied to the bearing in the ordinary method of lubrication. The chief claim for it is that it keeps the two metals of the bearing surface separate and prevents the film of oil from becoming destroyed, thus prolonging the life and efficiency of the oil and reducing friction. It is also stated that it will not cake, cannot be crushed out of service, cannot be squeezed out of the bearing and will not damage bearings.

## National Iron Filler Cement

The S. Obermayer Company, Cincinnati, Chicago and Pittsburg, has placed on the market the "National Iron Filler Cement."

It comes in the form of a powder which has simply to be mixed with water to the consistency of a stiff putty and applied to the crack or other defect. After a few hours this cement metalizes and becomes a part of the iron itself.

It is said that defects so repaired can scarcely be noticed and the material permits of machining, as it has virtually become a part of the casting.

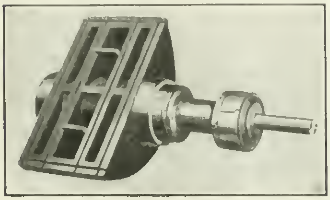
## The Baker Balanced Piston Valve

The accompanying illustration and text describe what is known as the Baker balanced piston valve, manufactured by the Baker Valve Company, Minneapolis, Minn.

The Baker piston valve consists of two heads joined together by a hollow connecting cylinder, the cylinder being threaded at each end, and made as long as the valve is wide. The heads of the piston, two in number, are made up of two plates threaded to fit the cylinder and having a fixed metal washer fitted in between. The heads, when screwed together, form a solid head containing two grooves. The object of having movable heads is so that they may be screwed farther apart or closer together to change the lead and point of cutoff as desired.

The piston rings are constructed by making one wide ring with a projecting houlder on the under side to fit in a groove in the piston head, and one narrow ring with a like shoulder to fit in the other groove in the piston head. The wide ring is wider than the port and enters each ide of the piston seat before leaving the other side. The wide ring laps over the narrow ring 1/16 inch and compels it to pass over the port. Both the wide and narrow rings are fitted with a small snap ring which acts as a key and prevents leakage through the joint of the ring.

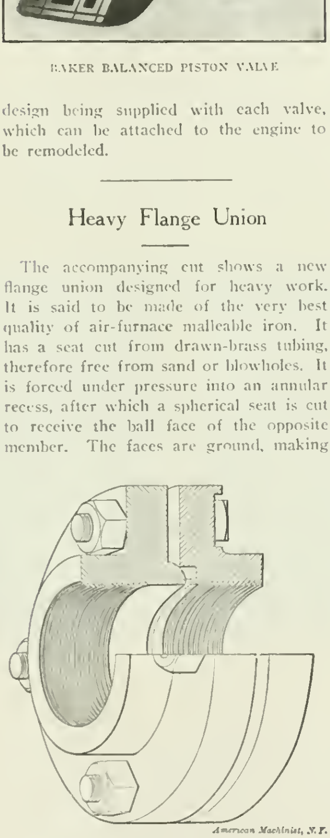
This piston valve can be fitted to any type of engine of the slide- or piston-valve design, a cage or valve seat of suitable design being supplied with each valve, which can be attached to the engine to be remodeled.



BAKER BALANCED PISTON VALVE

## Heavy Flange Union

The accompanying cut shows a new flange union designed for heavy work. It is said to be made of the very best quality of air-furnace malleable iron. It has a seat cut from drawn-brass tubing, therefore free from sand or blowholes. It is forced under pressure into an annular recess, after which a spherical seat is cut to receive the ball face of the opposite member. The faces are ground, making a tight joint under pressure as high as 3000 pounds, it is claimed.



A FITTING FOR HEAVY WORK

The brass ring is set within the iron away from the inner bore of the fitting. It makes no difference in applying this fitting whether the pipes are in line or not. The joint is spherical and it will adjust itself to the pipe even though the pipe may be out of line by several degrees.

This fitting is being made in all sizes from 1 to 10 inches by the Jefferson Union Company, Lexington, Mass.

## Blowoff Protector

A new design of blowoff protector has been placed upon the market, known as the "Fuller and Barbrick." It is made of cast iron, ¾ of an inch thick, with reinforced back to prevent warping, and in lengths as ordered, the standard being 24 inches. It is cast in two sections, with lugs to receive bolts, and can be adjusted in a few moments without removing the blowoff pipe or disturbing the masonry in any way.

Elbows are also furnished and are adjusted in the same way as the straight lengths. They can be filled with asbestos if desired, and when placed in position, with the top of the protector inside of the reinforcement rivet heads, it cannot drop apart, even though the top bolts should burn off.

It is said to cover in every way the requirements of the State law, and is manufactured by Fuller and Barbrick, 50 Standhope street, Boston, Mass.

## Castolin for Brazing Cast Iron

A new process for brazing cast iron has recently been introduced into this country by the Castolin Company of America, 1609 Wright building, St. Louis, Mo. It is claimed for this process that it is not only an easy and reliable way to braze cast iron, but it does not require special apparatus, is always ready for use, the brazings are unaffected by water, ashes or heat and cannot fail, as they contain no oxide. It is said that it can be easily and successfully applied by mechanics working to the simple instructions given, and that the brazed castings do not break again in the same place, nor deteriorate with age.

It is claimed for it that, in the saving of time, it is a money saver, as it gives engineers early use of machinery, due to the fact that repairs can be made in a comparatively short time. It is said, also, that with careful workmanship and carrying out the instructions given on the process, cast iron brazed by this method has given tensile breaking strength of 7½ tons per square inch. It is also claimed that the dimensions of castings are not altered by this process and where edges have not been damaged it is difficult, after polishing, to detect the brazing. In clamping pieces together when ready for brazing ordinary wrought-iron clamps will do for simple castings, but for complicated castings it will be advisable to pin them in position in order to get the two surfaces together.

## Stevenson Association Outing

The eleventh annual outing of the Stevenson Association No. 44, National Association of Stationary Engineers, of New York City, was held at Eitner's park, Grant City, Staten Island, N. Y., Sunday, August 15. Over four hundred were in attendance, including many persons prominent in engineering circles, as well as a generous sprinkling of the fair sex and little ones.

The fun started with a baseball match between a team selected from members of No. 44 and the "Bunch," which resulted in a victory for the "Bunch" by the score of 13 to 8. The game was extremely interesting, many brilliant plays being executed. John McGinnes gave complete satisfaction as umpire.

At the conclusion of the ball game, dinner was announced. Following the dinner a program of athletic games took place, a prize being awarded the first and second in each event.

This association is always partial to the ladies and children, and favors were handed to them on entering the park. The Dearborn Drug and Chemical Works donated seven costly prizes, which were drawn by the ladies, and "Trix" McVicker distributed toys to the little ones.

The N. A. S. E. "Bunch" were introduced by Frank Martin and gave an enjoyable entertainment in the pavilion. Dancing followed and concluded a most delightful day.

## Eccentric Firemen Presentations

On Saturday evening, August 7, at the conclusion of a regular business meeting of the Eccentric Firemen's Association, held in its new home, 158 East Twenty-seventh street, New York City, Timothy Healy, the international president of the organization, called to the platform "Steel Mixture" John H. Foote, of the McLeod & Henry Company, and Thomas Carleton, John J. Chisholm and Herman Molendo, and presented each a handsome medal as a mark of esteem for their many courtesies to the association.

## Obituary

Mayor John T. Carmody of Cedar Rapids, Iowa, a member of the local N. A. S. E. association, No. 9, died August 7, after a lingering illness brought on by a bullet wound at the hands of a burglar, whom Mayor Carmody encountered in his residence on May 24, two days after he delivered a memorable address of welcome to the delegates at the Iowa State convention of the N. A. S. E. Mr. Carmody was born December 12, 1854. His friends were many, especially among the N. A. S. E., and manufacturers and supplymen. He was the proprietor of a large foundry, machine-shop and supplyhouse business.

## Business Items

The Peerless Rubber Manufacturing Company has opened a branch at 1556 Wazee street, Denver, Colo., in charge of D. L. Cubberly, manager for George B. Carpenter & Co., agents.

The Wm. B. Scaife & Sons Company, Pittsburg, Penn., is sending out, in pamphlet form, copies of a paper by J. C. Wm. Greth on "Feed Water Heaters as Purifiers." In it the author makes clear that not only are feed-water heaters of value as heaters, but in their proper capacity they are purifiers as well, removing from the water scale-forming and corroding impurities before it goes into the boilers, etc.

On Wednesday, August 4, the export department of the Western Electric Company received from Pekin, China, a cablegram stating that a contract with the Chinese government to supply a complete common-battery telephone plant for the city of Pekin had been signed. The Chinese government, through the president of the board of communications, had ratified the sale, which came as a result of negotiations of a year's standing.

The Edge Moor Iron Company, of Edge Moor, Del., has just issued a new edition of its catalog, 93 pages, 6¼x9¼ inches, bound in cloth, treating of its plant and products, with chapters on shop practice, shop tools, etc. That part of the catalog which relates to boiler data is a reprint of previous editions. An important addition is the section relating to the company's reinforced screwed pipe connection, which has been patented and is now being placed on the market. The catalog is finely printed and illustrated.

The United Electric Company, Chambersburg, Penn., has contracted with the Ball & Wood Company, Elizabethport, N. J., for two 750-kilowatt Rateau-Smoot high-pressure turbines and 60-cycle three-phase generators, to be installed at its plant at Lemoyne, Penn. The United Electric Company is owned by the Cumberland Valley Railroad Company, and the latter is, in turn, controlled by the Pennsylvania Railroad Company. The specifications for the units just contracted for were issued by the Motor Power Department of the Pennsylvania Railroad Company.

"Castings for the Sugar Industry and the Chemical Trades" is the title of a booklet treating of vacuum pans, multiple-effect evaporators, distillers, defecators, rosin stills, soda kettles and similar apparatus, together with surface, jet and barometric condensers, wet- and dry-vacuum pumps, cooling towers, centrifugal pumps and other vacuum apparatus manufactured by the Wheeler Condenser and Engineering Company, of Carteret, N. J. The numerous and handsome illustrations of such apparatus given in this book will be of interest to engineers, manufacturers and others who employ evaporating and condensing machinery.

The transmission dynamometer, invented and patented by Prof. W. H. Kenerson, and illustrated and described by him in a paper read before the meeting of the American Society of Mechanical Engineers, at Washington, in May, 1909, is a device which indicates by means of a pressure gage, the amount of power transmitted through it. The dial on the gage is graduated to show the horsepower per hundred revolutions per minute of the shaft to which the dynamometer is attached. It is said to be sensitive and correct to a degree very closely approximating that of the ordinary gage for indicating pressure, and the construction is such that it cannot easily be deranged. This transmission dynamometer is being built and placed on the market by the Builders Iron Foundry, Providence, R. I.

The Westinghouse Storage Battery Company, which was incorporated July 12, has acquired all of the plant, patents and equipment of the storage-battery department of the Westinghouse Machine Company and of the General Storage Battery Company, and will manufacture at Boonton, N. J., both the Westinghouse and Bijur types of storage battery for those classes of service in which each has proven superior. The Westinghouse Storage Battery Company enters the field with greatly increased manufacturing facilities and the best engineering talent obtainable, and will maintain thoroughly equipped testing and commercial laboratories, insuring uniformity of both materials and product. The general offices of the company will be located at Boonton, N. J., with sales offices in the principal cities of the country.

The Crocker-Wheeler Company has recently booked several large orders for direct-current apparatus. One of these, from the Indiana Steel Company, calls for 70 mill motors, totaling about 2100 horsepower. This order is an addition to the 11,000 horsepower of Crocker-Wheeler motors employed at the present time by this company. Another order, from the Gould Paper Company, of Lyons Falls, N. Y., calls for electric drive for a new paper-making machine which is about to be installed. A sale has been made to J. M. Kohler Sons Company, Sheboygan, Wis., of one 750-kilowatt, 250-volt double-current generator. The King Bridge Company, Cleveland, O., recently placed an order for one 150-kilowatt compound-wound, 250-volt generator, to be used for supplying lightand power. Another sale, made to the American Lace Manufacturing Company, Elyria, O., covered one 100-kilowatt, 250 revolutions-per-minute generator. The Bethlehem Steel Company has recently added to its 8800 horsepower of Crocker-Wheeler motors by an order for a 225-horsepower compound-wound motor, to be installed at its Saucon plant. An order received from Beadleston & Woerz, New York City, covers 187 horsepower in compound-wound, 115-volt motors and one 150-kilowatt 125-volt compound-wound generator. Among orders for induction motors recently received by the Crocker-Wheeler Company is one from the Roessler & Hasslacher Chemical Company, Perth Amboy, N. J., which totals 295 horsepower in three-phase 60-cycle 860-volt motors of the squirrel-cage type.

## Help Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," Power.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

AGENTS WANTED to sell Burgmann celebrated engine packings in territories not yet covered. See our advertisement on page 83.

WANTED—Sales agent in each manufacturing center. High-grade steam specialty. Address, E. I. M. Co., 1451 West Harrison St., Chicago.

WANTED—Experienced draftsman on power plant design. Give age, experience, nationality and salary expected. Box 94, Power.

## Situations Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

WANTED—Work, by an engineer, mechanical and electrical, 12 years' shop practice, 11 years' chief and superintendent in electric light, dredge, ice-ammonia compression. All kinds of boilers, engines, pumps, d.c. and a.c. generators, installing and operating, flue gas analysis. Ten years in South America. Speaks Spanish. Spanish country preferred. Address W. B. Kelsey, 328 Main St., East Aurora, Erie Co., New York.

CHIEF ENGINEER, first-class and capable executive; specialty: operation of power houses, industrial, refrigerating and water works plants. "Engineer," 40 Walnut St., Neponset, Mass.

POSITION as stationary engineer; technical education; 15 years' practice; am good erector and pipe-fitter; can manage dynamos and engines; have indicator and tool kit; will go anywhere on 15 days' notice. Good reference. Will work on trial to prove ability. Box 93, Power.

# Two-Stage Air Compression

## An Interesting Account of the Results of the Conversion of a Single-stage Compressor into a Two-stage Machine by a Novel Method

BY GEORGE L. FALES

The article following is somewhat unusual practice in compression of air, but the results obtained from compounding and intercooling are interesting and may be of value to other interested parties. It treats of converting a single-stage compressor into a two-stage machine by using a portion of the air from a compressor in low-pressure service as first-stage air. The main object of this conversion was not so much one of economical compression as an increased output of compressed air. The compressor is an Ingersoll-Sergeant straight-line, piston-inlet type, 18 and 18¼ by 24 inches, compressing air to a pressure of 120 pounds per square inch. The pressure is too high for one-stage compression, but is necessary on account of using the air to move sulphuric acid.

With normal consumption of air this compressor and a Norwalk tandem-compound two-stage machine, 10 by 16 and 9½ and 14 by 16 inches, were just about enabled to supply the required amount of air at very near their maximum speed, the supply going not only to pump acid but also to tamp converters, boiler-shop work, etc This was 24-hour duty, and when repairs were needed on either compressor the supply of air was always short until the compressor was again in service. At the pressure and speed, 100 revolutions per minute, at which it was necessary to operate to get the required pressure with the Ingersoll compressor, the air was so hot when delivered that occasionally the oil in the receiver would ignite and burn and the packing on the air-cylinder heads would char and blow out.

This compressor is located between two Nordberg Corliss cross compound blowing engines, 15 and 30 and 40 by 42 inches, compressing air to 12 pounds for blowing converters; each of these engines has a large air receiver connected to the outlet flanges over each air cylinder, and the two receivers are connected together by two 12-inch lines of pipe running horizontally between the ends.

The bottom pipe, shown in Fig. 3, was used as a source of supply of first-stage air. The pipe was cut on the bottom side and a 4-inch saddle flange riveted on; a short nipple and valve *A* were put on and a tee with valve *B* attached, thus connecting the 4-inch line to the atmosphere. From the tee the pipe continued down through the engine room floor to the intercooler, through the intercooler and up through the floor again to the Ingersoll compressor, going through an inclosing sleeve around the piston inlet rod. The cooling-water line for the air compressor jacket was fitted with valves *F*, *G* and *H*, and the water was bypassed as shown, going into the jacket after it had first passed through the intercooler. The drip line and valve *I* removed the oil and water that accumulated in the bottom of the intercooler. To run single-stage, the valve *A* is closed and valve *B* opened, using air at atmospheric pressure through the intercooler.

The intercooler, shown in section in Fig. 4, was constructed of a piece of 12-inch pipe, 10 feet long, with flanges attached at each end. The tube sheets were two blank flanges 1 inch thick, drilled and recessed as shown in the drawing. On the inside of one of the tube sheets a baffle plate was riveted in the center, extending the whole width of the pipe and three-quarters of the length, to make the entering air traverse the full length of the tubes. The heads on each end were formed from ¾-inch iron, flanged and dished, and twenty-eight 1⅛-inch brass tubes were inserted through stuffing boxes. A 4-inch saddle flange on each side of the 12 inch pipe at one end provides entrance and exit for the air, and a 1-inch opening on the bottom at the opposite end acts to drain the intercooler. The 4-inch line going from the intercooler to the compressor ends at the floor line in a reducing 6-inch flange which is tapped out for ¾-inch cap screws instead of bolts; from this flange a 6-inch companion flange and a piece of 6-inch pipe extend upward to the 6-inch ell fitted at the end next to the compressor. A stuffing box and gland inclosing sleeve *A* fit into the other end of the ell and allow for any expansion or contraction. When it is necessary to

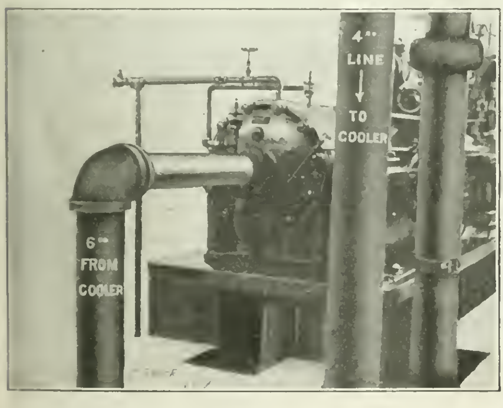


FIG. 1. AIR CYLINDER OF AIR COMPRESSOR

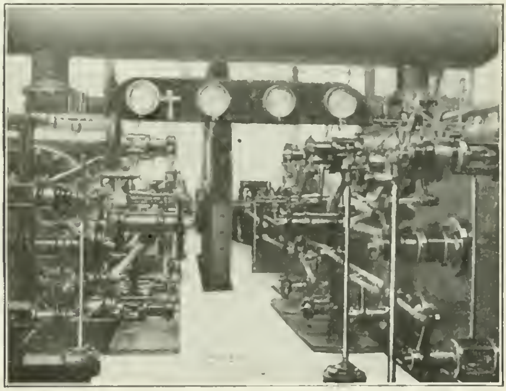


FIG. 2. CONVERTER BLOWING ENGINES

pack the compressor gland, the cap screws on the 6 inch flange at the door are removed, and the sleeve and packing gland, which are all one, are moved out enough to enable packing to be inserted in the stuffing box.

A detail of the sleeve inclosing the piston inlet rod is shown in the drawing to consist of a piece of 5 inch pipe, turned smooth on the outside. The original packing gland *E* was cut down as illustrated, leaving a shoulder which sleeve *A* was forced up against and pinned in place. A flange *F*, which fits loosely on the sleeve *A*, was made to fit up against the shoulder on the gland and holds it in place against the packing, being drawn into the stuffing box by the original gland bolts.

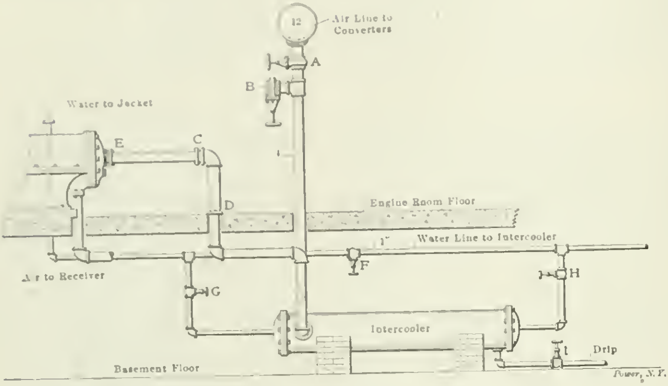


FIG. 3. PIPING TO AIR CYLINDER OF COMPRESSOR

The tracings of the indicator diagrams taken from the air cylinder show the comparative increase of volume in delivered air due to the compounding and intercooling. Since running two-stage the Norwalk compressor has not been in service at all, except when repairs were being made on the Ingersoll compressor, when it was put on to hold what air it could until the compressor under repairs was again in service. As a consequence there is always a spare compressor, a plentiful supply of air obtained at a medium speed of the compressor, and the delivered air is at a much lower temperature. There has been but one joint put in the air head since the compressor has been running two-stage, which is five or six months; previously it was about twice a week.

Once on each shift of 12 hours a cake of white soap is dissolved in two gallons of water and fed into the air cylinder through an oil cup on the inclosing sleeve of the piston inlet. This keeps the valves, packing rings, etc., so free from carbon deposits that the compressor never has to be opened to clean up from this cause. The amount of air used from the converter engine is hardly discernible as the same amount of work is done with the engine as formerly; it takes some seven or eight revolutions of the converter engine per 100 revolutions of the compressor. The photographs show the Ingersoll-Sergeant compressor as fitted up and also the engine which supplies the first-stage air.

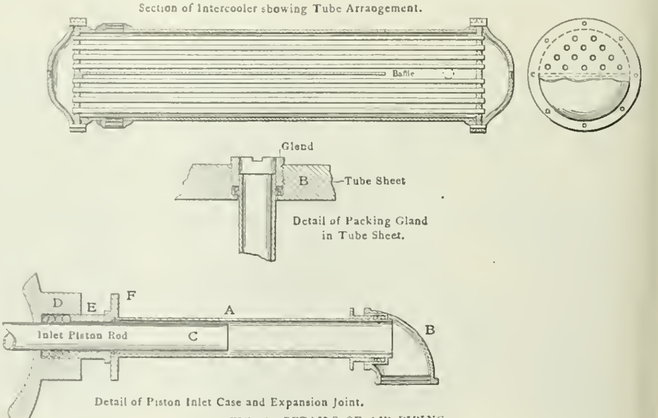

Section of Intercooler showing Tube Arrangement.
Baffle
Gland
B
Tube Sheet
Detail of Packing Gland in Tube Sheet.
D
E
F
A
Inlet Piston Rod
C
B
Detail of Piston Inlet Case and Expansion Joint.

FIG. 4. DETAILS OF AIR PIPING

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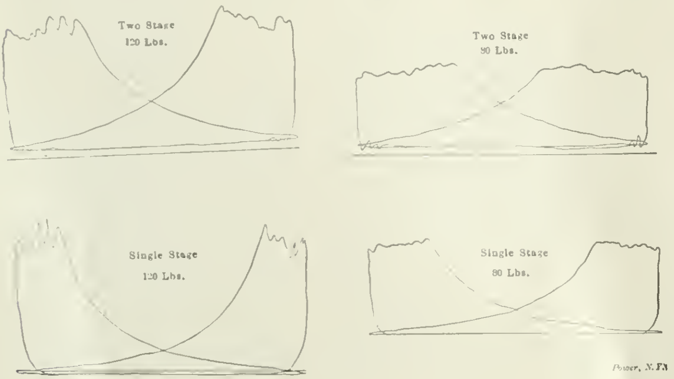


FIG. 5. DIAGRAMS TAKEN ON SINGLE-STAGE AND TWO-STAGE OPERATION

## Potblyn, P. D., and Volute Pumps

By John Watson

On looking through my copy of Power the other evening, I was amused to read C. Wilhelmsen's "Trouble in a Pumping Plant" (on page 975). Not that I was amused at his trouble, although it is much easier to get amusement out of the other fellow's trouble than out of our own, but his call for help was like many others that I had seen. Many a time have we had local practitioners fix up a cripple so that it would hobble along, but before a real cure was effected some expert like our friend Potblyn had to be called in for consultation. When I reached my office the next morning I sent for the "Doc" to come up to see me. The home team had received a terrible drubbing the day before, so "Doc's" interest in baseball was rather low for this season of the year, and I got his attention without the usual preliminaries. I showed him the article re ferred to and waited while he read it through.

"Well, Mr. Watson, I tell you what it is. I ain't much on this long-distance engineering. I want to see the critter, generally, before I say much about her. And then again I am a little scarish about them centrifugal pumps, darned things. We haven't been building them very long and I haven't been up against them enough to feel sure that I know just where I am at. A fellar has to learn the pump business all over again when he gets into trouble with one of them the first time. They don't act at all like the good old reciprocators, and a fellar's got to do a lot of guessing and trying first one thing and then another. That's why I like to be right on the job instead of trying to size it up long distance. Lots of times your first guess ain't right, but you can cover it up and try some new line of 'dope' without anybody knowing about it; but when you've got to write out the prescription it's got to be about right the first time."

"Oh, cut it out, 'Doc,'" I replied. "Don't try to hedge; be a sport and put your bet all on one throw."

"All right," says "Doc," "here she goes, a swat at the first ball pitched; and, say, speaking of that, you'd ought to see the way Finnegan landed on the first one Saturday afternoon. He caught it right on the nose and came within about a foot of hitting the bull on the fence. They certainly—"

"Oh, let up, 'Doc,'" I broke in, for I saw that he had got started and I had better head him off at once. "Doc" grinned, fished in his pocket and pulled out the stub of a blue pencil and proceeded to mutilate my copy of POWER.

"Well, you see it's like this, Mr. Watson. We send out, same as all of the other fellars that make these whirligigs, a drawing showing the pump set in about forty different positions, and we say that we can make a pump to fit any of them, if so specified. This 'ere pump is set just like one of them figures, and the fellar can't be blamed for putting it in so. It's in the catalog and ought to be all right, but I'll bet there's a whole lot of them that are not giving the capacity that they are supposed to. You know how it is sometimes in a discharge main. The air collects in a pocket at some high point and you can't force water through to save your neck. Well, this blamed thing gets air-bound. You see, the connection from the top of the volute to the discharge pipe is cut off by the casing right there (see *A*, Fig. 1), and the air collects gradually in the top of the casing until there is only room to get about half the water through. Then one leg of the suction will supply all of the water that will go through and the other leg lets go. He shuts down, starts his ejector and so takes the air out of the casing, and off she goes, first crack. He don't need to shut down, as it would probably pick up the suction in the other leg if he started the ejector while the pump was running. Now, the joke is that the pump ought to have been built and set this way (see Fig. 2). You see, the air don't stand any more chance to collect than my landlady does. It just sneaks around the corner and up the discharge pipe. He wouldn't have had any trouble if it had been made like that. They ought to have told him about it when he bought their old merry-go-round. And another thing, while you're looking at it, that there elbow (see *B*, Fig. 1) is a bad thing for one of these machines. You never ought to put a close elbow near the pump. It's bad enough anywhere in the line, but it seems to be bad, and then some, when you put it close to the outlet on one of these cantankerous critters."

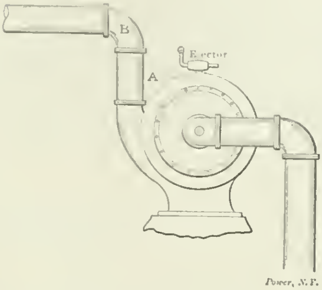


FIG. 1

"What made the box and elbow get hot?" I asked.

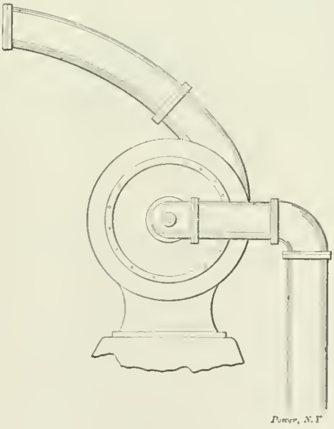


FIG. 2

"Well, you see," replied "Doc," "When she lost the water on one side, that, of course, took off the balancing of the thing and shoved right over, and the end thrust soon het it up, and with no water to cool it she just got 'hot under the collar.'

"Say, do you know, Mr. Watson, that air is a funny thing in the pump business? It's just like some medicines, it's good 'dope' if applied right, but a short cut to the scrap heap if 'tain't regulated. I read an article in POWER a few weeks ago about a fellar that fixed up a pump by changing the valve springs and, gee, but I had to laugh, for it reminded me of a job I bucked up against that showed that some things ain't so. I was in our Blankton store one day some years ago, and a call came in for a man to go over to one of the big office blocks and put some heavy valves springs in a pump. The regular repairman was out, so the boss asked me to go over and fix it. He seemed to know just what was wanted, for he gave me a set of springs and said all that I would have to do was to take the old ones out and put these in and the pump would be all right. He was so dead sure that it all looked easy, so I sailed over with my cigar at an Uncle 'Joe' Cannon angle, and with an easy-money smile. When I got there the pump was running all right, as far as I could see, so I got after the engineer and wanted to know what the blazes he sent for me for. He began to lay out a line of his troubles that sounded like the spread of a contagious disease. No kicking in the engine room apparently, but out along the line the neighbors and the fellars in the offices were having a high-kicking match that I guess even our janitor would have noticed. It was a triplex pump and you know how they telephone out along the discharge line sometimes so that even miles from the pump you can count the revolutions by the banging in the pipes. Gee! it's fierce, sometimes, and this was one of the times. They had had it once before and some cheap guy from the store went over and put some stiffer valve springs in. When they started again, it was all right, and the vibrations had quit.

"After some time they began to start in again and kept getting worse. The engineer says to himself: 'Valve springs must be losing their elasticity and getting weak, so we'll get some new springs and fix it.' Lovely theory, wasn't it? Didn't look very good to me, but I thought I would look over the water end, seeing I was there. I opened her up and found the springs O.K., and good as ever. Mr. Engineer was stumped, so was I; only he let on about it and I didn't, and that's the difference. I says: 'I guess the pump's all right, let's try it.' I put the handhole plates back on again and we started up once more. Vibration and noise all stopped and everybody happy but me, for I had to figure out what kind of 'dope' caused it. I'll bet I lit that old cigar twenty times before the idea struck me that it was probably about this way:

"There must have been some pockets in the discharge chamber and when we took off the handhole plates it allowed these to fill up with air that got trapped in and formed a cushion or regular small air chamber to take up the pulsations.

Now that's just what the other fellar did, only he didn't know it. He thought that it was the springs that he put in, when really they didn't have any more to do with it than Depew does with running the Government. Sometimes the water you take the pills in does more good than the pills, if you only knew it. Well, I made 'em change the piping so as to put on a good big air chamber close to the pump and it fixed 'em up all right, all right.

"Ain't it funny how those things go? Here is one fellar with too much air in the wrong place and another with not enough air in the right place. Some fellars are bothered finding ways to spend their money and I'm usually up a tree trying to find the money to spend. Why, yes, I don't care if I do have a cigar; I guess I can use it in my business. But, say, Mr Watson, if you write that POWER fellar anything about this business, you tell him that this ain't all hot air; there's some truth in it."

The "Doc" started out but, as he reached the door, turned to say: "Tell 'em I'm strong on air chambers but not on the top part of the casing of a volute pump."

## Use of the Indicator in Gas Engine Operation

By LOUIS J. BUSCHMAN

Practically all gas engines are now built so that the proportion of gas to air and the point of ignition may be adjusted through a wide range. Upon these adjustments depend the power developed and the economy of operation. For each different load there is a setting of the mixture and ignition adjustments that will give better economy than if the adjustments are left constant at some average point. By a little experimenting in adjustments with the aid of the indicator, the engineer can determine the most economical settings for each load.

An engine driving a dynamo may have a very small load during the day and a heavy load at night. If the engine is of considerable size, it would pay to adjust the mixture and spark at different points for the two loads.

The accompanying diagrams show the principal effects of varying the spark and proportion of mixture. With a good mixture and the spark advanced to the proper point, a diagram about like Fig. 1 will be obtained.

If the proportion of gas be decreased, the top of the diagram will be rounded as in Fig. 2, and this will increase with a further decrease in the proportion of gas. On an engine governed by throttling the mixture, care must be taken to have full load on the engine when taking diagrams. Even if the adjustments are correct for full load, diagrams like Fig. 2 will be made when the load is less than normal. With light loads the diagram can be improved and better economy obtained by changing the mixture and point of ignition. When making adjustments, the load should be kept steady for some time before taking diagrams, and only one adjustment should be changed at a time. When nearly correct it is hard to tell whether the mixture or point of ignition should be changed, but a little experimenting will quickly determine this.

If the spark be retarded, the pressure will not rise as rapidly, and the line $BC$, Fig. 1, will incline more to the right. If the spark be still further retarded the diagram will be about like Fig. 3. If, on the other hand, the spark be advanced too far, the engine will probably thump and the diagram will show a negative loop, as in Fig. 4, indicating considerable loss by back pressure on the piston.

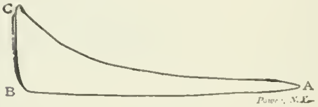


FIG. 1

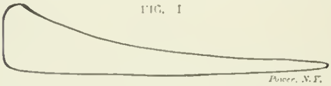


FIG. 2

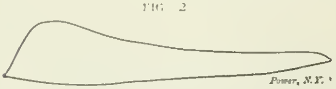


FIG. 3

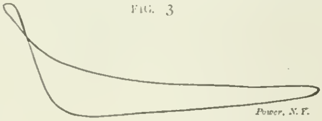


FIG. 4

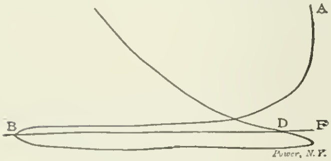


FIG. 5

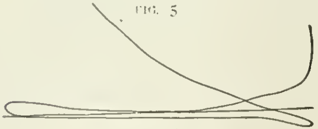


FIG. 6

The design of the cam of a gas engine determines the opening and closing of the valves. With the same cam, the time of opening cannot be changed without affecting the time of closing, and *vice versa*. Consequently, the gas engineer has not the chance for making changes in the setting of the valves that the steam engineer has.

As the pressures during the exhaust and suction strokes are both within 5 pounds of atmospheric, they do not show except as a straight line when using the 250- or 300-pound indicator spring. In order to find out anything about the valve setting, or whether the valves and valve passages are large enough, a lighter spring must be used. A 20-pound spring will give a good diagram. A piece of steel tubing must be slipped over the piston rod of the indicator and the length so adjusted that the hight of the diagram will be less than $1\frac{1}{2}$ inches. Figs. 5 and 6 show diagrams taken with a 20-pound spring. The curve $AB$ gives the pressure variation during the exhaust stroke. If the exhaust valve opens too late, or the exhaust passages are too small, or there are too many bends in the exhaust line, this line will drop more slowly to the pressure of 2 or 3 pounds, as shown in the diagram. The more quickly the exhaust gases can be got rid of, the less will be the back pressure on the piston, and, therefore, the more power available for work. Another advantage is that if the pressure falls quickly, the temperature will fall quickly, and the engine will run much cooler; furthermore, if the cylinder is at a lower temperature a greater weight of mixture will be taken in.

The diagram shown in Fig. 6 was taken from a two-cylinder vertical engine. The rise in pressure at the end of the exhaust stroke was thought to be due to an obstruction in the exhaust pipe, but this was taken down and found clear. As the engine was rigged for experimental purposes, a branch from the exhaust pipe close to the engine could be opened. When this was done, the exhaust line on the diagram dropped to within 2 pounds of atmospheric pressure, showing that the exhaust passages were either too small or too long.

If the exhaust valve closes too early, part of the exhaust gases will be compressed and suction will not begin at the beginning of the stroke. This would be shown by a rise in pressure at the end of the exhaust stroke. In Fig. 6 the suction line does not cross the atmospheric line until part of the suction stroke has been made; consequently, too little fresh mixture was taken in.

Referring again to Fig. 5, the suction pressure is shown to be 4 or 5 pounds less than atmospheric. A quick drop in pressure with a consequent rise at the beginning of the stroke shows that the inle valve did not open soon enough. Th compression line crosses the atmospheri line at the point $D$. The ratio $\frac{BD}{BF}$ give the volumetric efficiency, that is, the ratio o the maximum amount of fresh mixtur that can be taken into the cylinder t the piston displacement.

The diagram in Fig. 5 was taken fro an engine with an automatic inlet valv The volumetric efficiency for this type valve varies from 80 to 85 per cent. Th may be increased considerably by usin mechanically operated valves.

# Single Belted Electric Elevators

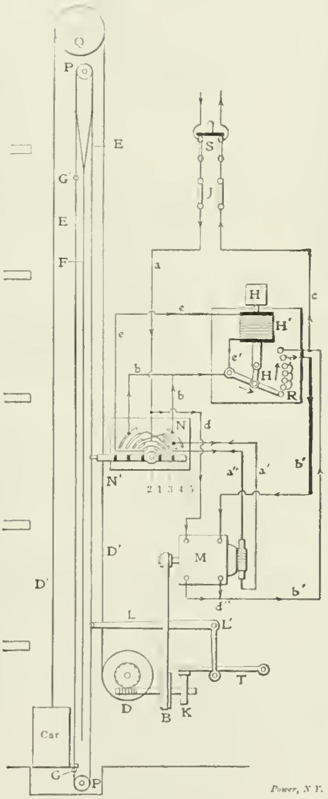
## Essential Features of the Construction and Operation of the Mechanisms That Are Employed, with Especial Reference to Motor Control

BY WILLIAM BAXTER, JR.

### SINGLE BELTED ELEVATORS

Single-belted electric elevators are constructed so that the direction of rotation cannot be reversed without reversing the direction in which the motor-driving belt runs; therefore, they must be operated by a motor arranged to run in either direction—a reversing motor. To make a motor run either way at will it is necessary only to provide a controller that will make the proper changes in the armature connections when moved in opposite directions.

The simplest way in which a motor and a single-belt elevator machine can be connected is shown in Fig. 10, in which the motor is shown at *M* and the elevator machine at *B*. The controller consists of an automatic rheostat *H* and a reversing switch *N*. The lever *L* serves to lift the brake shoe when the elevator machine starts and to lower it on the brake when the machine is to be stopped. The switch lever $N'$, when moved upward, connects the motor circuits so that the armature will rotate in one direction, and when moved downward it connects the circuits so that the armature will rotate in the opposite direction. All the lines in this diagram that represent wires through which the current always flows in the same direction have arrowheads on them to indicate what this direction is, and the lines that represent wires through which the current flows in one direction when the elevator runs up and in the opposite direction when the elevator runs down have double arrowheads to indicate this fact. The contact segments *1* of the reversing switch *N* are connected with the line wire *a* and the segments *2* connect with the wire *c* which carries the current to the magnet $H'$ of the automatic rheostat. Segments *3* and *4* are connected with the wires $a'$ and $a''$, which lead to the commutator brushes. Segment *5* connects with the wire *b* that leads to the swivel end of the rheostat lever *H*. If the lever $N'$ of the reversing switch is raised, the bridge plates on its left end will connect the segments *1*, *2* and *4* with each other, and also connect the segments *3* and *5*; then the current in the main line *a* will pass to the wire $a'$ and thereby to the lower commutator brush, through the armature to the upper brush and the wire $a''$, thence to the segment *3* and to the wire *b* and on through the other circuits in the direction indicated by the arrowheads. If the lever $N'$ is moved downward, the bridge plates on the right hand end of the lever will connect the three segments *1*, *2* and *3* with each other, and also connect the segments *4* and *5*; then the current from the wire *a* will pass through the wire $a''$ to the upper commutator brush, through the armature to the lower brush, thence to the wire $a'$, and through the segments *4* and *5* to the wire *b*, and follow the paths indicated by the arrowheads. This change of the direction of the current flowing through the armature will cause it to run in the opposite direction. Whether the lever $N'$ is moved up or down, the segments *2* will connect the wire *c* with the main line wire *a*, so as to permit current to pass through the magnet $H'$ of the automatic starter, which will gradually cut out the starting resistance from the armature circuit.



Power, N.Y.

FIG. 10

From the wire *a*, a branch wire *d* leads to a binding post on the upper left-hand corner of the motor. This connects with the shunt-field winding of the motor, the other end of which is carried to the lower left-hand post, from which the wire $b''$ carries the current to the wire *c*, leading back to the line. It will be clear that the shunt-field coils are permanently connected in the circuit, and that the only way to cut off the current is by opening the line switch *S*. This method of connection is used to avoid opening the circuit of the shunt-field winding every time the motor is stopped. The object of keeping the shunt-field circuit closed is to obviate the danger of injuring the insulation by the destructive action of the high electromotive force induced in the field coils whenever the circuit through them is opened, all of which was explained in a previous article. With nonreversing motors there is no danger of this kind because the shunt-field winding and the armature can be connected permanently so that the current flowing through the field winding does not die out instantly, and there is no inductive action of serious magnitude. With reversing motors, however, it is possible so to arrange the switches and circuit connections as to open the connection between the shunt field and the main line every time the motor is stopped, and at the same time not open the shunt-field circuit. How this can be accomplished will be explained presently.

Following the path of the current after it passes through the rheostat lever *H* and the resistances *R*, it reaches the wire $b'$ and then passes to a binding post on the upper right-hand corner of the motor frame. This wire connects with a field winding that is in series with the armature and, therefore, is traversed by the current that passes through the armature. These series-field coils are generally used to increase the field strength and thereby to keep down the armature current while starting the motor, but in some cases they are used to keep down the armature current when lifting extra-heavy loads. When the series coils are used for the sole purpose of keeping down the current in starting, the controller is so made that when the motor reaches full speed, and after all the starting resistance is cut out, the series-field coils are also cut out.

When the controller is made so that these coils may be left in circuit so as to keep down the current while running, the controller is arranged so that the operator in the car can cut out the coils or leave them in service, at will. In Fig. 10 it will be seen that when the rheostat switch lever *H* reaches the uppermost position it rests upon a contact that is connected with the wire *c*, by this means the series-field coils are cut out of the circuit. The type of reversing switch illustrated in the diagram, Fig. 10, is used only with small motors, of from 3 to 5 horsepower, because switches of this kind do not stand well the severe arcing they are likely to be subjected to if they have to carry the strong currents required for motors of larger size. Fig. 11 shows a switch of this class made by the Cutler-Hammer Company, and the way in which its several contacts are connected in the circuit is shown in the wiring diagram, Fig. 12. In this diagram an automatic rheostat of the solenoid type is included so as to complete the circuit connections with the motor.

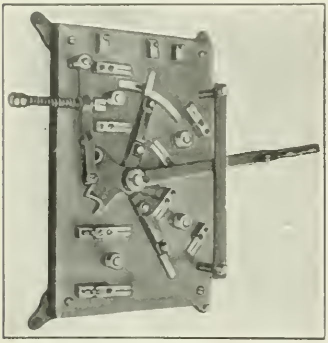


FIG. 11

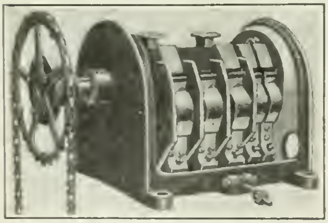


FIG. 13

Through all the wires of the system the current flows always in the one direction indicated by the arrowheads, except in the wires *b'* and *b''*, which connect the commutator brushes with the contacts *4*, *5* and *2*, *8* of the reversing switch. Through these wires the current flows in one direction when the switch lever *N'* is moved downward to connect contacts *1* and *2* through the bridge *10*, and contacts *5* and *6* through the bridge *11*. If the lever *N'* is moved upward, so that the bridge *10* connects contacts *3* and *4*, and the bridge *11* connects contacts *7* and *8*, the direction of the current through the wires *b'* and *b''* will be reversed, as may be readily seen by following the paths of the current through the reversing switch from the wire *a'* for the two positions of the lever *N'*. In whichever direction the lever *N'* may be moved, the contact *9* will be connected with the wire *a* and current will pass to the magnet *H'* to set the rheostat switch in motion.

Reversing switches for large motors are made in many forms, some of which are operated mechanically and others by means of electromagnets. In some cases even switches of the general construction of Fig. 11 are used for such service, but when they are so used it is in connection with main-line switches arranged so that the reversing switch is not moved until after the circuit is closed or opened by the main-line switch. With this arrangement of the circuits there is no objection to these switches because the contacts are never drawn apart while there is a current passing through them; therefore, there is no possibility of producing a spark.

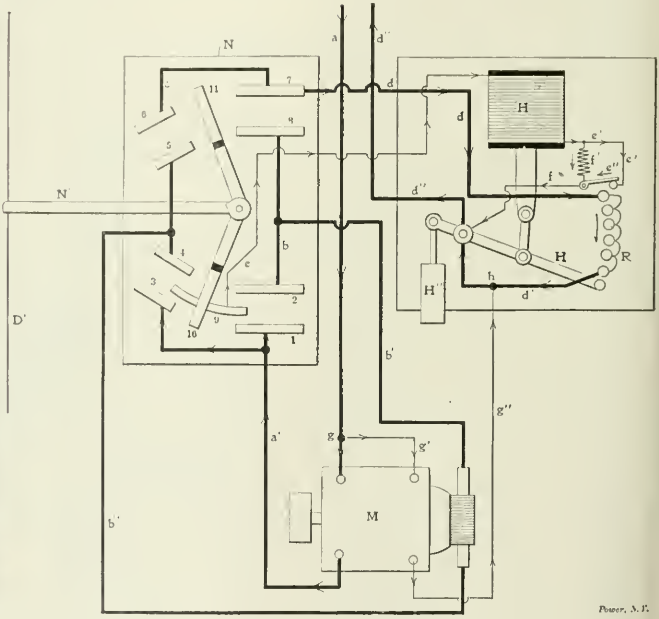


FIG. 12

A common form of reversing switch used when the circuit is broken at the switch contacts in the act of starting is what is known as the drum type. This is the kind commonly seen on trolley cars, and the construction of its contacts are such that it can withstand severe arcing for a considerable length of time before it becomes seriously damaged. A drum-type reversing switch of Cutler-Hammer make is shown in Fig. 13, and a wiring diagram showing the way in which it is connected in the circuit is given in Fig. 14. In this diagram the stationary finger contacts, shown on the side of the drum in Fig. 13, are marked *1, 2, 3, 4, 5, 6, 7, 8*, and the connecting segments on the cylinder are marked *9, 10, 11, 12, 13, 14, 15, 16*. If the cylinder is rotated so that the connecting segments move to the right, segments *9* and *10* will pass under fingers *6* and *8*, and segments *13, 14, 15* and *16* will pass under fingers *2, 3, 4* and *5*, and the motor will be set in motion in one direction. If the cylinder is rotated in the opposite direction so that the segments move to the left, segments *13* and *14* will pass under fingers *7* and *8*, and segments *9, 10, 11* and *12* will pass under fingers *1, 3, 4* and *5*, and the motor will be set in motion in the opposite direction. With the connections of the fingers and cylinder segments last-named, the path of the current through all the wires of the system will be as indicated by the arrowheads, and the dotted arrows show how the currents pass from one finger to the others through the connections made by the connecting segments on the drum. These segments are connected with each other as indicated by the heavy vertical lines.

In the wiring diagram, Fig. 10, the shunt-field winding circuit is kept closed when the motor is stopped by reason of its being connected permanently with the wires *a* and *c*. In the diagram, Fig. 12, the shunt-field circuit is also kept permanently closed by the connection of the end *g'* with the wire *a*, and of the end *g''* with the wire *d'* at the point *h*. In Fig. 14, however, the shunt field circuit is opened every time the motor is stopped.

Generally, when the switches are made so as to operate in this way a high resistance circuit is connected across the shunt-field terminals when the switch is opened, so that the high-voltage current induced in the field coils may be able to discharge through this circuit. In some cases this circuit is kept constantly closed, and in others it is closed just before the motor circuits are broken, and opened just after they are closed in starting. The way in which the switches are arranged to accomplish the latter result will be shown later.

The exact operation of the apparatus represented in Figs. 10, 12 and 14 may not be clearly understood owing to the fact that the several parts are not so disposed as to show the changes in connections effected by the movement of the reversing switch as clearly as might be desired; but the principle can be made entirely clear by reference to the simplified diagram, Fig. 15. In this diagram the arrangement of the reversing switch has been modified so as to be able to run the lines indicating the wires in a more direct manner. The two bridge plates *N'* and *N''* represent the bridges on the lever *N'* of Fig. 10 and the contacts on either side represent the segments of the latter diagram. The shunt-field winding is represented at *F*, *A* is the armature and *S* is the series-field winding. It will be noticed that the shunt field is permanently connected with the line wires + and —. When the bridges *N'* and *N''* are in the central position shown, the circuits through the armature and through the solenoid magnet *H'* are open. This fact can be more clearly seen in Fig. 16 which illustrates the connections in the simplest possible form, showing the conditions when the motor is stopped. Looking at Fig. 15 it can be seen that the only change made in the connections when the bridges *N'* and *N''* are moved to one side or the other is to reverse the connections of the armature terminals, *3* being connected with *N'* when the latter is moved to the

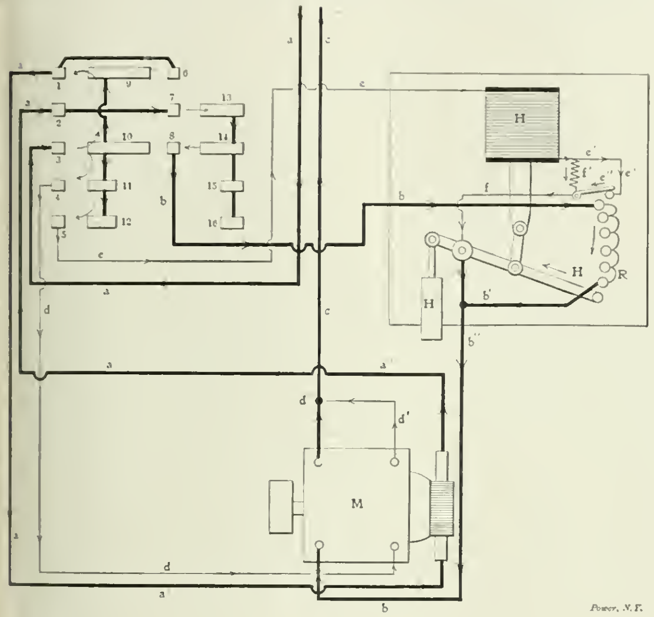


FIG. 14

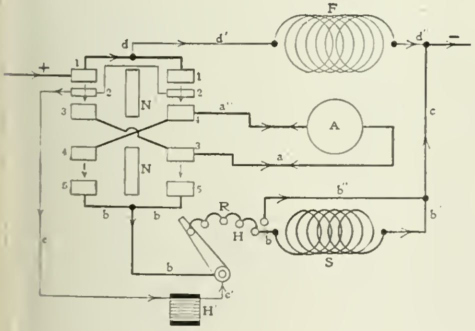


FIG. 15

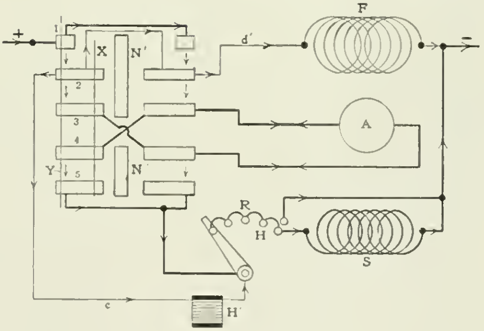


FIG. 17

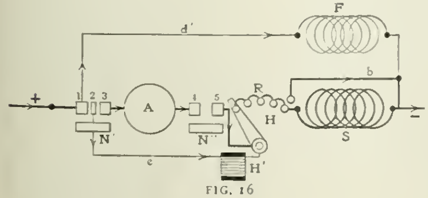


FIG. 16

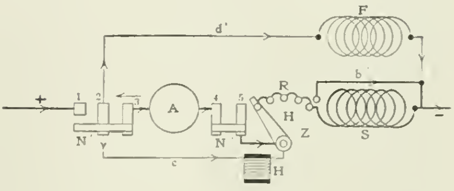


FIG. 18

left, and with N'' when the movement is to the right.

Now looking at Fig. 16 it will be noticed that when the motor is stopped the circuit of the armature is broken at contacts 2, 3, 4 and 5; hence when stopping the motor there will be arcing at these points, and under certain conditions the arcing may be very severe. If the motor is running at full speed when it is cut off, the arcing will be slight, because the counter e.m.f. of the armature will so nearly balance the line e.m.f. that the difference will not be sufficient to keep up an arc of any length, and this difference is the only voltage that acts to produce an arc. If the motor is started and then cut off before it gets a fair start, as is the case when the operator misses a landing and starts up to go a foot or more farther, then the arcing will be severe, because in such a case the counter e.m.f. of the armature is low and, therefore, there will be a considerable difference between it and the circuit e.m.f. to keep the current flowing across the switch contacts as they are separated. Owing to this fact it is desirable to arrange the controller switch contacts so as to keep the armature circuit closed in the act of stopping, and this is easily done by a slight modification of the reversing switch of Fig. 15. This modification, shown in Fig. 17, consists in connecting the terminal wire *d'* of the shunt field to the contact *2* instead of to the point *d* (as in Fig. 15) and in making the contacts *2*, *3*, *4* and *5* longer than the contact *1*. With this arrangement, when the motor is started, the bridges *N'* and *N''* are carried over as far as they will go, the line *Y* indicating the position when the movement is to the left. In stopping, the bridges *N'* and *N''* are not returned to the central position, but only as far as the line *X*, and the connection with the line is broken through the separation of the contact *1* from the bridge *N'*, but the motor armature and field coils are left connected in a closed circuit, as is more clearly shown in Fig. 18. When this arrangement of the reversing switch is used, no arc is produced except between the contact *1* and the bridge plate *N'*, as this is the only point at which the current is broken. This arc is small because the inductive action of the field is prevented by the e.m.f. generated in the armature, which tends to keep up the current flowing through the field winding.

In some cases the armature circuit is not kept closed when the motor is started, but the shunt field winding and the magnet *H* are connected with each other in the way shown in Fig. 18, then, when the motor is stopped, the current induced in the field winding circulates through the coil of the magnet, flowing through it in the direction opposite to that indicated by the arrowheads on the wire *e*. This arrangement offers considerable protection to the shunt-field winding because, although there is an inductive action in the coil of the magnet *H'* when the motor circuit is cut off, it is very much less than that in the field winding, because the field magnet is very much larger and has more turns of wire on it.

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# Primer of Electricity

## THE SERIES CIRCUIT

The simplest electrical circuit is one in which the entire current passes through all of the conductors which form the circuit.

Fig. 2 represents such a circuit. Here, *D* is supposed to be a source of electricity, such as a dynamo, and the six crosses indicate six devices—say arc lamps—through which the current from the dynamo passes.

Such a circuit is called a "series" circuit because the current passes through all of the apparatus "serially"—one after another. Of course, the passage of current through the whole circuit is practically instantaneous when the circuit is first "closed" or completed, and continuous after that, but, nevertheless, it passes through the various parts of the circuit one after the other. "Series," therefore, in electrical language, means connected successively, in sequence. The dynamo *D* and the lamps represented by crosses in Fig. 2 are said to be "connected in series."

In a series circuit, the current passing through any one element of the circuit is exactly the same as that passing through any or all of the other elements or parts of the circuit. For example, if the current sent out by the dynamo in Fig. 2 is 10 amperes, the current in every part of the circuit will be 10 amperes, whether it be in the lamp *a*, which the current passes first, the fourth lamp *b*, or the last lamp *c*.

The direction in which a current flows through a circuit is determined by the way in which the circuit is connected to the source of current.

In Fig. 2 one "terminal" of the dynamo *D* is marked "+" and the other one "−;" these marks signify "positive" and "negative." The positive terminal of a dynamo, battery, or other source of electricity is that from which the current goes out to the outside circuit; the negative terminal is the one to which the current returns in completing its course through the circuit.

If the circuit shown in Fig. 2 were connected to the dynamo as represented in Fig. 3, then the current would flow through the circuit in the opposite direction, as indicated by the arrows.

Every electrical conductor offers some resistance to the passage of electricity; hence, all electrical devices offer resistance to current flow. In forcing a current to flow through a circuit, therefore, a certain amount of pressure is used up.

The total resistance of a series circuit is equal to the sum of the resistances of its various parts. Referring to Figs. 2 and 3, if the resistance of each lamp is 5 ohms and the resistance of all of the wire in the circuit is 0.9 ohm and the resistance of the dynamo itself is 0.1 ohm, the resistance of the complete circuit will be

$$(6 \times 5) + 0.9 + 0.1 = 31 \text{ ohms.}$$

In the previous primer chapter it was explained that the electromotive force required to overcome resistance is equal t the resistance in ohms × the current i amperes.

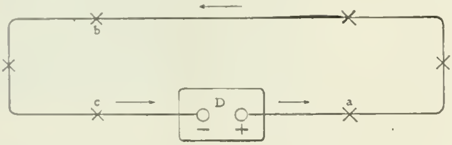
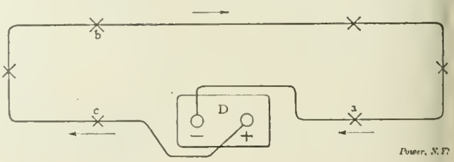


FIG. 2



Power, N.Y.

FIG. 3

In the present example, therefore, if th current in the circuit were 10 amperes th pressure or e.m.f. necessary to force tha current through the complete circuit woul be

$$10 \times 31 = 310 \text{ volts.}$$

So long as the circuit remains as de scribed and the dynamo generates 3 volts, the current in the circuit will 1 10 amperes. But if by any means tl dynamo should be made to increase i e.m.f. to 372 volts, then the current every part of the circuit would be i creased to

$$372 \div 31 = 12 \text{ amperes.}$$

Again, if the dynamo continued to ge erate 310 volts and two of the lamps we removed from the circuit, leaving fo lamps and the same length of wire, t resistance of the whole circuit would reduced to

$$(4 \times 5) + 0.9 + 0.1 = 21 \text{ ohms,}$$

and the current would then increase to

$$310 \div 21 = 14.76 \text{ amperes.}$$

# A Study of the Boiler Blowoff

## Its Function and Efficiency; Causes and Effects of Impurities in Feed Water; Both Bottom and Surface Blowoffs Desirable; Results of Analyses

BY J. C. WM. GRETH

All waters fed into steam boilers con-ain some impurities, which are either oluble or insoluble, or both. These im-urities may be divided into two classes: ncrusting and nonincrusting. The former s made up of the suspended matter, lime nd magnesia salts, silica and the oxides f iron and alumina; the latter includes nly the sodium salts.

The impurities in the feed water ac-umulate in the boiler by the action of eat and the concentration due to evapora-n. Heat drives off the soluble carbonic d and thus reduces the solubility of the rbonates. By the evaporation of the ter into steam all the impurities, in-uding the suspended matter, are left ind and eventually supersaturation of soluble scale-forming impurities is ached, when these impurities crystallize with the suspended matter deposit as le or sludge. Sometimes the combined ect of heat and concentration causes mical reaction with a consequent pre-ation.

perating a boiler with water contain-g any impurity will, by heat and con-ration, cause any or all of the follow-, depending on the amount and kind impurity:

Accumulation of suspended matter.
rmation of scale or sludge.
rrosion.
oncentration of nonincrusting sub-stances.

hese in turn may cause any or all of the following, which are objectionable from the viewpoint of economy and y:

e overheating of plates and tubes.
ss by waste of fuel due to scale, reducing the efficiency of the boiler.
duced heating surfaces in water-tube ers and decreased water space in all ys of boiler
cessity for cleaning and repairs.
ming and foaming.
ss due to the investment in spare rs to put into commission when it cessary to take boilers out of service for cleaning or repairs.
Loss of fuel due to heat lost on cooling a boiler for cleaning or repairs and that required again to bring it into service.
Cost of tube-cleaning machines, repairs to them, interest and depreciation on the money invested and labor and power required for operating them.
Loss of efficiency in earning power of improved furnaces and stokers; these are installed to increase evaporation, which correspondingly increases the concentration of impurities, thus forming a greater deposit of scale or producing more active corrosion and hence a great reduction in the efficiency and life of the boilers.

All types of steam boiler are subject to the same general condition of water contained in them after they have been under steam for a time. That is, on account of the concentration and precipitation of impurities, the water becomes foul, and to eliminate some of the impurities and keep down sludge, a part of the water is blown off while the boiler is in service. The introduction into the boiler of any chemicals or boiler compounds increases the amount of impurities, both soluble and insoluble, and increases the frequency of blowing off.

Blowing off is generally done from the lowest point on the boiler, on the assumption that all impurities in suspension will settle with the heavy suspended matter, such as the mud or silt of the feed water; hence the name "mud drum." This settling may occur in certain types of boiler, especially in the return-tubular, but it is doubtful if such is the case in many of the water-tube boilers.

Heat will force out of solution practically all those incrusting solids which make up the temporary hardness, namely, the carbonates of lime and magnesia held in solution by the carbonic acid, which is expelled by boiling. These precipitated carbonates may be carried to the mud drum or part of the boiler designed to receive them, or may be deposited on the heating surfaces.

The permanent hardness, made up of the sulphates, chlorides and nitrates of lime and magnesia, is not acted on by heat alone, as its being forced out of solution depends on the temperature and the amount in solution; so that no appreciable precipitation of these substances occurs unless a concentration is effected, and concentration in the mud drum or leg is possible only to a very limited extent. The chloride and nitrate of magnesia will, however, suffer partial dissociation and precipitation, even much below boiler temperature.

The nonincrusting solids are rarely if ever present in feed water to such an extent as to reach supersaturation by evaporation and thus be forced out of solution. Furthermore, the solubility of the nonincrusting solids as a rule increases with the rise in temperature.

The circulation of the water in the return-tubular boiler is such that there is a considerable deposit of sludge in the bottom of the boiler. At the water line there is also a considerable accumulation of suspended matter, and no matter from what part of the return-tubular boiler water is taken, it shows practically a uniform diffusion of the soluble impurities.

In the water-tube boiler an entirely different state of affairs exists, varying with the type of boiler. Some water-tube boilers are provided with mud drums, others with legs from which the blowoff is taken; in others the blowoff is located at the lowest point with no special provision for collection of sludge; in some the feed water enters the steam drum, mixes with the water in the boiler and passes down a bank of tubes, where it is heated to boiler temperature, which is supposed to bring about the precipitation of the scale-forming matter and carry it, together with the suspended matter in the feed water, into the mud drum, to which the bank of tubes is connected and through which all the water entering the boiler circulates.

In other types the mud drum is not in the direct path of the circulating water but is a dead end; in this type the water in the mud drum is practically static. In other types of the water-tube boiler the water is fed through drums, tubes, pans, etc., in the boiler, so as to heat the water to boiler temperatures before mixing with the water in the boiler, and depending upon the circulation to carry the suspended impurities in the feed water, or those forced out of solution, to the lowest point of the boiler or the blowoff opening. The mud drum or blowoff is usually located in the coolest part of the setting, or, in other words, where there are the least circulation and evaporation.

The blowoff is intended not only to remove suspended matter and deposited sludge, but to reduce the concentration of the soluble impurities; therefore, it should be so located that a minimum quantity of blowoff water will remove the greatest amount of suspended matter and that portion of the water showing the greatest concentration of soluble salts. The greatest concentration of soluble impurities occurs in that part of the boiler where the evaporation is most rapid, and not in the coolest part, where little or no evaporation takes place.

The blowoff from the mud drum or lowest part of any boiler does not carry out all the matter deposited, but simply that in the immediate vicinity of the opening, so that in those boilers having a dead-end drum or leg, the greater part of the deposited suspended matter remains in the water. In those boilers where there is a circulation of the water through the mud drum or leg, it must necessarily prevent the deposition of all of the suspended matter and much of it will be carried into the boiler proper, where, with the scale-forming matter forced out of solution, it adds to the scale formed.

There are many theories about ebullition in a steam boiler, but just what changes in the impurities in the water take place in the boiler are not known, nor can they be positively determined. The analysis of the feed water shows the impurities it carries into the boiler; the analysis of scale shows what has been deposited as a result of heat and concentration; the analysis of water taken from various parts of the boiler will show that reactions have taken place; just how, when or under what conditions they take place is a matter of conjecture.

Those reactions I shall cite as having taken place are conclusions reached from the analyses of many hundreds of samples of boiler-feed water, blowoff water and scale; samples taken of almost every possible water supply, raw, softened, etc.; blowoff water from nearly every type of boiler, operating under every conceivable condition. There are, however, some reactions cited that do not seem to have always taken place. This can only be accounted for by the presence or absence of other salts and the difference in boiler-operating conditions.

For instance, to precipitate calcium sulphate which, at boiler temperatures, is soluble to about 25 grains per United States gallon, it is necessary, if a water which contains only 3 grains per United States gallon is fed into the boiler, to have the temperature and concentration to the point at which it will be forced out of solution for that particular water. This point is a variable one and depends on the nature of the other substances in solution in the water, as well as the temperature at the pressure under which the boiler is operating.

An increase of impurities is shown in any boiler after being in operation for only a few hours, and there will be a continual increase in the amount as long as the boiler is making steam, irrespective of the amount blown off. (See the writer's article, "The Effects of Superheating Moist Steam," POWER, July 7, 1908.) This point is illustrated by the following analyses, showing the raw water and the boiler water after four days' operation, with regular blowing off:

| | Feed Water. | Concentrated Boiler Water. |
|---|---|---|
| | Grains per U. S. Gallon. | |
| Volatile and organic matter | 0.25 | 7.40 |
| Silica | 0.35 | 0.65 |
| Iron and alumina oxides | 0.05 | trace |
| Calcium carbonate | 4.50 | 3.77 |
| Calcium sulphate | 0.68 | 10.13 |
| Magnesium sulphate | 1.98 | 21.15 |
| Sodium sulphate | 0.44 | 25.40 |
| Sodium chloride. | 0.45 | 30.00 |
| Total solids. | 8.70 | 98.50 |
| Suspended matter.. | 0.90 | 130.60 |
| Incrusting solids | 7.56 | 35.70 |
| Nonincrusting solids | 0.89 | 55.40 |

The foregoing analyses also illustrate the difference in concentration of the different salts and the effect of heat on forcing out of solution some of the salts, depending on their solubility at the temperature and the other substances in solution. The sodium chloride (salt) in the raw water shows 0.45 grain; in the boiler water, 30 grains, showing over 66 concentrations.

Sodium chloride may be used as a basis for determining the concentration, as practically no chemical change takes place between the sodium chloride and the other salts in solution; also, because the solubility of sodium chloride increases with the temperature, so that at no time will there be any material reduction in the sodium chloride, on account of cehmical change or precipitation, as the boiler would not steam with the concentration of the sodium chloride at a point where it would be forced out of solution. Some of it may be mechanically carried down with the scale-forming matter and be deposited with the scale, but the amount is usually extremely small, as scale analyses rarely show any appreciable amount of sodium chloride. Of course, measuring the concentration of the impurities by means of any soluble salt is liable to error on account of variations in the feed water.

Sodium chloride will sometimes react with magnesium sulphate, especially at the higher temperatures and pressures and after considerable concentration, forming sodium sulphate, precipitating magnesium hydrate, which is very insoluble (less than 1 grain per United States gallon), and liberating hydrochloric acid, which will combine with the calcium carbonate if present; if not, it will attack the iron of the boiler. This is not the case in the foregoing analyses as there is no calcium chloride present and the sodium sulphate shows less concentration than the sodium chloride.

Sodium sulphate may also be taken as a measure of the concentration on account of its great solubility, and its not being subject to chemical change, except in concentrated solutions. In the foregoing analyses the sodium sulphate only shows 58 concentrations as against 66 for the sodium chloride. Ordinarily this concentration should be the same, but slight changes in the impurities in the feed water may account for the difference. There is not a sufficient quantity of either one present to cause a precipitation and the scale from this boiler does not show either, except as traces.

Calcium carbonate at boiler temperatures varies in solubility from about ½ grain to 8 grains, depending on the other salts in solution.

Calcium sulphate, as already explained, is soluble to about 25 grains, and in this particular water shows only 10.13 grains (probably its solubility for this particular water and temperature), or about 15 concentrations as against 66 for the sodium chloride, so that in all probability a considerable amount of it has been precipitated, either as suspended matter or as scale-forming sludge.

The magnesium sulphate which, at boiler temperature, is quite soluble, also shows about 11 concentrations.

The volatile and organic matter has a decided influence on the solubility of various salts, but in most water supplies the quantity present is not such as will affect the solubilities of other salts until after concentration. Volatile and organic matter is usually present to some extent in scale but it does not necessarily follow that it will cause scale in the absence of lime and magnesia salts. Silica, and iron and alumina oxides are usually presen in most waters in small quantities an they deposit as scale in the boiler.

The large quantity of suspended matter is undoubtedly due to the impuritie forced out of solution and to the concentration of the suspended matter introduced with the feed water. The sodium chloride shows 66 concentrations, whil the suspended matter shows about 14 concentrations.

Other substances in solution in boile feed water may, under heat and concer tration, become insoluble, such as magnesium carbonate, which is quite simil to calcium carbonate as to solubility, b it is usually dissociated into magnesiu hydrate and carbonic acid; the magnesiu hydrate being precipitated and the ca bonic acid going off with the steam.

Magnesium chloride and magnesiu nitrate are easily dissociated, beginni at 200 degrees Fahrenheit, into magnesiu hydrate and hydrochloric acid or nit acid, as the case may be. Both acids a very soluble at all temperatures but th will recombine with calcium carbonate it is present. If no calcium carbonate present, these acids will attack the iron the boiler, forming the corresponding ir salts, which react like iron sulphate, whi will be discussed later.

The following analyses will illustr the decomposition of magnesium chlori the hydrochloric acid formed combini with the calcium carbonate and the c bonic acid going off with the steam, a the magnesium hydrate precipitated for ing either scale or sludge:

| | Feed Water. | Concentrated Boiler Water. |
|---|---|---|
| | Grains per U. S. Gallon. | |
| Volatile and organic matter. | 0.35 | 2.90 |
| Silica | 0.35 | 0.45 |
| Iron and alumina oxides. | 0.10 | trace |
| Calcium carbonate | 1.02 | 2.02 |
| Calcium sulphate | 2.11 | 7.68 |
| Calcium chloride | ... | 1.19 |
| Calcium hydrate | ... | 0.33 |
| Magnesium sulphate | 0.93 | ... |
| Magnesium chloride | 0.32 | ... |
| Magnesium hydrate | ... | 0.32 |
| Sodium chloride | 0.10 | 12.77 |
| Total solids | 5.31 | 27.66 |
| Suspended matter | 0.05 | 0.80 |
| Free carbonic acid | 0.33 | none |
| Incrusting solids | 4.86 | 11.99 |
| Nonincrusting solids | 0.10 | 12.77 |

From the preceding analyses, which show what is usually considered a good natural water supply, there have been, based on the sodium chloride, about 120 concentrations. This water also shows the decomposition of the calcium chloride and the formation of calcium hydrate, and the presence in solution of some magnesium hydrate. This water has a decided caustic reaction. The boilers are operated at a pressure of about 175 pounds.

A similar state of affairs exists also in the following analyses; being rather a bad water. From the analyses of the water it would seem that a greater dissociation should have taken place compared with the preceding analyses. The water in this case also has a caustic reaction:

| | River Water. | Concentrated Boiler Water |
|---|---|---|
| | Grains per U. S. Gallon. | |
| Volatile and organic matter | 0.85 | 4.90 |
| Silica | 0.30 | 0.25 |
| Iron and alumina oxides | 0.10 | trace |
| Calcium carbonate | 6.47 | 1.50 |
| Calcium sulphate | 5.64 | 26.66 |
| Calcium chloride | 6.96 | 52.41 |
| Calcium hydrate | ... | 0.45 |
| Magnesium chloride | 3.42 | ... |
| Magnesium hydrate | . | 0.23 |
| Sodium chloride | 18.81 | 239.73 |
| Total solids | 42.55 | 326.13 |
| Suspended matter | 2.55 | 14.50 |
| Free carbonic acid | 0.11 | none |
| Incrusting solids | 22.89 | 81.50 |
| Nonincrusting solids | 18.81 | 239.73 |

Magnesium sulphate in itself will not usually form scale. There is, however, a reaction between the magnesium sulphate and calcium carbonate, in which the magnesium hydrate is formed and precipitated, carbonic acid going off with the steam and a corresponding amount of calcium sulphate being formed. This calcium sulphate will, of course, form scale after concentration to the limit of solubility for the particular water.

The following analyses will illustrate the formation of the calcium sulphate from the magnesium sulphate, also the decomposition of the magnesium chloride. It will be noted in these analyses that the concentrated boiler water still shows some magnesium chloride but no magnesium sulphate. This reaction is quite common in nearly all boiler waters:

| | Raw Water. | Concentrated Boiler Water. |
|---|---|---|
| | Grains per U. S. Gallon. | |
| Volatile and organic matter | 1.40 | 2.80 |
| Silica | 0.35 | 0.45 |
| Iron and alumina oxides | trace | 0.15 |
| Calcium carbonate | 6.25 | 1.50 |
| Calcium sulphate | 3.64 | 16.35 |
| Magnesium sulphate | 1.02 | |
| Magnesium chloride | 1.01 | 0.28 |
| Magnesium hydrate | | 0.15 |
| Sodium chloride | 4.68 | 146.44 |
| Total solids | 18.35 | 168.12 |
| Suspended matter | 0.25 | 15.90 |
| Free carbonic acid | 0.33 | none |
| Incrusting solids | 12.27 | 18.88 |
| Nonincrusting solids | 4.68 | 146.44 |

Iron sulphate is sometimes present as a result of drainage from coal mines and manufacturers' waste, also sulphuric acid, which, with the iron of the boiler, forms iron sulphate. The iron sulphate is decomposed at boiler temperatures, liberating sulphuric acid, precipitating the iron as the oxide, the acid taking up a new supply of iron, again forming the iron sulphate, which in turn is again dissociated. This cycle continues indefinitely with an increased corrosion of the boiler iron, corresponding to the increase of acid resulting from the iron sulphate introduced in the feed water.

In a return-tubular boiler, samples of water taken from the blowoff of a 72-inch by 18-foot boiler, the blowoff located about 18 inches from the back head, and from a floating surface blowoff, gave the following analyses:

| | Blowoff Water. | Water from Surface Blowoff. |
|---|---|---|
| | Grains per U. S. Gallon. | |
| Volatile and organic matter | 3.60 | 3.30 |
| Silica | 0.85 | 0.75 |
| Iron and alumina oxides. | 0.15 | 0.85 |
| Calcium carbonate | 3.00 | 3.54 |
| Magnesium hydrate | 0.17 | 0.25 |
| Sodium sulphate | 94.15 | 96.44 |
| Sodium chloride. | 69.05 | 70.20 |
| Sodium nitrate | 0.31 | 0.39 |
| Total solids | 171.28 | 175.72 |
| Suspended matter | 0.15 | 192.25 |
| Incrusting solids. | 4.17 | 5.39 |
| Nonincrusting solids. | 163.51 | 167.03 |

In this case water taken from a floating skimming blowoff shows practically the same analysis as from the bottom blowoff, except that the amount of suspended matter shows about 192 grains per United States gallon, showing that a surface blowoff is more efficient in this type of boiler than the bottom blowoff, on account of the reduction of suspended impurities.

A water-tube boiler of standard make (which I shall designate as "Type A"), with a mud drum, was fed with a softened water of the following analysis:

SOFTENED WATER.

| | Grains per U. S. Gallon. |
|---|---|
| Volatile and organic matter | 0.85 |
| Silica | 0.25 |
| Iron and alumina oxides. | trace |
| Calcium carbonate | 1.25 |
| Magnesium carbonate | 0.88 |
| Magnesium hydrate | 0.44 |
| Sodium carbonate | 0.77 |
| Sodium sulphate | 12.21 |
| Sodium chloride | 6.76 |
| Sodium nitrate | 0.55 |
| Total solids | 23.96 |
| Suspended matter | 0.05 |
| Incrusting solids | 2.82 |
| Nonincrusting solids. | 20.29 |

After being in operation for about 700 hours, the blowoff showed water of the following analysis:

BLOWOFF WATER.

| | Grains per U. S. Gallon. |
|---|---|
| Volatile and organic matter | 0.10 |
| Silica | 1.25 |
| Iron and alumina oxides | trace |
| Calcium carbonate | 1.43 |
| Magnesium hydrate | 0.46 |
| Sodium carbonate | 9.06 |
| Sodium sulphate | 258.08 |
| Sodium chloride | 107.02 |
| Sodium nitrate | 5.10 |
| Total solids | 382.50 |
| Suspended matter. | 17.80 |
| Incrusting solids | 3.14 |
| Nonincrusting solids | 379.26 |

On the other hand, water drawn from the gage column at the same time analyzed as follows:

WATER FROM GAGE COLUMN.

| | Grains per U. S. Gallon. |
|---|---|
| Volatile and organic matter | 0.15 |
| Silica | 2.45 |
| Iron and alumina oxides | trace |
| Calcium carbonate. | 0.71 |
| Magnesium hydrate | 0.58 |
| Sodium carbonate | 9.85 |
| Sodium sulphate | 438.07 |
| Sodium chloride. | 175.50 |
| Sodium nitrate | 8.50 |
| Total solids | 635.81 |
| Suspended matter. | 41.90 |
| Incrusting solids | 3.74 |
| Nonincrusting solids | 631.92 |

No sample was obtainable from the surface, as the boiler in question had no surface blowoff, but if the suspended matter shown in the analysis of water from the surface blowoff of the return-tubular boiler cited is used as a basis, the water at the surface would show the greatest concentration of both suspended matter and soluble impurities. This would be in the steam drum and not in the mud drum.

The analyses of samples from the feed, bottom blowoff and water column in an-the type of watertube boiler ("Type B") also provided with a mud drum, but of a totally different construction and where an entirely different set of conditions existed, are as follows:

| | Feed Water | From Blow-off | From Water Column. |
|---|---|---|---|
| | Grains per U. S. Gallon | | |
| Volatile and organic matter | 0 [illegible] | 14.00 | 17.00 |
| Silica | 0 [illegible] | 0.45 | 1.07 |
| Iron and alumina oxide | trace | trace | trace |
| Calcium carbonate | 2.02 | 6.43 | 7.[illegible]2 |
| Calcium sulphate | 0.6[illegible] | 2.80 | [illegible].80 |
| Magnesium sulphate | 0.29 | 4.56 | 6.17 |
| Sodium sulphate | 3.17 | 132.[illegible] | 141.[illegible]2 |
| Sodium chloride | 0.99 | 108.77 | 120.[illegible] |
| Sodium nitrate | 0.31 | 6.12 | 6.13 |
| Total solids | 7.05 | 275.15 | 305.19 |
| Suspended matter | 0.05 | [illegible].75 | 16.15 |
| Incrusting solids | [illegible].[illegible]1 | 14.04 | 18.34 |
| Nonincrusting solids | [illegible].47 | 247.09 | 68.15 |

No such marked difference exists between the two blowoff samples in this case as in the preceding example with boilers of "Type A," yet an appreciable difference exists both in the suspended matter and in the soluble impurities; showing a greater concentration in the water from the water column, also a larger amount of suspended matter than from the regular blowoff.

Any number of similar analyses might be cited to show the same condition of affairs and in nearly every case the analysis of water taken from the gage column shows a larger amount of soluble impurities than does the water from the blowoff. The amount of suspended matter, except in a very few instances, shows higher from the water column than from the blowoff, and where samples could be obtained from the surface, the suspended matter was still higher, and in the case of all water-tube boilers the greatest concentration of both soluble and suspended impurities is found to be in the water in the steam drum at the water line.

The location of the blowoff at the bottom of the boiler is on the assumption that the suspended matter would settle out. This would undoubtedly be true if the water were static, but the circulation of water in a boiler in operation must necessarily be very rapid, and very little if any settling can take place while the boiler is steaming, so that the suspended matter introduced in the raw water, together with that formed by those substances which are forced out of solution, is swept along with the water, some of which deposits as scale, the remainder eventually as sludge.

There seems to be a tendency for the suspended impurities to collect at the surface as a sort of scum. This scum may be more or less broken up by the steam leaving the water, but the upward current of the steam and water tend to carry the suspended matter to the surface, where much of it is held by the surface tension. All these forces tend to make the water line the collecting place for suspended matter rather than the mud drum.

Taking everything into consideration, the water line is the more rational location for the blowoff for the removal of impurities than the so-called mud drum, or bottom of the boiler. A blowoff at the bottom of the boiler is absolutely essential, but the intelligent use of a blowoff at the surface of the water in addition to the bottom blowoff would result in improved operating conditions, by reducing the amount of suspended impurities, as well as the concentration of the soluble substances, thereby reducing scale formation and increasing economy in fuel and boiler maintenance.

It is, of course, essential that the water fed into the boiler should be of the best possible quality obtainable; that is, free from suspended matter, as soft as possible and low in sodium salts. If natural water, practically free from lime and magnesia salts, cannot be obtained, nearly all natural supplies can be softened, purified and filtered at small cost, thereby preventing scale formation; but the blowoff is still necessary, as concentration will take place and this must be reduced by blowing off, and that at the point of greatest concentration to remove the greatest quantity of impurity, soluble and insoluble, with a minimum quantity of blowoff water. However small the amount of incrusting and nonincrusting solids may be in any natural or purified water, concentration cannot be prevented, but a slight diluting effect can be brought about by blowing off and replacing with fresh feed water.

Blowing off, then, is necessary to improve the conditions under which a boiler is to make steam and therefore every boiler should be supplied with properly located blowoff valves and an intelligent engineer to use them.

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It is stated that a rust-preventing coating for iron, used by a German manufacturing company, consists in coating iron and steelware first with lead, then electrolytically with zinc, and finally heating this coating, so as to obtain an alloy of the two metals which has the same potential as zinc

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# The Inception of the Steam Loop

By James H. Blessing

The steam loop is a device for returning the water of condensation from a heating system, located below the water level of the boiler, directly back into the boiler without in any way opening to the atmosphere.

Under favorable conditions the steam loop will work as well as though the heating system were placed high enough above the water level in the boiler to permit all the water of condensation to graviate back into the boiler.

In a general way the mode of operation of the loop is this: The heating system is so arranged that the water of condensation from the different radiators graviates toward some low point and thence is led into the top of a receiver. After this is done it is found that owing to friction, caused by the velocity of the steam passing through the different pipes and condensation due to radiation, the steam pressure in the small drip receiver is much less than that in the boiler. This difference will determine the hight, or the length of the loop, that must be employed so that the water will gravitate throught it into the boiler; that is to say, if there is ten pounds' difference in pressure, the descending leg of the loop should extend about thirty feet above the water level in the boiler, since a column of water 2 3/10 of a foot high is equal to one pound pressure, and, given a difference in pressure of ten pounds, it would require a column of water 23 feet high to equal this difference in pressure. If we make the loop 30 feet high we shall have an additional length of 7 feet with which to overcome friction. The water, after it reaches the top of the loop, composed of a larger section of pipe, will flow into the boiler through the descending leg with a velocity due to the extra seven feet added to the discharging leg.

Some of the steam loops that have been in use were constructed similar to Fig. 1. This style of steam loop was brought to the attention of the public about 1890

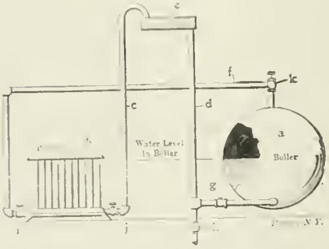


FIG. 1 THE STEAM LOOP

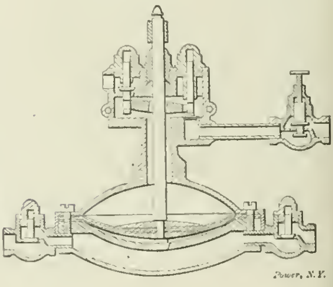


FIG. 2. DIAPHRAGM TRAP

In the loop shown it is not necessary to use a receiver to contain the water from many radiators as there is only one shown.

Referring to Fig. 1, *a* is the boiler, *b* the radiator, *c* the drip pipe from the radiator, *d* the return leg, *e* a short piece of pipe larger than the receiving or discharging leg, which forms the receiver, or separator, *f* is the main steam pipe for supplying the system, *g* is a check valve opening toward the boiler to prevent the water returning to the system, *h* and *i* are hand valves used on occasions that will be explained later.

To start the loop in operation with steam in the boiler, we first open the steam hand valve *i* to admit steam into the radiator, then open the steam hand valve *h* that opens to the atmosphere and the steam entering the radiator will displace the air and water from the radiator up through the drip pipe *c* into the top side of the large pipe *e*, and so on down through the discharging leg *d* that leads from the bottom of the large pipe *e* and so on through the hand valve *h* to the atmosphere. When the air and first water have been removed from the system, close the hand valve *h* and after the discharging leg of the loop has become nearly full of the water of condensation, the circulation will continue through the check valve into the boiler. This circulation will continue as long as there is no air or an unusual flood of water, for when this happens, the pipe *e* will fill solid with water. Under these conditions the pipes *c* and *d* (the two legs of the loop) are equal, one balancing the other, and the circulation stops until the equilibrum is displaced by blowing through as has been before described.

In the year 1868 I was employed as perintendent of the Townsend Furnace d Machine Works, of Albany, N. Y., a cern established in 1813, the proprietors which in 1868 were Franklyn Townsend d George P. Jackson, who then concted the works under the firm name of wnsend & Jackson. The plant was n located ih a part of the city about 50 feet above tide water in the Hudson ver The buildings were all heated with team, the apparatus for that purpose havg been installed by Joseph Nason, a well wn heating and ventilating engineer, t 1856. The heating plant was made in part of practically all the different stems in use at the present time. The ces were heated by direct steam, the ter of condensation gravitating back to the boiler. The machine and pattern ps were heated, while the engine was ning, by exhaust steam, the water of ndensation escaping to the atmosphere rough nonreturn steam traps. It may terest the reader to know that the backessure valve used in connection with e heating system was simply a flat disk ld on top of the exhaust pipe by a bolt d spring, the bolt forming a guide r the movement of the valve. In the autumn when it became necessary to use the heating system the person in charge had to send a man to the roof of the building, there to attach the back-pressure valve to the top of the exhaust pipe, where it remained as long as the heating system was in operation. While it may seem strange to some to have the back-pressure valve on top of the exhaust pipe above the roof, my recollection is that it caused no trouble and that the system was on the whole very satisfactory.

During 1870 the proprietors of the Townsend works deemed it best to remove their establishment down to the river front. As the area of the new works was to be considerably greater than that of the old, it was necessary to make some changes in the heating system. I concluded to use the exhaust steam for heating the foundry and part of the upper floors, and to heat the offices, machine and pattern shops with direct steam taken from a boiler to be especially installed for that purpose. I intended that the boiler should be set in a pit so that the water of condensation from the heating system of the lower floors would gravitate into it. After having settled on this plan, believing it to be all right, I arranged with a contractor to remove as much as possible of the old heating system and replace it in the new works and to furnish all the extra pipe and fittings necessary to complete the system as I had planned it. After arranging with the contractor, I paid very little attention to the matter, as we had over a hundred men employed in the different shops and my time and attention were fully occupied with the details of the business and the removal of the works. Therefore, I did not discover the gross error I had made until after nearly all the work was done, with the exception of the setting of the boiler. You can imagine my position, after explaining to my employers what a simple and effective plan I had devised for the return of the water of condensation back to the boiler, when I learned how impracticable it was to place the boiler low enough to have the water from the lower floors gravitate into it, owing to the fact that each tide caused the level of the water in the river to rise higher than the fire box of the boiler. In order to overcome this condition it would be necessary to set the boiler in a tank anchored to prevent its floating. This would have been very expensive and under the circumstances impossible.

After having discovered the character of the problem that confronted me, my first thought was to secure a trap that would return the water of condensation to the boiler without the aid of pumps. After making a thorough inquiry, I failed to learn of any such device.

In an effort to solve the problem presented, my mind turned naturally to the thought of returning the water of condensation to the boiler by gravity, and my first experiments were all in that direction. My first return steam traps, invented during 1871, were placed above the water level in the boiler, the steam being taken from the steam space of the boiler and acting upon the upper side of a diaphragm contained within the trap and intended for equalizing the pressures. This diaphragm acted simply as a dividing wall between the water on the one side and the steam on the other. The steam used for each discharge of water from the trap was, as in the case of a steam pump, exhausted to the atmosphere.

In my experiments with the diaphragm trap several interesting facts came to light. Among other things, I discovered that the inlet pipe for conveying the water of condensation to the trap receiver from the coils contained steam and water, for, after the first condensation, due to the extra amount of steam condensed when steam was first let into the heating apparatus was worked off by a few rapid discharges of the trap, it would require several minutes to collect water enough to again fill the trap. While this was filling up one could hear the inlet check valve on the inlet pipe rattling on its seat, caused by the water and steam passing through it. As a result of this observation and the experiments I had been making, it occurred to me that after all, the coils and radiators were only a part of the direct steam pipe that conveyed the steam from the boiler through them and finally terminated in the small pipes used for collecting the water of condensation.

If this smaller return pipe were connected, so I reasoned, to the top of a vessel of proper size placed a certain distance above the water level of the boiler, the water and steam would pass over into such receiver, the water falling to the bottom and separating itself from the steam. The steam pressure in the receiving vessel would be about the same as the pressure in the system at its farthest point from the boiler. If this pressure were near enough to that in the boiler and the receiver were placed at a hight sufficient above the water level in the boiler so that the solid water column would make up for the difference in the pressures, the water would gravitate back into the boiler through a return pipe extending from the bottom of the receiver. With this understanding of the conditions, I prepared a spherical vessel twelve inches in diameter as the receiver to be used in the system with which I was experimenting. I believed that a receiver of the size mentioned would be ample for the purpose as the capacity was less than one gallon per minute. The receiver was placed on the floor above the boiler where the coils were situated and about nine feet above the water level in the boiler. After the receiver was connected up and steam turned on and the first water and air removed by blowing to the atmosphere, circulation began and was perfectly maintained.

# Some Useful Lessons of Limewater

## Testing for Iron; An Interesting Simple Experiment with Boiler Scale; A Handy Form of Homemade Hydrogen Sulphide Apparatus

### BY CHARLES S. PALMER

The next metal to try in analysis is iron, for, whether you work up some scale from a boiler tube or some evaporate from your water supply, you will be almost certain to find some iron. Indeed, iron in small quantities is almost everywhere, and the tests for it are equal to the emergency. The first thing to do is to make a solution of common green vitriol, sulphate of ferrous iron. In an earlier lesson it was explained that this will surely turn brown in a few days, especially if left open to the air; and it was pointed out that this brown rusty stuff which comes is the ferric hydroxide, or the hydroxide of the higher form of oxidation which iron shows.

Have your reagents ready, and note that the common reagents are the hydroxides and carbonates of the common alkalies, sodium (or potassium, which closely resembles sodium) and ammonium. If you add some of the alkaline hydroxide to a solution of a metal, down goes some of the hydroxide of the metal in question; if you add some of the solution of the alkaline carbonate to a solution of some metal, down goes the insoluble carbonate of the metal attacked. For none of the metals has soluble hydroxides or carbonates, except the alkali metals, and most of the heavy metals have insoluble sulphides. Now try the fresh solution of green vitriol and you will find that iron gives with sodium hydroxide a dirty green hydroxide which will rust over to the brown or red ferric form of the hydroxide in a few minutes, according to the following equation.

| $12FeSO_4$ | $+6H_2O$ | $+3O_2$ | $=4Fe_2(SO_4)_3$ | $+4Fe(OH)_3$ |
|---|---|---|---|---|
| Ferrous Iron Sulphate Soluble | Water | Oxygen | Ferric Iron Sulphate Soluble | Ferric Iron Hydroxide Insoluble |

Such reactions will go on more quickly as a rule in proportion as the solution is alkaline. In this case, if you are fortunate, you may see the fresh precipitate of ferrous hydroxide from the green vitriol first whitish, which will, however, soon become green, and then rusty.

If you try the alkaline solution of ammonium or sodium carbonates on the green vitriol solution, you will get also a whitish ferrous carbonate, which rapidly changes to dark, owing to oxidation and other decompositions. Ammonium sulphide (noted in a previous lesson) gives with green-vitriol solution a black precipitate of ferrous-iron sulphide (FeS). The special potassium-sulphocyanate, KCNS (or ammonium sulphocyanate $NH_4CNS$) test gives nothing noticeable with the solution of green vitriol, but after standing, the solution goes blood red owing to the natural oxidation to ferric iron. There are also some other interesting reactions with "yellow prussiate of potash" (potassium ferrocyanide, $K_4FeC_6N_6$) and with the "red prussiate of potash" (potassium ferricyanide, $K_3FeC_6N_6$); but these precipitates are complex, and are related to a raft of things which in general are called the "prussian blues." On the whole, the iron in green vitriol acts much like a typical basic metal, with its insoluble sulphide, hydroxide and carbonate.

#### OXIDIZING GREEN VITRIOL

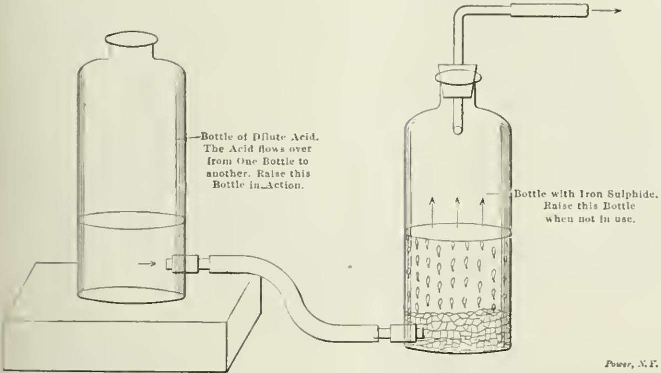
Now take some green vitriol and boil it with a little nitric acid. At first you will get the brown color, showing that the nitric acid is being itself reduced in oxidizing the ferrous iron over to the ferric iron, and also showing that some of the ferrous iron of the green vitriol has not yet been oxidized, because the dark color is due to a compound of the nitric fumes with some ferrous iron. So add some more of the nitric acid and boil until there is no more dark color in the solution, but the whole is a light wine color. Now all of the iron has been oxidized over to the higher form of ferric iron, and you will see this by getting an entirely different set of reactions with the same reagents which you used on the ferrous iron of the green vitriol. By the way, you will want to oxidize the green vitriol over with the nitric acid out of doors or in a good draft where you do not get the nitric fumes in your breath.

Now if you try for the ferric hydroxide, with the sodium or ammonium hydroxides, for the ferric carbonate with the sodium or ammonium carbonates, and for the ferric sulphide with the ammonium sulphide, all that you get in every case is ferric hydroxide, a reddish gelatinous precipitate. The reason for this is that the ferric iron is too much oxidized to act as a good base, being something between a base and an acid. It is able to form a hydroxide—almost any metal can do that—but it is too acid to unite with a weak acid like carbonic acid or with hydrogen sulphide, which is sometimes called "hydro-sulphuric acid." In fact, you will see the effervescence of the carbon dioxide and of the hydrogen sulphide as you pour some of the alkaline carbonates and sulphides into separate test tubes of the ferric salt. I forgot to mention that you had better put your solution of oxidized green vitriol (which is now a mixture of ferric sulphate and nitrate) into a clean bottle and label it "Ferric Iron Salts." But if you test this solution of ferric iron salts with some potassium or ammonium sulphocyanide, you will get the dark blood red of ferric iron; and if you dilute some of this by tenths, pouring half an inch into a test tube and filling it up some four or five inches with water, and then diluting this in another test tube until you can hardly get any color, you will find that you can thin the solution with water until the last test tube in which you can see color is some millionth-fold of dilution. I once carried this solution up to the fifty-millionth dilution; so it is clear that it is one of the most sensitive and delicate of tests; and yet you easily practice your eye so that you can tell something as to the approximate strength of the ferric-iron solution with which you are working.

But we must not lose sight of the main point—we have two entirely distinct solutions of iron, one the ferrous, which acts like a basic metal, and the other the ferric, which acts like an almost acid This is not the end; for if you will pu a piece of sheet zinc in a test tube and pour some of the solution of ferric-iron salts over it and leave it for an hour o two, you will reduce the iron down an back to the ferrous form where you wi again get the greenish-white hydroxide the black sulphide and the white carbon ate which darkens. You can easily te when this change from ferric iron to fe rous iron is about done because then yo will get hardly any of the blood-red colo with potassium or ammonium sulpho cyanate, or at most only a faint colo for the oxygen of the air is always your elbow, and so some of the iron w be carried back to the ferric state as fa as the hydrogen from the zinc has r duced it to the ferrous state. You c make this test for the blood-red col of ferric iron in the reducing solution, taking out a drop of the solution from t test tube (where the zinc is getting in work) with a stirring rod of glass, a touching a drop of the potassium or a monium sulphocyanate previously plac on a white saucer. You will find t saucer test very handy in many ot cases where I may not take time to m tion it, and where you do not care to clean a test tube nor to waste much of the solution; for one thing which you want to learn is to get good tests with small quantities of solutions and reagents.

### Attacking Boiler Scale

Now, we want to attack some of that boiler scale which certainly has some calcium and magnesium, and which also may have some iron in it; and hence we will see how the presence of iron may modify the apparent behavior of a good, straight solution, and in groups where the iron does not come down. Suppose that you have dissolved your scale, say half an ounce or perhaps less, in nitric acid, or you can take hydrochloric acid if you know that there is no lead present( you will not be liable to be bothered with the silver and mercury of the first group of analysis). If you use hydrochloric acid, you can assume that there is no first group (lead, silver and mercury) and can go straight to the second group; here is where the iron comes in to bother things. Now take some of the solution of the dissolved scale and lead some hydrogen-sulphide gas into it. Here you may note a strange action; there is a fine light yellow precipitate, and it can not be the sulphide of mercury (mercuric mercury), nor that of copper, because both of those are dark. Neither is it due to cadmium, arsenic, antimony, nor tin, for all of those are bright yellow or orange (excepting one of tin, which is brown). In fact, this light yellow precipitate is not a metal sulphide at all, but is simply sulphur, from the oxidation of the hydrogen sulphide by the ferric salts which got dissolved with the other stuff of the scale. You will see how this happens. You remember that ferric iron can be reduced by the hydrogen coming off from zinc; hence, ferric salts are oxidizers; and hence, as oxidizers, ferric salts can oxidize such reducers as hydrogen sulphide.


Bottle of Dilute Acid. The Acid flows over from One Bottle to another. Raise this Bottle in Action.
Bottle with Iron Sulphide. Raise this Bottle when not in use.
Power, N.Y.

SIMPLE HYDROGEN-SULPHIDE APPARATUS

Now, if you turn back to the oxidation table of sulphur, you will see that sulphur is the first stage from hydrogen sulphide, going from the reduced to the oxidized end of the table. Hence, it is entirely natural that sulphur should appear as a precipitate as you lead in hydrogen sulphide into the solution. But we are getting ahead of our story. To prove that this fine yellowish sediment is sulphur, there are several tests; one of the easiest is to let the hydrogen sulphide run for some time and then filter out the sediment, collect it on filter paper and scrape off some of it and burn it on a thin bit of glass. It will take fire, when dry, and burn like sulphur, leaving no ash as the metal sulphides would unless they were heated hot.

Having shown that this sulphur can come down in the second group (and tend to deceive you into thinking that there is some second-group metal when really there is no such thing in your boiler-scale solution), the point is that this appearance of sulphur in the second group is only a forewarning that there is some iron in the third group. Of course, if most of the iron present should happen to be already in the ferrous or lower form of iron oxidation, then there would be no showing of sulphur in the second group, and so you would not be put to much trouble; for you have used only a small part of your solution and the rest is ready for the third group; you must boil this with a little nitric acid to oxidize any iron to the ferric state completely. This is done with the whole of the boiler-scale solution so that you may go right on with the analysis, as told in the last lesson.

### Hydrogen-sulphide Apparatus

Right here let me describe a handy form of hydrogen-sulphide apparatus. Get a couple of small pickle bottles and bore a hole through the side of each bottle with a rat-tail file. Break off the end of the file so that you will have the sharp and fresh crystals of the steel to cut the glass. The outside of the glass is a thin but hard enamel while the inside is more crystalline and stony, and as soon as you get through this outside enamel you can work through the glass walls by a quick rotary motion of the file. Wet the outside of the glass where you start to bore the hole with a little turpentine and camphor, or with a drop or two of heavy engine oil, or even with a little water. As soon as you break the enamel you can grind your way through the glass by turning the file and keeping the point moist with the turpentine or oil. Select the side of the bottle to bore through which is fairly thick, because you are going to bore the hole big enough to carry a small cork and glass tube, as indicated in Fig. 1. After you get well started in boring the hole use a larger file so that you can make a hole say ½ or ⅝ inch in diameter. After boring the bottles, arrange the apparatus as shown in the accompanying sketch.

In one bottle put some iron sulphide and in the other bottle some dilute sulphuric acid, one part acid to five parts water, and remember in diluting to pour the acid into the water. By raising the bottle containing the acid (the two bottles being connected with a rubber tube), the dilute acid will flow on the iron sulphide and make hydrogen sulphide. When you are through using the gas, lower the bottle that first held the dilute acid and raise the bottle holding the iron sulphide, when the acid will drain away and the apparatus will be ready for use at another time.

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## Bore of Cylinder Larger Than Stated

In the article reporting a "Good Record by a Suction Producer and Hit-and-Miss Engine," on page 1027 of the June 8 number, the statement that "the engine is of the four-stroke-cycle horizontal type, with a 24-inch stroke and a bore of 6 inches" is erroneous, the bore of the cylinder being 16 inches. The speed of the engine is 194 revolutions per minute. This plant is located at 61 Poplar street, Brooklyn, N. Y., and is worthy of inspection.

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The boilers in the power plant of the Ampere building, 55 West Thirty-third street, New York City, are being reset, and during repairs power is maintained by means of a 100-horsepower boiler located in the street, with a steam pipe leading into the building through a coal chute. The street boiler is equipped with a stack 100 feet high supported against the side of the building. Contractor Michael Fogarty is doing the work. Chief Engineer John J. Wheeler, of the Ampere building, is in charge of the temporary plant.

# Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think,
Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

## Testing Transformer Oil for Water

A very small amount of water in transformer oil will lower its insulation to a marked degree; moisture to the extent of [illegible] per cent. reduces the dielectric strength of the oil to about 50 per cent. of the value when it is free from moisture.

The most satisfactory method of testing insulating oils for the presence of water is to measure the breakdown voltage required to force a spark through a given gap between two brass balls immersed in a sample of the oil. Oil free from moisture should have a breakdown voltage of at least 25,000 volts between brass knobs ½ inch in diameter and separated by a 0.15-inch space.

Often it is desirable to determine the insulating qualities of an oil when there are no high-potential testing transformer and apparatus available for making a test. When this is the case a very good idea of the insulating properties of the oil can be obtained by testing for the presence of water with anhydrous copper sulphate.

To prepare the anhydrous copper sulphate, heat some copper sulphate crystals (blue vitriol) on top of a hot stove. The heat will drive out the water of crystallization, leaving as a residue a white powder, which is anhydrous copper sulphate.

Fill a test tube with a sample of the oil, add a small quantity of the anhydrous copper sulphate, and shake well. If there is any moisture present in the oil, it will combine with the anhydrous copper sulphate, forming a distinctly blue solution. This test is quite delicate and a very small quantity of moisture can be detected by it. If this test does not show the presence of water it is safe to assume that the insulating qualities of the oil are fairly high.

When obtaining a sample of oil for testing, always get the sample from the bottom of the package, because, as water is heavier than oil, the maximum quantity of water will always be found at the bottom of the package. To obtain a sample from the bottom of a barrel or can, use a long glass tube of small diameter, hold the thumb tightly over one end and plunge it to the bottom of the barrel. Remove the thumb, letting the air escape. Then press the thumb tightly over the end of the tube and withdraw it with the sample of oil.

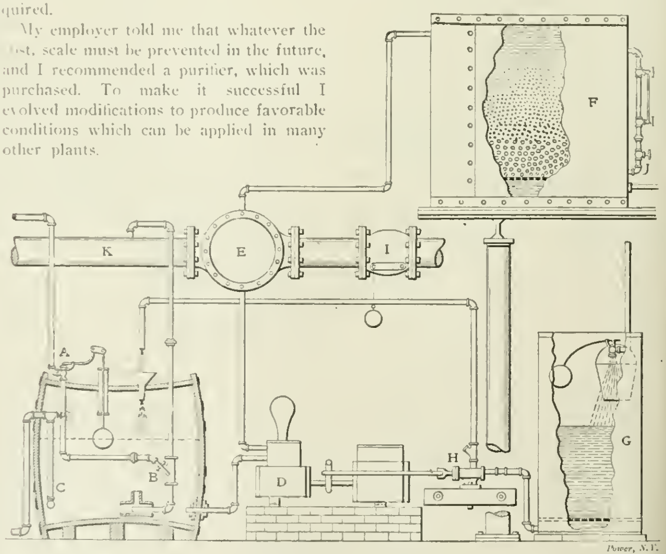
H. M. Nichols.

Kenyon, R. I.

## Preventing Scale

I have had both failure and success in fighting scale, and after experimenting five years with chemical and metallic compounds, also a mechanical cleaner, I tried a crosscut saw, with coarse teeth, between the tubes to remove the scale. This caused them to leak so badly that a new set (three hundred $3\frac{1}{2}$-inch) was required.

My employer told me that whatever the cost, scale must be prevented in the future, and I recommended a purifier, which was purchased. To make it successful I evolved modifications to produce favorable conditions which can be applied in many other plants.



MODIFIED WATER PURIFIER

An old oaken tun, or fermenting vat, was purchased from the local brewery, to be used as a hotwell. The hard spring water from the float valve *A* mingles in the homemade siphon condenser *B*, with exhaust steam from the main *K*. Returns from the heating system, etc., also enter the tun through the swinging pipe *C*. The temperature of the water in the tun averages 160 degrees Fahrenheit. The pump *D* pushes the water through the closed exhaust heater *E*, where the temperature is increased to about 200 degrees Fahrenheit. Then it goes through the filter into the boilers. The chemical is dissolved in the tank *G*, a perforated pail being used as a percolator. The pump *D* drives the chemical pump *H* which is so adjusted that the small pump sends 30 inches of solution containing 45 cents worth of chemical into the tun, for every 10,000 gallons of water that the pump *D* forces into the boilers.

The small pump *H* gave continual trouble, from phosphate of lime and other causes. A hoop, covered with burlap, was placed near the bottom of the chemical tank, and loose-fitting disks, cut from new belt leather, were put into the swing check valves of the chemical pump. Leather was used as phosphate of lime does not stick to leather, which should be of the proper thickness and a loose fit so that it will remain flat when the leather swells.

Although the chemical reaction in the tun was all that could be desired, the filter *F*, containing 4 feet of fine sand, failed to remove the sludge, which caused the boilers to foam; the trouble was found in the water column on the filter, the water bypassing through it. I put in a valve at *J* which compelled the water to go through the sand.

We now have cleaner boilers, and the matter of safety alone is worth the cos and fixed charges, while washing out and inspecting boilers is now an easy job. We have not noticed any difference as to saving in fuel.

CHARLES HAEUSSER.

Albany, N. Y.

## Location of Blowoff

As to a reply to a suggestion of a better plan of connecting up a blowoff, asked for by Thomas Sheehan, I submit a sketch of one that I have run across that I think would give better results than the one he has.

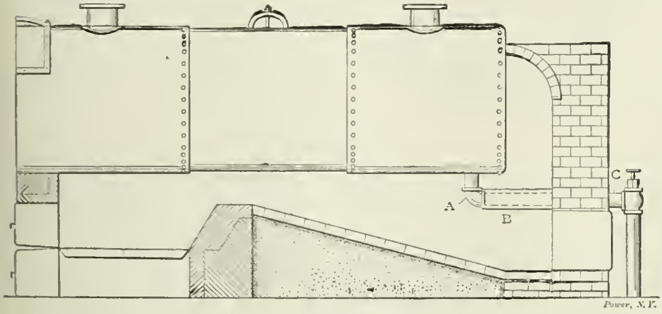
The idea is to have the pipe run as drawn, with an ell at *A* and a pipe of larger diameter at *B* to protect the blowoff pipe, this to extend until flush with the outside face of the outer wall; and in place of his ell I would use a good angle valve. I also should suggest putting in a blowoff cock between the wall and the angle valve, at *C*.

As a further caution, too, I should have a card printed: "Danger: Do Not Blow Boiler Down," and whenever a boiler is down and men are at work on it, just hang one of these cards in front of the blowoff line.

A person cannot be too cautious. I worked in a plant once where one of three boiler blowoffs was stuck and the oiler left the valve open all night and the next morning the repairman went to work on the blowoff line just below the one that was stuck and put in a new blowoff valve on No. 2 boiler, with no knowledge whatever of No. 1 blowoff valve being open, until after the job was done. Then they went to No. 1 boiler to blow her down and found it open. Well, the sweat stood out some when they knew what they had been up against.

H. G. BRIARD.

State Farm, Mass.



MR. BRIARD'S SUGGESTION FOR BLOWOFF

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It seems to me that a 1½-inch pipe, as indicated in the sketch accompanying Mr. Sheehan's letter, is altogether inadequate for blowoff purposes, particularly in cases where deposits of scale and sediment may be expected to obstruct a free passage through the pipe by lodging in the elbow joining the vertical with the horizontal sections. As a general proposition, a 2-inch blowoff pipe is none too large, no matter what the size of the boiler or the conditions of operation, and in the majority of instances, a pipe 2½ inches in diameter, or even 3 inches, is much more desirable.

The ordinance governing the installation of steam boilers in this city requires that all horizontal return-tubular boilers be provided with a 4-inch blowoff connection, while the 4 inch pipe attached thereto and making a right angle in the combustion chamber and passing out through the wall of the setting in the ordinary way, must in all cases terminate in a specially designed four-way fitting, or cross, constructed somewhat after the manner shown in Fig. 1. One opening of this fitting is threaded to receive the 4-inch pipe leading from the boiler, while the opposite opening is flanged and closed with a blank flange, which may be removed at cleaning time for exposure and inspection of the interior of the pipe. The two lateral openings are each threaded to receive 2-inch pipe—the feed pipe branching from one of these openings and the blowoff pipe proper from the other—the aforesaid 4-inch pipe really constituting a combined feed-water and blowoff attachment.

The admission of the feed at this point might be objected to in some quarters, and perhaps with good reason, on the score of permitting the comparatively cool water to spread out upon the hot furnace sheets directly it enters the boiler; but to offset this objectionable feature of the device, it has at least the advantage of producing a circulation which must materially aid in preserving the life of the pipe. This circulation, however, could just as well be obtained by other means.

Perhaps Mr. Sheehan could overcome the tendency of his blowoff apparatus to occasional disruption by adopting a plan of connection arranged somewhat after the manner of the one described here, leaving out, of course, the feed-water connection, and likewise introducing other slight modifications. It might be suggested as a substitute for the arrangement shown in Mr. Sheehan's drawing, that a 2½-inch, or, better still, a 3-inch pipe be carried out from the boiler and terminated in a tee plugged at the outer end, as shown in Fig. 2, and that a 2-inch pipe branching from thence downward be used to form the connection to the blowoff main, which should also be increased to a diameter of about 3 inches.

By placing a plug cock or some good straightway valves especially designed for blowoff purposes, of which there are several different makes, in the horizontal section of the pipe as the main blowoff valve, and an ordinary gate valve in the drop from the tee as a supplementary valve—two valves should be used as a precautionary measure against the possible contingency of an obstruction, as a stray bolt or rivet, preventing the closure of the blowoff valve—all danger of any water hammer severe enough seriously to threaten the integrity of the tee at the end of the horizontal lead would be eliminated; for, when blowing down, the main valve could be first opened wide, and then the auxiliary gate valve could be used to start and arrest the blast of water, while the excess capacity of the 2½-inch or 3-inch main lead over the 2-inch branch would

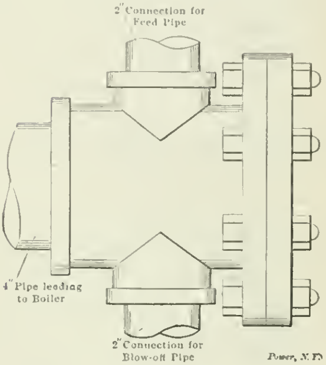

2" Connection for Feed Pipe
4" Pipe leading to Boiler
2" Connection for Blow-off Pipe
Power, N.Y.

FIG. 1

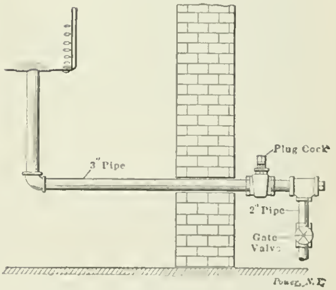


FIG. 2

insure a comparatively moderate velocity for the water moving from the boiler toward the plugged end of the tee. Likewise there would be practically little danger of the blowoff pipe choking up—that is, of course, if it were blown out at regular and frequent intervals.

A. J. Dixon.

Chicago, Ill.

## Internally Fired Boilers

Will some engineer tell me some of the advantages and disadvantages of internally fired boilers with Morrison corrugated flue, and how they compare with return-tubular boilers in first cost, efficiency and maintenance for a plant of 200 horsepower capacity?

F. B. De Motte.

Eureka, Ill.

## Installation of Producer Gas Plants in Cities

In view of the many articles which have appeared of late in which the low operating costs of the small producer-gas plant are set forth, one is led to inquire why more of these plants are not being installed in New York City, which, to a casual observer, would seem to offer an exceptionally good field for the introduction of a power unit which is claimed to possess an economy so much superior to that of the small steam plant.

Is this to be accounted for by the "inertia" which so often opposes the introduction of a new and improved type of apparatus and retards its general adoption, or is there still some doubt among power users, and particularly among engineers, as to the reliability of this type of plant?

The writer recently had occasion to look up the rules of the National Board of Fire Underwriters in regard to the installation of coal-gas producers, and it would seem as if these rules would have to be considerably modified before gas producers can be installed to any great extent in city buildings. As the rules now read, "the installation of gas producers in cellars, basements, or any other places where artificial light will be necessary for their operation, is considered hazardous, and will not be permitted except by special permission of the Underwriters having jurisdiction."

As gas producers, in connection with gas engines for power purposes, are likely to have a greatly extended use in the near future, it should be of considerable interest to your readers—and it certainly would be to the writer—to learn from those persons who have had experience with this type of plant more concerning its operating characteristics and economy, and also to learn under what conditions such a plant may, at the present time, be installed in the basement or cellar of a city building.

Isaac P. Storm.

New York City.

## A Homemade Prony Brake

In the article on "A Homemade Prony Brake," in the July 13 number, the point is not clearly brought out that the weights hung at the point *Y* (see reproduced sketch) to counterbalance the struts *F* are to remain attached to the brake permanently. This is not absolutely necessary, however, provided that when the counterweight is not used, the scale reading is corrected by adding the pull which must be exerted at *J* to support the brake when it is resting on the knife edge at *X*. This correction should be made at the time the scale *N* is graduated. It should be evident that the counterweight at *Y* and the correction at *J* are not equal, but the latter is smaller in the same ratio that the leverage at *J* is greater.

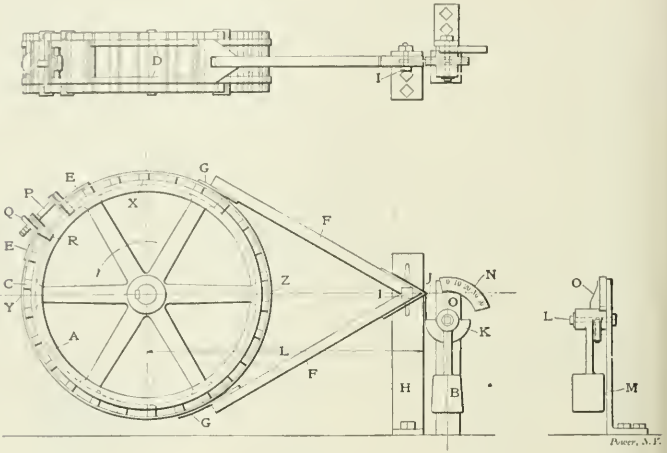


FIG. 1
(Reproduced)

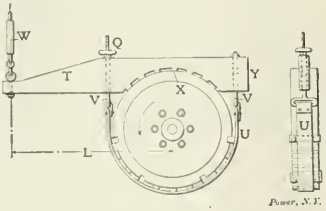


FIG. 2
(Reproduced)

Unless the brake straps are quite stiff, there is some distortion of the brake when it is supported at *X*. To prevent this, I mount the brake on a balanced wooden frame with a small shaft through the axis, forming an almost frictionless bearing. A frame of this kind is indispensable when ropes are used in place of metal straps for connecting the brake shoes.

A. S. Merrill.

Oak Park, Ill.

## More Expert Advice

In a certain plant a large drier was heated by live steam, as the owners were told by the party who installed the apparatus that exhaust steam would not give sufficient heat to do the work. The engineer, who has very little to say in this plant, finally convinced the proprietors that by adding about 5000 feet of 1-inch pipe they could use some of the exhaust steam that was then going to waste. The job was finished and it resulted in a saving of nearly three tons of coal per day, at $3.25 per ton, or $9.75 per day.

Louis B. Carl.

Marshfield, Wis.

## Filing Clippings

Several methods of filing clippings have appeared in Power, but I believe my method is as simple as any heretofore described. I have five "Amberg cabinet transfer cases" lettered on the outside thus: "A—E," "F—J," "K—O," "P—T," "U—Z." These cases are filled with 8½x11-inch standard loose-leaf folders that can be purchased at almost any stationery store for 35 cents per hundred.

The subjects are written on the upper right-hand corners of the folders and arranged alphabetically in their respective cases. For example, under "Engines" there would be one folder for each of the following subjects: "Blowing Engines," "Corliss Engines," "Gas Engines," "High-Speed Engines," "Rotary Engines," etc.

Any clippings filed thus can readily be found by leafing over the folders, as the ubjects are always visible, and as the lippings are filed alphabetically one can ell at a glance in which particular case he information is kept.

JOHN I. BAKER.

Allentown, Penn.

## Proper Amount of Lead

If one was asked the proper amount of ead to give an engine to get the best onomy and running condition, it would a difficult question to answer, as a reat deal would depend on the type of e engine, whether single- or double-rted, style of valve gear, speed, and ny other conditions which would make y general rule impossible to apply in all ses.

If diagrams were taken from a Corliss gine as shown in Figs. 1 and 2, it is ctically certain that Fig. 1 would be lected as representing the more cor-t valve setting. When one comes to sider the action which takes place in engine to produce these diagrams, wever, there is room for a considerable ference of opinion as to which would ve the best all-around results.

With the valves set to take the diagram in Fig. 1, the admission valve begins to open when the crank has reached the position shown, or about 10 or 15 degrees before it has reached the center. From that point until the crank has passed the center about the same distance, the full boiler pressure is exerted on the piston, and as the crank is so near the center practically none of the power is transmitted to the shaft.

With the valves set as in Fig. 2, there is little or no lead, the compression being just sufficient to bring the reciprocating parts to rest and reverse the pressure on the bearings as the crank reaches the center, at which point the admission valve begins to open and gradually brings full pressure on the piston when the crank has reached the position shown, or about 10 or 15 degrees past the center. This allows the crank to float past its centers, and the full pressure is applied only when it has reached a point where it becomes effective.

An engine having a piston 18 inches in diameter will contain an area of 225 square inches, and with 100 pounds initial pressure the amount of the pressure brought on the bearings with the valves set as in Fig. 1 will amount to almost 13 tons. As this pressure is exerted during about 1/9 of each revolution at a time when the crank is too near the center to allow the power to be transmitted to the shaft, the only result can be a loss due to friction, excessive wear on the bearings, and a large amount of oil required to prevent heating.

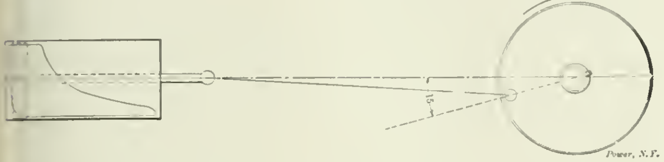


FIG. 1

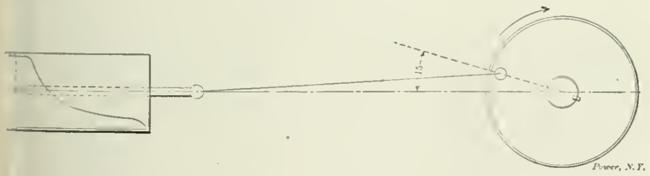


FIG. 2

S. KIRLIN.

New York City.

## Some Simple Kinks

One of the simplest lessons I ever learned and, at the same time, among the most useful, was in reference to the proper handling of the field rheostat. Simple as it is, many old engineers have not thought of it, which we see evidenced by the manner in which they handle these instruments. It came to me by accident at the time, so I claim no credit for anything except for my disposition to "take a hint." I had charge of a plant in which they had an exciter that was too small for the alternator. They told me that the commutator of the exciter "runs in a ring of fire," which I found to be quite true. I noticed that this was especially true when the load was heaviest, which of course indicated that the exciter was overloaded. I tried different methods of adjusting the resistances in the exciter and generator fields, and found that with all resistance out on the generator-field circuit, and keeping as much resistance in on the exciter-field circuit as possible, the sparking was not so bad. I then decided to handle it this way and after smoothing up the commutator, fitting and cleaning up brushes, etc., I found that I could get along very nicely.

Now the explanation is very simple. When we run with resistance cut in on the generator-field circuit we put additional load on the exciter. The armature circuit of the exciter and the field circuit of the generator are the same. The load on the exciter depends on the amount of current flowing through the generator fields and the resistance against which the current flows. The less the resistance, therefore, in the generator-field circuit, the less will be the load on the exciter. It is a good plan, I think, to spare the exciter as much as conditions will warrant, and in many instances I have found this plan to save much trouble.

When I came to my present position, I found an exciter furnishing exciting current for the fields of a 150-kilowatt alternator which had been giving trouble. It would not run without excessive sparking, and had made deep furrows in the commutator. They told me that it had but recently been turned down and put in good condition, and that for a few days it ran very nicely, and then went wrong again and became as bad as ever. One cause was that the brushes were not correctly spaced, and they were not set with their points in line with each other, some of them projecting as much as ¼ of an inch ahead of their fellows. This made good commutation out of the question. I had the commutator turned down again, and adjusted the brushes properly, and since this was done we have had no recurrence of the trouble.

In this same plant we had a 225-horsepower gas engine of the four-cylinder four-stroke-cycle type. This machine had been giving lots of the "mysterious" troubles for which this type of prime mover is famous. There were but few things that the mind of man can conceive that would exasperate that this engine had not been guilty of. The igniters would stick, and when one would stick it would short-circuit all the others, due to the way they were connected up. There was no way provided for cutting the bad one out of circuit, so there was an interruption every time this occurred, which was frequently. The remedy was to arrange for cutting out a defective igniter, and inspecting them at frequent intervals and keeping them in perfect condition. In fact, after regular attention was given to the igniters, the trouble entirely disappeared.

There was another trouble which occurred at intervals far too frequent for the engineer's peace of mind. The engine would get "logy," and when an attempt to start it with compressed air was made, we could not get up enough speed to get compression of the gas, and as a result we could not get an explosion, our air would soon be gone, and we could then rest an hour or so, and incidentally "sweat blood," while waiting to get another supply of air pumped up. Sometimes we would spend a half day in getting the engine started. I noticed that she would limber up gradually, and I finally came to the conclusion that the trouble was due to the fact that the engine was dry when shut down, and after she had the oil supply turned on for starting and the oil lubricated the cylinders she started off as nicely as one could wish. There were on each piston five rings ¾ inch wide, and having a circumference of about four feet. This made a frictional surface equal to 1¼x4 feet. The effect when this surface became dry can easily be imagined. I gave positive orders to see that the engine had ample lubrication in the cylinders, as well as all other parts, especially just before shutting down, and to this time we have been immune from this trouble.

I wish to say in conclusion that I am not a friend nor an enemy of the gas engine. There is no question but that it has "come to stay" and those of us who have scalps that we consider worth saving had best get next to them. I believe too, that as they are now being built by the best builders, they are capable of giving reliable service in the hands of competent engineers. Their complication is not so great as would seem, and as a machine they are as positive in their action as the steam engine. In the gas engine you have the events of admission, compression, ignition or explosion, and expansion. These events are positive in the best engines, and when you get them your engine will run just as the steam engine will when the events occur properly, and the engine is in proper condition otherwise.

Another thing in connection with this engine is worth mentioning, and might be helpful to some fellow engineer. The bearings for the main shaft were four in number, were sixteen inches wide, and the lubrication was accomplished by means of oiling chains, one to each bearing, which it will be seen for a machine of this size and bearings of this length was not adequate for the purpose. Besides, the chains were too small, and they had been using an oil that was too heavy to distribute until the bearing had become abnormally warm. I removed the small chains, and the heavy oil, and used a regular gas-engine oil instead, and for chains I used regular bicycle chains, which brought the oil up in a flood, and distributed it through the ample grooves that I cut in the main bearing caps. If any fellow engineer is having trouble with a proposition of this kind, I advise him to try this.

WILLIAM WESTERFIELD.

Lincoln, Neb.

## Governor Trouble

In the plant where I am employed we had considerable trouble with the speed regulation of two Corliss engines, one 14x30, running at 120 revolutions per minute, and one 18x42, running at 100 revolutions per minute. The governors were of the flyball type, spring-loaded. When the small engine had about half load the speed dropped to 115 revolutions per minute, and any additional load caused the engine to drop still farther, until at full load it only ran at 98 revolutions per minute. The only speed at which the large engine would run without hunting was at 80 revolutions per minute.

The manufacturers sent a man to locate the trouble and he found that the small-engine governor would come down only a certain distance, no matter how heavy the load was, and if pulled down by hand it would jump back to its former position when released. On the large engine the governor would jump to the highest position and stay there until the speed dropped way down, when it would come down with a jump and keep going up and down as long as the governor was set to operate at more than 80 revolutions per minute.

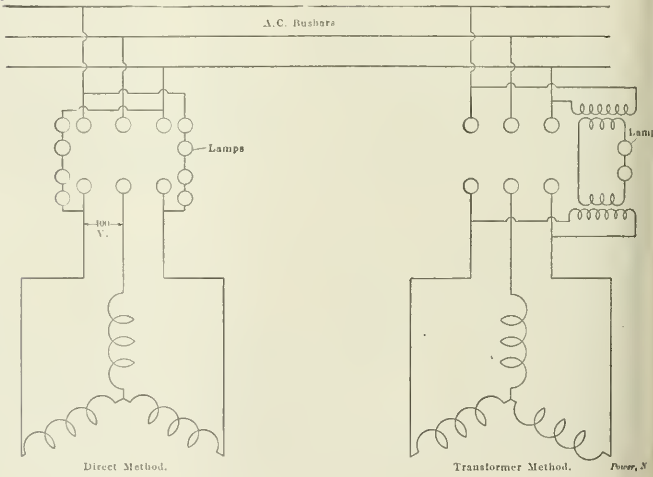
It was finally decided that the fault was in the design of the governors and the man was going to notify his employers to that effect when I noticed that while the springs on the small engine (both engines were shut down) had no tension on them, those on the large engine had considerable, but if we put more tension on the springs the speed at light load would be too high. On measuring the pulleys on both governors we found that the one on the large engine was 2 inches smaller than the one on the small engine. We then changed the pulleys, put more tension on the small-engine governor springs and slacked up on the large-engine springs, when both engines regulated nicely. In comparing the numbers on the pulleys and governors we found that they had been put on wrong when installed.

LOUIS B. CARL.

Marshfield, Wis.

## Connecting Synchronizing Lamps

In the issue of June 22, J. F. Foote has an article on "Connecting up Transformers for Synchronizing and Phasing Lamps."



CONNECTING SYNCHRONIZING LAMPS

But Mr. Foote evidently made a mistake, when he said: "I prefer to ha the lamps dark when the phases are step, largely for the reason that with direct method only dark *lamps can* used" (the italics are mine). This i mistake, as with the direct method it as easy to have the lamps bright synchronism as to have them dark.

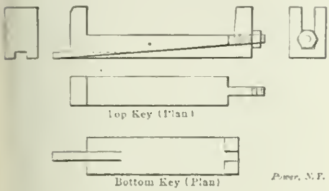
The accompanying sketch illustr how the lamps may be bright at synchr ism, for both the direct and transfor methods. All that is necessary to have br lamps is to connect the lamps across tween two of the lines with the end the series on opposite sides of the sw instead of connecting the series dire across the switch, as illustrated by Foote. To change from dark to br lamps with the transformer method only necessary to reverse the connec of the primary or secondary of *on* the transformers. In most cases the nections are such that the lamps are but this is largely a matter of choice, as one method has very little actual advantage over the other. An operator familiar with the bright lamps will do quite as well as the one familiar with the dark.

C. L. Greer.

Handley, Tex.

## Keying Flywheels

A recent article about keying flywheels made me think that it might interest to describe how the flywheel is keyed on "my" engine. I have only been on this job about six months, but it has not shown any signs of trouble. I am informed that they were fitted some two or three years ago. The engine was put down about in 1882. The flywheel, cast all in one piece, weighing about 4½ tons, is 10 feet in diameter and fits very loosely on the shaft. It has given a great amount of trouble through keys working out. I submit a rough sketch of the key used. It is in two parts.



KEYING FLYWHEELS

The upper part, which I consider as the key proper, being thicker and heavier, is tapered underneath, while the bottom one is much thinner and has a forked head and long tail of rectangular section. The tail passes through a slot provided under the head end of the top key, to keep the two straight. The top one has a threaded tail which goes through the forked head of the other and has a nut on it.

H. Kenworthy.

Manchester, Eng.

## Steam Turbine Dangers

That no great advance in economical science is without its attendant drawbacks is as true of power-plant construction as in any other field. The steam turbine, admittedly the latest word on the economical development of power, is not without its own peculiar troubles and dangers. The turbine requires and permits far less adjustment and manipulation than the reciprocating engine, but perhaps for that very reason it receives less intelligent and skilful care. Its moving parts are all protected by its case, needing to be opened only at long intervals, but meanwhile the engineer can do little more than guess at what is going on inside.

A great merit is the absence of any abrupt change in strain, or in speed and direction of motion, but the ear misses the sounds which are generally the best evidence of the performance of the engine and the first indication of trouble. The high speed means, of course, better regulation, but it also means less opportunity and shorter warning in case of any derangement of the governing mechanism. Without the shock and strain of the reciprocating engine, nevertheless, the unprecedented high speed of the turbine not only demands far better workmanship and material than the older type but encroaches much farther than is realized on the margin of safety. A factor of only 2 to 1 is small enough, and especially when we know that even this is calculated on the highest tensile strength and the best quality of metal, and when we further realize that the strains increase, not directly, but with the square of the speed.

While turbines do not store up their tremendous energy in heavy flywheels, with their liability to explosion, still their great speed makes them even more subject to disruptive accidents. According to figures to which the writer recently had access there are fewer than 3000 turbines in service in the United States; but there are at least three accidents of this kind to one of the reciprocating-engine flywheels. In a recent explosion near Boston, a broken pin in the safety device of the governor was not observed or was disregarded by the engineer. In this case the generator end of the engine proved to be the weaker and gave way first. In a plant at Providence the engineer threw the wrong switch by mistake; the 2-inch bolts that held down the casing were promptly twisted off before he could correct his error. With this fast-running machinery there is no time to correct mistakes; one must make the right move the first time. In New York, on the other hand, it was the failure of a reciprocating engine that sent a current through the turbine, wrecking both machines.

In a large turbine in a Chicago power house a bolt or bit of metal carelessly left in the boiler or steam pipe was thought to have been carried over into the turbine blades with disastrous effect. In Philadelphia the corrosion of the blades and consequent breaking off of small fragments resulted in the destruction of the whole machine. In Boston the oil pipe supplying the main bearing in some way became clogged with a bit of waste. The oil pressure on the bearing was destroyed and the entire rotor was thrown bodily from its place. In Los Angeles a surging of the load back and forth between two machines, operating in parallel, culminated in oscillations that the governor could not or did not control. In a similar case that of a large unit, where each step of the governor represented in itself nearly 300 horsepower, the sluggish action, or sticking, of one step proved to be enough to bring disaster.

Of course, some of these disruptions were installation accidents and not chargeable to regular operation of the plant; others belong to the period of experimenting and perfecting new designs and devices. Still others were due to the inexperience of new engineers handling an unfamiliar machine. But the turbine must now be considered as having passed the experimental stage. It will be judged the more rigidly. It must vindicate not only its economy but its safety. While design and type are fixed, there is still room for greater improvement in construction, for a still higher standard of material, for fool-proof connection and appliances, for further safeguards peculiar to its own conditions and needs.

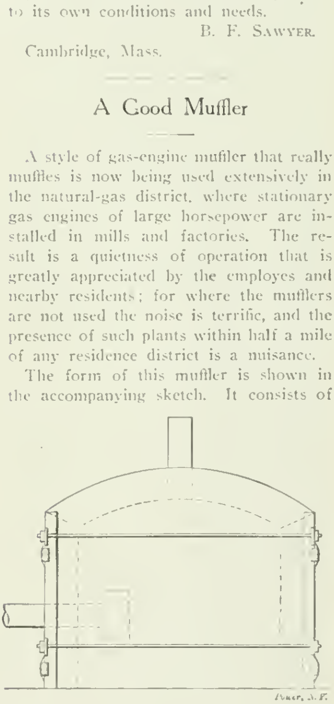
B. F. Sawyer.

Cambridge, Mass.

## A Good Muffler

A style of gas-engine muffler that really muffles is now being used extensively in the natural-gas district, where stationary gas engines of large horsepower are installed in mills and factories. The result is a quietness of operation that is greatly appreciated by the employes and nearby residents; for where the mufflers are not used the noise is terrific, and the presence of such plants within half a mile of any residence district is a nuisance.

The form of this muffler is shown in the accompanying sketch. It consists of a square brick box with an arched top. The exhaust pipe from the engine enters one side of the box and terminates in a tee with its openings vertical. A pipe 4 or 5 feet long and of the same diameter as the engine exhaust is placed in the center of the top of the muffler, and forms the only opening to the atmosphere. The box may be several feet deep and is filled with water up to within a few inches of the lower opening of the tee. For a 100-horsepower engine the muffler would be about 6 feet square, and made of hard-burned bricks—vitrified or fire bricks



GAS-ENGINE MUFFLER

—with 9-inch walls laid up in cement mortar. Corner irons and tie rods are used to strengthen the structure, and the top is arched just enough to make it self-supporting. The total depth would range from 6 to 10 feet. With this form of muffler large engines using natural gas are exhausting as quietly as steam engines.

F. W. Brady.

Scranton, Penn.

## Steam Consumption from Indicator Diagrams

Take an indicator diagram of the engine; find the per cent. of the cylinder that is filled with steam at the instant the exhaust valve opens, also the pressure of the steam at that instant; then by referring to the steam table find the weight of one cubic foot of steam at that pressure, and multiply the per cent. of the cylinder filled with steam at release by the weight of steam per cubic foot at release pressure, and mulitply this by the area of the piston in square feet and then by the piston speed in feet per minute. This result multiplied by 60, and divided by the horsepower, as computed from the indicator diagram, will be equal to the pounds of steam used per horsepower-hour. To this must be added the amount of cylinder condensation, which has been found by different experimenters to be approximately from 0.215 to 0.165 times the

$$\sqrt[4]{\textit{ratio of expansion.}}$$

In the case of compound engines this ratio of expansion is taken from the cylinder which has the greatest number of expansions and the smaller of the foregoing factors used. In calculating the steam consumption of compound engines either the high- or low-pressure cylinder may be used. When using the low-pressure diagram the mean effective pressure of the high pressure cylinder should be divided by the ratio of the cylinders and added to the mean effective pressure of the low-pressure cylinder; or if the high-pressure card is used the low-pressure mean effective pressure should be multiplied by the ratio of the cylinders and added to the mean effective pressure of the high pressure cylinder.

If the water rate of a simple engine is to be calculated, it is best to calculate it from a number of cards and then average the results. The following example will serve to illustrate the foregoing formula:

The diagrams shown in the accompanying illustration represent the action of the steam in a 14x28x24-inch compound engine, running at 160 revolutions per minute. In this example we shall figure the steam consumption from both cylinders, and then average the results. The line *A B*. in the high-pressure diagram is equal to 95 per cent. of the length of the diagram and the line *C D* in the low pressure diagram is equal to 93 per cent. of the length of the diagram. The release pressure on the high-pressure diagram is 42.5 pounds and 7.7 pounds on the low-pressure, which correspond to weights of 0.10293 and 0.02068 pound per cubic foot for the high- and low-pressure diagrams. Reducing the area of the high-pressure cylinder to that of the low-, we have the mean effective pressure of the high, as 57.95, which divided by 4 (ratio of cylinders) is equal to 14.49, and adding this to the mean effective pressure of the low-pressure cylinder, we have

$$10.37 + 14.49 = 24.86$$

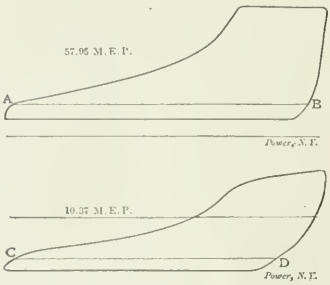
pounds per square inch. Then multiplying the mean effective pressure of the low-pressure cylinder by 4,

$$4 \times 10.37 = 41.48,$$

and adding the mean effective pressure of the high-pressure cylinder gives

$$41.48 + 57.95 = 99.43$$

pounds per inch square, the total mean effective pressure at the high-pressure cylinder. The horsepower of this engine, as per the indicator diagrams, is equal to



DIAGRAMS FROM A 14 AND 28 BY 24-INCH ENGINE

$$\frac{99.43 \times 640 \times 153.93}{33{,}000} = 296.82,$$

and the steam consumption per horsepower-hour computed from the horsepower diagram is

$$\frac{0.95 \times 640 \times 1.062 \times 0.10293 \times 60}{296.82} = 14\ 03$$

pounds per horsepower-hour. From the low pressure diagram we get

$$\frac{0.93 \times 640 \times 4.26 \times 0.02068 \times 60}{296.82} = 10.62$$

pounds per horsepower-hour.

As the ratio of expansion is 4, in the high-pressure cylinder, the per cent. of cylinder condensation is equal to

$$0.125 \times \sqrt[4]{4} = 0.25$$

or 25 per cent.

Adding 25 per cent. to the amounts found above, we get 17.53 and 13.27 pounds for the high- and low-pressure cylinders, respectively, and the average is equal to 15.4 pounds per horsepower-hour.

Since the factors, piston speed and area of piston, appear in both horsepower and water consumption formulas they can be eliminated and a much simpler formula is the result. In the following let *A* equal the area of the piston in square inches, *B* the area of the piston in square feet, *S* the piston speed in feet per minute, *X* the per cent. of cylinder filled with steam at release pressure, and *W* the weight of steam per cubic foot at release pressure. Then

$$\frac{M.E.P. \times S \times A}{33{,}000} = \text{H.P.}$$

$$X \times B \times S \times W = \textit{Water consumption per minute;}$$

and

$$\frac{X \times B \times S \times W \times 60}{\dfrac{M.E.P. \times A \times S}{33{,}000}} = \textit{Water consumption per horsepower-hr.,}$$

which is equal to

$$\frac{X \times W \times 33{,}000 \times 60}{M.E.P. \times 144} = \frac{X \times W \times 13{,}750}{M.E.P.}$$

Taking one of the foregoing cylinders as an example we have

$$\frac{0.93 \times 0.02068 \times 13.750}{24.86} = 10.64$$

pounds per horsepower-hour for the low-pressure cylinder. The slight difference in decimals in the two calculations is due to the dropping of decimals in the first method.

Louis B. Carl.

Marshfield, Wis.

## The Engineer's Responsibility

A short time ago a State inspector visited the engine room of a local factory and after watching 50 minutes for someone to make an appearance who might be in charge of the plant, finally sought the proprietor, who informed him that the engineer was "somewhere about the building probably upstairs." The engineer when found, was notified to appear befor the "board" and his license was ver properly revoked.

At first thought this seems a simpl and just disposition of such a gross offense, but in looking closer into the cas one is prone to wonder if the engineer i wholly to blame, and if the condition under which he works do not tend to ir duce an exceedingly dangerous kind carelessness. The plant comes under th third class, and such, as a rule, does n require the services of but one man, wl acts as engineer and fireman, and wl also takes care of the elevators, main lin of shafting and belting throughout t building and is generally the "handy ma around the place, the care of the boil and engine being regarded by his e ployer as incidental.

How the practice that soon becon nothing short of criminal carelessness formed can be easily seen. The n man comes on the job and sooner or la is informed that a belt has broken or elevator has "hung up" and as he wis to show his proficiency in doing that k of work, he "fixes" the fire, sees that the water level in the boiler is all right, looks the engine over and selects the tools he will need and then ascends perhaps to the top of the building, remaining there as long as he thinks the engine and boiler will take care of themselves. Should he refuse to do this work another man who is not so particular is sought and, when found, is quickly installed in his place.

I was at one time employed in such a plant with the nominal title of engineer, and, following the procedure set forth above, was eventually caught by the inspector and was extremely fortunate in escaping with a severe lecture, including the assurance that my license would be revoked if it occurred again. I besought the inspector to speak to the owner. The inspector replied that the law did not implicate the owner in any way and that he (the inspector) would consider leaving the plant alone for over fifteen minutes evidence of untrustworthiness, and if caught it would mean the revocation f my license. A conference with the wner was next in order and the inspector's ultimatum set forth. "You will ither have to do the work or I must get a man who will," was the answer. He t another man who did the work and ventually lost his license.

If ever serious consideration is given the real or imaginary short-comings the Massachusetts license law by the w-making bodies, I hope they will not il to take up the owner's liability, in es of this kind, and prescribe a penalty r any owner who insists or knowingly lows his plant to be left alone while peration. In most instances, I think will be found that the owner is far ore to blame for this careless practice n the engineer.

Arthur F. Clawson.

Boston, Mass.

## ementing Elevator Brake Leathers

For some time I have had charge of ld-style water-balance elevator, and stopping between the bottom and is done entirely by the brake the ers do not last long.

ently I took out one brake shoe, h the elevator man said had not been aired for more than three years, and that the leather was cemented to brass shoe and pegged on with den pegs, which were also cemented he leather and brass.

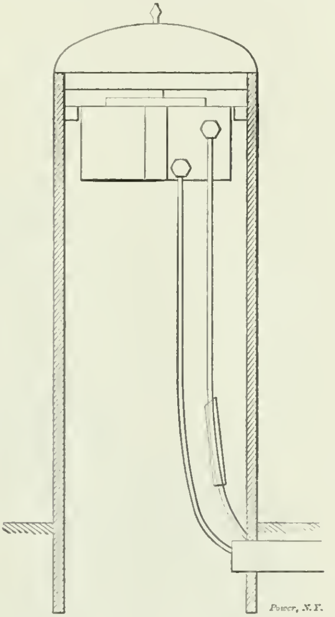
s this is the first time I have ever across a brake lining put on in this ner, I should be grateful to any reader who will describe the operation of ing brake linings on in this manner, also give the kind of cement used.

E. W. Erskin.

t. Paul, Minn.

## A Temporary Insulation for Arc Lamp Leads

In central-station work it does not often occur that an orthodox repair can be made at a time when it is most needed, and for this reason it may be interesting to describe a temporary repair which was effected on one of the leads of an arc-lamp switch. The insulation of the lead had broken down at a point close to where the leads went underground into the conduit, and it was impossible to repair this insulation without taking up the pavement because of the fact that a man could only get one arm down the pillar. This, it may incidentally be mentioned, is a fault in design which is frequently met with in such street pillars owing to the over-anxiety of manufacturers to economize space, which results in undue crowding of the part in the interior of the post. If the lead had not been repaired it is probable that the whole of the arc-lamp circuit would have broken down.



METHOD OF MAKING REPAIR TO ARC-LAMP LEADS

Under the circumstances a temporary repair was effected by means of a broken 16-inch gage glass obtained from the power house. The terminal of the faulty wire was unscrewed and the gage glass slipped down over the lead until it reached the point where contact with the ground was made by the conductor. The sketch shows roughly the method adopted, and it will be seen that the cable at this point was virtually inclosed in a glass insulator. By means of this device the arc lamps were run all night without mishap and the permanent repair was made on the following day when the lamps were not in use for some hours.

J. A. Seager.

Newcastle-on-Tyne, Eng.

## Why the Drop in Pressure?

A few days ago I had a class of students gathered about a 12x12-inch Ideal single-valve automatic engine, instructing them upon the subject of the "Steam Engine Indicator," just as had been my custom at this particular part of the course for the past dozen years with this particular engine.

The engine gets its steam through a 5-inch pipe somewhat over 200 feet long and containing one gate valve, four 90-degree ells and two 45-degree ells. The engine is provided with the "quick-opening" type of throttle valve, and a steam gage is located on the steam pipe just above the throttle valve, with a separator interverning between.

The engine is direct-coupled to a Westinghouse compound-wound, 110-volt, direct-current generator, which forms the only load, the unit being used to supply the power for lights and motors throughout the school.

We had just finished taking a number of diagrams with the engine running normally at about full-rated load, and were proceeding to take some more with the engine throttled, so the boys might note the effect upon the form of the diagram. I had throttled the engine enough to cause the voltage to drop from 110 down to a little less than 105, just enough to make sure that the governor would let the cutoff run out to about the maximum, this change, of course, resulting in a lowering of the load somewhere about 10 per cent.

While engaged in taking these diagrams one of the boys asked why the gage pressure dropped while the engine was throttled, and also asked if it should not go up instead of down.

I was somewhat surprised, and at once opened the throttle wide and again closed it off to the former position. Sure enough, the gage hand dropped back about 5 pounds lower with the engine throttled than it had been with the throttle wide open.

To gain a little time for cogitation, I asked him to explain why the gage indication ought to be higher when the engine was throttled than when wide open, and he, of course, at once explained that the reduction in load ought to reduce the demand for steam and thus lessen the "drop" in the steam-supply pipe. The facts very plainly, however, failed to accord with this theory, as the pressure plainly fell about 5 pounds instead of rising slightly.

By this time I had my explanation ready, and I proceeded to express to the class my surprise at not having thought out all the years I had been watching. thought of this simple method of proving that the efficiency of such an engine is much greater when cutting off at about quarter stroke and getting the full benefit of the expansion than it is when operating at late cut-off and governing the mean effective pressure by throttling.

In this particular case even the 10 per cent reduction in load, due to the reduction in speed, is not sufficient to counteract the greater loss, due to throttling with later cut-off, the result being that the engine demanded so much more steam that the steam-pipe drop increased nearly 5 pounds.

Mature consideration, however, makes it seem surprising that this increase in drop should be so great as it really is. Perhaps the apparent increase in drop is not real, but is due in some way to the change in steam flow from pulsatory to steady flow.

J. M. Kent.

Kansas City, Mo.

## Designing a Vacuum Tank

The "boss" told the engineer that he was going to install a new drying system and would need a vacuum tank 120 inches in diameter and 20 feet long. He had been to the boilermakers to get their quotation, but there seemed to be some doubt about the correct thickness that would be safe and yet not have the tank unnecessarily heavy. As the boss knew the engineer had studied boilers and engines he wished him to figure out the correct thickness for the tank, so he would know that the boiler company was not putting in too much weight. He also suggested that a factor of safety of four would probably be ample, as there would be no severe strains and wear, such as are encountered in steam boilers. Of course the engineer was delighted; it was only a small matter to figure out boilers, and he would bring the figures in the morning.

After supper the engineer took time to read the evening paper, as he knew he could look up about that tank and figure it out in less than an hour. When he was ready he got out his textbooks and looked up boilers, riveted joints, etc., but couldn't find anything that seemed to fit this case. A boiler made of about ⅛-inch plate would be safe for 15 pounds pressure per square inch inside, but would the same boiler stand the same pressure from the outside? He did not think so, because if the boiler were a little out of round the pressure would tend to flatten it, whereas with internal pressure it would always keep its shape. After more searching he came to the section on boiler flues and this time it seemed as though he had found just what was wanted, for surely a long boiler flue was under almost the same conditions as this vacuum tank.

Longridge's rule for boiler flues gave the following:

$$\textit{Thickness} = \sqrt{\frac{120 \times 15 \times 4.4721}{50}} =$$

12.088

or 13/32 inch, nearly 7/16 inch. This very inches, nearly 7/16 inch. This very much much astonished the engineer, who was expecting to find about ¼-inch plate amply strong. He felt that something was wrong. He could not tell the boss that the tank should be made from 7/16-inch boiler plate, which would be strong enough for 50 pounds steam pressure, unless he was convinced that it really ought to be that thick.

The engineer searched for more information and came across the famous Fairbairn's rule, which gave 15/32 inch. This showed that a still stronger plate would be needed, and this caused him much discomfort, for instead of getting nearer to what he expected he was getting to still thicker plates. This was not the worst, however, for he now felt doubtful as to the accuracy of these formulas; up to now he had always fondly supposed that the formulas used in boiler construction were based on a mathematical analysis of the strains and, therefore, should all give the same results. He further found that the well known Board-of-Trade formula gave ⅝ inch thickness and Seaton's formula gave 21/32 inch. These results showed that the thickness of the plate should be 13/32 inch or 15/32 inch or ⅝ inch or 21/32 inch, so the plate ought to be anywhere from 7/16 inch to 11/16 inch thick.

It was past midnight now, but there seemed to be no satisfactory solution to this blamed tank, and what in the world to say to the boss in the morning he did not know. He might tell him he could not say for sure, but the tank should be somewhere between 7/16 inch and 11/16 inch thick; but as this was the first time the boss had ever given him any figuring to do he did not wish to fall down, especially as he had been studying nights to be ready when the first opportunity came. He could specify that the tank be made of ¾-inch plate and be sure to be on the safe side, but then how would he feel should the boilermakers laugh at such a thickness and offer to guarantee a 7/16-inch one. Perhaps he had better take a chance and say that 7/16 inch would be right. But he had to work next to that tank all day and suppose it were to collapse? No; he did not wish to take chances, and so he was all tangled up. He researched all his books, but could find nothing more. After some pondering as to what to do he remembered that a brother engineer had a copy of Kent's "Pocket Book," and as he did not live far away he decided to go and wake up the family and borrow it, for he now was desperate and the risk of waking a healthy man up at 1 a.m. to borrow a pocket book never occurred to him. This intention he carried out. He got the book and hurried home and quickly found that the Board-of-Trade formula was good only for flues up to 10 feet long, so instead of being helped he felt more bewildered than ever; however, farther along he found a table such as is used by the U. S. supervising inspectors for flues and tubes, and although it went only up to 40 inches diameter he found that the minimum thickness increased 1/100 inch for every 1 inch increase in diameter from 12 inches to 40 inches, the limit of the table, and so it seemed as though it would be safe to extend this method to the 120-inch diameter. The thickness for 40-inch was 0.50 inch, and therefore for 120-inch it would be 1.30 inches. Oh, my, how his head did spin! He imagined himself telling the boss that the tank must be at least 1¼ inches thick.

In another part of the book he found many formulas on "Resistance of Hollow Cylinders to Collapse," but these formulas were based on Fairbairn's and the English Board-of-Trade's, and as Fairbairn's experiments were on tubes varying from 4 inches to 12 inches in diameter and from 19 inches to 60 inches long, it did not seem as though they could be relied upon when applied to a tank 120 inches in diameter and 20 feet long. Then the Board-of-Trade formula, from what was said elsewhere, was good only for flues up to 10 feet long. However, there was an account of where various flues i Cornish and Lancashire boilers had collapsed under certain pressures, and th formula Clark deduced from these wa

$$P = \frac{200{,}000 \times t^2}{d^{1.75}}$$

where

$P$ = Collapsing pressure in pounds pe square inch.
$t$ = Thickness of the plate in inche
$d$ = Internal diameter of the furna tube in inches.

By taking $P$ as 60 pounds, which allov a factor of safety of four, and transpo ing, the formula became

$$= \sqrt{\frac{120^{1.75} \times 60}{200{,}000}} = 1.1424$$

inches, and so the thickness was 1.14 inches or, say, 1⅛ inches. As this about the same as that used by the Unit States supervising inspectors, it certai seemed as though the thickness should over 1 inch instead of 7/16 inch. It v now time for the poor muddled and wildered engineer to go to work, wh he did, and he told the boss that nearest estimate he could give was t the shell should be 1⅛ inches thick. which he fell, in the boss' estimat from a promising engineer to a rav theoretician.

George P. Pierc

Exeter, N. H.

# The Lea Continuous Engine Recorder

## An English Device to Record Water Rate of Engine, Compare Engine Economies for Various Adjustments and Measure Water Flow in General

BY WILLIAM H. BOOTH

Continuous recorders of the amount of carbon dioxide gas in the effluent gases from boiler furnaces are now very usual accessories of power houses. Yet such recorders are only very partial in their records, for while it is very desirable to know how much dioxide is being made, it is perhaps of greater importance to know how many volumes of carbon monoxide is going with it. This the recorder does not tell, and while a 13 per cent. record may appear to be better than one of 12 per cent., their true value is really fixed by the percentage of monoxide that goes with each case.

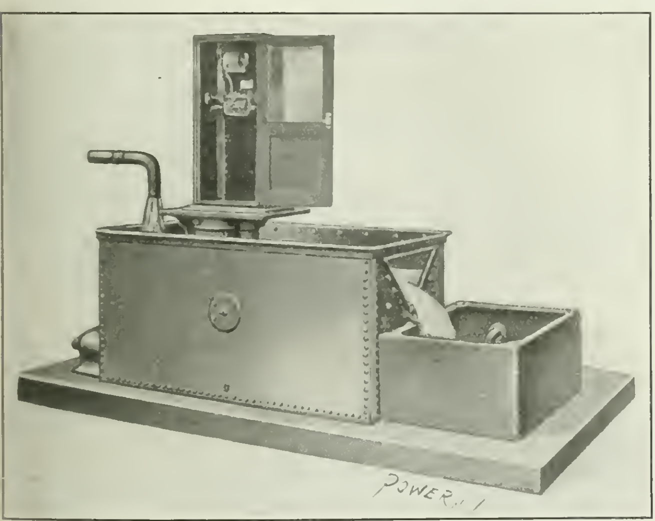


FIG. 1. LEA TANK AND RECORDER

In the Lea engine recorder there is no ambiguity. But first what is the a recorder? It is an instrument that ls how much water is discharged from surface condenser of a steam engine. he rate of discharge can be read off at instant by the position of the pointer. amount of the discharge in a given eriod of time can be measured off on e diagram by means of a planimeter. is thus a very universal implement.

In general there are four different types f condensing plant in a power station. he best for the purposes of the Lea corder is that in which each engine has s own independent surface condenser. Next is the case of the one surface condenser serving more than one engine. Thirdly, there is the case of the separate jet condenser to each engine and fourthly, the jet condenser serving more than one engine. Since the sole duty of the recorder is to measure the discharge of the air pump, it is obvious that the most direct results are those obtained with the first disposition of the condensing plant, since each engine's steam consumption is found at once. If the disposition is that of case 2, it is clear that any change in the behavior of a particular engine of a group of several engines can only be found by some process of elimination or differentiation and reasoning.

In case of jet condensers, the engine consumption can only be found either by some such means as measuring both outflow and jet inflow, or by reasoning from the rise of temperature that takes place in the jet when passing through the condenser. It will be sufficient here to describe the instrument as it is applied in the first and simplest case of the separate condenser to each engine.

### Arrangement and Mechanical Construction

In its simplest and most compact form, Fig. 1, the instrument stands on the top of a tank about 5 feet 6 inches in length, and half that breadth. The length of the tank is divided into two equal halves by a transverse plate which extends from the upper edge to within about 4 inches of the bottom. Near the top of the first division is a horizontal plate freely perforated, over which the air-pump discharge is delivered. It serves to break the rush of the water and distribute it over the area of the division, from which it is then free to flow with no remaining eddy or swirl below the division plate into the second division. In the first division is immersed a closed cylindrical chamber. This has no communication with the water in the first division. It stands in that division merely as a concession to self-contained compactness. It may equally well be placed at the other end of the room. The chamber is connected by a pipe to the second division or notch chamber. If at a distance, the pipe should be large enough to avoid skin resistance, and so sloped as to be maintained always free from air. The water level in the cylinder is thus always exactly that in the second division of the tank, which henceforward will be called the notch chamber, because its outer end is closed by a plate to which is fitted a carefully cut and smoothed gun-metal plate with a 90-degree triangular notch.

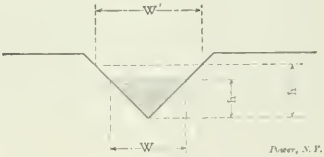


FIG. 2. TRIANGULAR NOTCH

Many years ago Prof. James Thompson, of Belfast, the inventor of the vortex turbine, made very careful experiments with notches, and he found that the coefficient for the flow over a triangular notch was always the same, no matter what the depth of water over the point. The formula he determined was,

$$Q = H^2 \times \sqrt{H} \times 0.305,$$

where

$H$ = Hight of the notch.

$Q$ = Cubic feet of water per minute.

The basis is that the rate of flow is proportionate to the square root of the hight, while the amount of flow is proportionate to the notch area, and the area of a triangle is as the square of its hight. Hence the values *H* and $\sqrt{H}$ in the formula, and 0.305 are simply the connective coefficient of time, hight and capacity in minutes, inches and gallons. See Fig. 2. This formula can therefore be applied at once when the depth of water over a notch has been measured.

### Recording Apparatus

In the Lea recorder, the cylindrical chamber contains a float, carrying a vertical rod, and the primitive idea would be to allow a pointer on the rod to be moved up and down a vertical scale, the pointer being adjusted to show zero on the scale just when the notch had drained the chamber down to the point, or zero level. But such a simple arrangement would require the formula to be worked out for every value of *H* and the usefulness of the instrument would be greatly limited thereby. In the Lea instrument, the calculation is performed once for all, and the instrument shows directly the amount of water that is passing at any instant. To effect this, the float rod is cut into a toothed rack which engages with a pinion on the spindle of a horizontal drum. A groove is cut in the face of the drum. It starts at one end of the drum with a plain cut at right angles to the axis. From this it diverges at a gradually increasing angle such that at any moment its departure from the dead point is represented by the value $H^2 \times \sqrt{H}$. The reasoning underlying this is, of course, that in a still pond the outflow over a notch varies in the way already described.

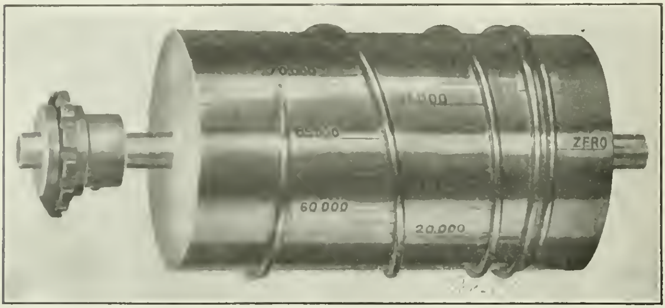


FIG. 3. DRUM OF RECORDS, SHOWING INCREASING-PITCH SPIRAL FOR ACTUATING RECORDING PEN

Thus, the outflow is represented by the increasing pitch spiral, Fig. 3. In this spiral groove is fitted a button on a lever, and as the drum rotates, this lever or bracket, is pushed laterally, and governs the position of the pen on the recording diagram. At the same time the drum itself is marked for so many gallons rate of flow per time unit, and a pointer at the button point stands against such figure on the drum as is also pointed on the diagram paper above by the pen. The diagram paper is folded upon a clock-actuated drum, and the record shows at any time just what was the rate of flow at that instant. By taking a similar autographic record from the wattmeter of the electrical generator driven by the engine, if an electric station is in question, the steam consumption per kilowatt at each instant can be calculated instantly by slide rule or otherwise. See Fig. 4.

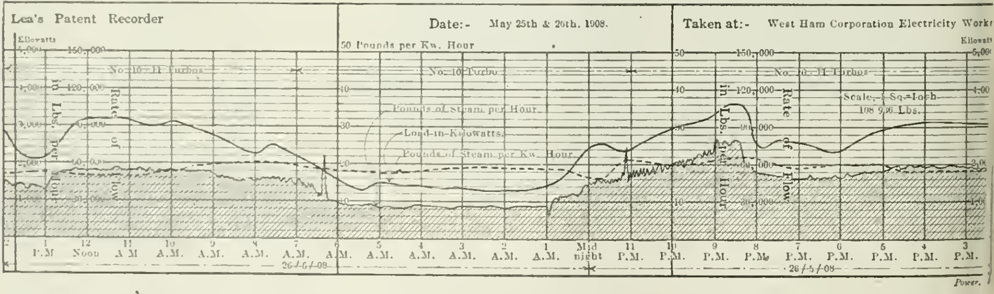


FIG. 4. CHART SHOWING STEAM CONSUMPTION PER KILOWATT-HOUR

Now, assuming the main engine is at rest, and the air pump is at work, there should be no outflow over the notch. Any outflow is a sign that the condenser tubes are leaking, and the sudden increase of the apparent water consumption of an engine a few days before writing this was a sign of this very fault. However, the condenser being proved tight and the instrument set to work, it is very easy to detect anything going wrong.

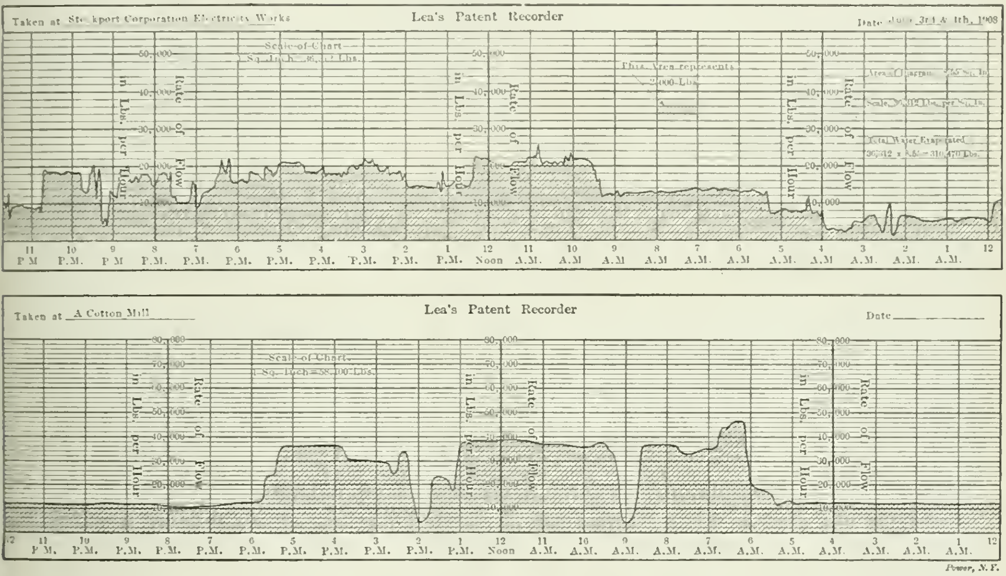
### Various Uses for Records

As an illustration of what the recorder will show, the writer made a trial of its capacity by varying the cutoff on the low-pressure cylinder of a 5000-kilowatt engine from three-eighths to one-half the stroke. The pointer of the recorder moved to a position showing considerably more steam being used. After a few minutes, the cutoff was put back to three-eighths-inch stroke and as soon as the air-pump delivery felt the difference—in a few seconds—the pointer went back to the original steam consumption rate. A rough calculation made on the spot showed tha the change represented a coal value pe week of $150 had the same rate of chang been carried through the whole of th engines.

It is plain that by means of this instru ment there can be made in a few hour a series of tests on steam engines wit every degree of cutoff. Such tests woul require many weeks' work with sever assistants to carry out and they woul involve considerable cost in excess fu during the uneconomical conditions. Th an engine may be tested at all ratios cutoff and the results plotted. It may tested for a series of boiler pressures, it may be tested on several superhe temperatures or with and without stea in the intermediate reheater. Only a f minutes will practically serve to dete mine the best cutoff on the low-pressu cylinder.

Though results cannot so promptly definitely be secured from engines group on one condenser, the recorder will sl very well in such a case, especially out of, say four engines, three are regu ly worked. The relative economy of *B* and *C* is at once comparable with of *B*, *C*, *D*, or *C*, *D*, *A*, and the sta engineer who watches his recorder begins to calculate what it is costin run the old engine that sends up record so badly. The firemen have kn it for a year or two, and there is a eral understanding that the old engi less economical than it might be, b has never been so plainly put upon record before.

In some engine rooms there is an instrument to each engine. In others there may be one instrument only and a notch tank to each engine, with a pipe to the float cylinder. But with this arrangement the continuous diagram cannot be obtained from each engine. If without known cause the record shows too high, it is an intimation that probably something has gone wrong. A circulating-pump inlet has become choked, or a vacuum-pipe joint is drawing air, or a piston is passing steam. There is no getting away from the record. It finds the best point of cut-off; the best ratio of circulating water, or the most economical load, and it soon invites you to examine the condenser for baking tubes or approves your exdenditure on paint for that long unpainted exhaust pipe that ought to have been scrapped, being blown in the casting.



*Power, N. Y.*

FIG. 5. REDUCED ILLUSTRATIONS OF TWO ACTUAL BOILER-HOUSE RECORDS

Where the volume of water to be measured is very large, there may be several notches in one notch plate, the tank being made wider to avoid excessive or inconvenient depth. On the other hand, if a small volume of water is to be measured, narrow-angle notches may be used through which the flow will vary in the ratio of the notch breadth. Thus, if 10,000 gallons per hour is a good flow for a 90-degree notch, the angles of 45 and $22\frac{1}{2}$ degrees will give 5000 and 2500 gallons with the same hight *H*, thus utilizing the full stroke of the instrument and correcting the reading by the use of 2 or 4 as a correcting divisor. Similarly with multiple notches, the reading of the instrument is to be multiplied by the number of notches in use.

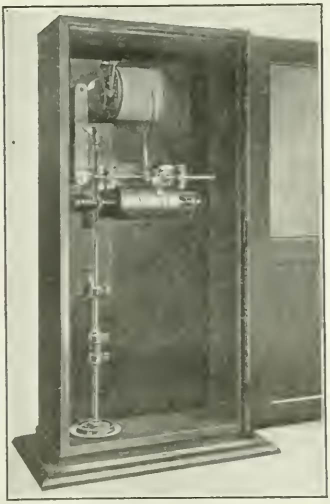


FIG. 6. RECORDING APPARATUS

The instrument is not confined to the one use. Boiler feed can be gaged by its use, and other obvious uses are the measuring of water served out to irrigation farms, or to miners, or the measurement of the volume of sewage that is flowing upon a given area of land. And recently the writer heard of a case where, with a notch that was little more than a slit, the amount of water that was flowing to damp wheat of a hard and dry variety was being measured.

A curious fact concerning these very narrow notches is that they allow more water to pass than do wide notches per unit of area. Thus a wide notch passes 800 gallons in a certain time. A notch only one-eighth as wide will pass more than one-eighth the quantity of water—more than 100 gallons in the same time. Each angle of notch has, therefore, to be calibrated, and its coefficient found. But, this found, it appears to hold good for all hights of that angle of notch. The readings of the instrument are claimed to be accurate within $1\frac{1}{2}$ per cent., and since water expands with temperature, and a given volume will stand higher over the notch, this error is more or less neutralized by the fact that the float will sink farther in warm water. This, of couse, supposes the float chamber to be immersed in the stream of water, as in the first chamber of the tank. The rate of flow of water over a V notch of 90-degree angle is given in the annexed table, the gallon being the British gallon of 10 pounds of water. Corrected for American gallons, the formula changes its coefficient from 0.305 to 0.366.

In certain water-softening systems, the endeavor is made to divide the water into two unequal streams. One of these is intended to be lime-saturated. By means of adjustable notches a stream of water can be divided very accurately and the ratio will be maintained for all hights of water in the tank.

In a station where coal is automatically weighed, either to the men or to the hopper of the stoker, the Lea recorder enables the average daily rate of evaporation to be readily ascertained and incidentally helps to make some use of the

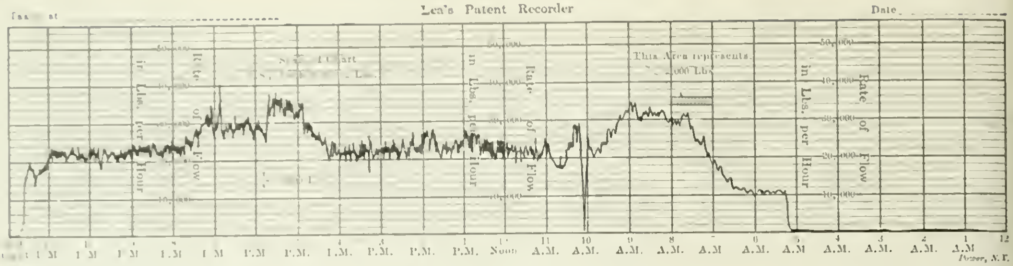


FIG. 7. ACTUAL RECORD FROM TRACTION LOAD

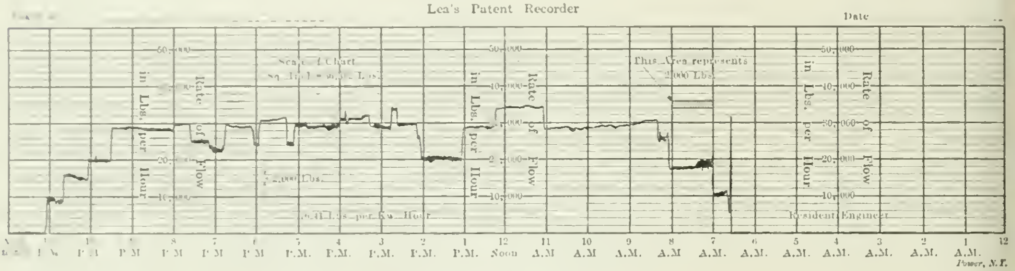


FIG. 8. RECORD FROM LIGHTING LOAD

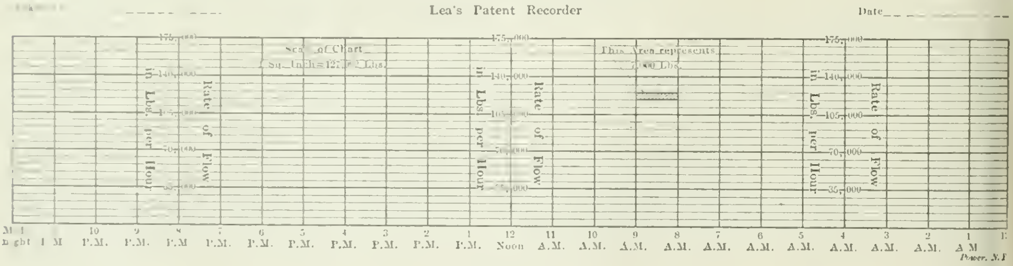


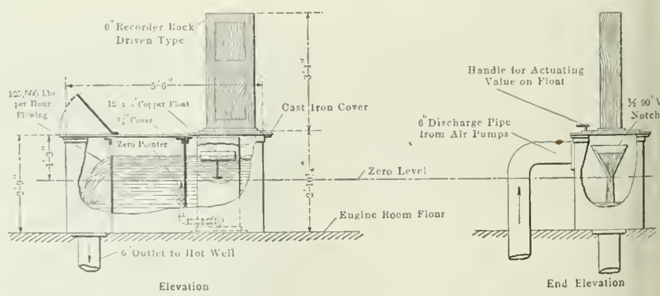
FIG. 9. BLANK RECORD

TABLE OF FLOWS THROUGH 90 DEGREE V NOTCHES.

| Depth in Notch in Inches | Flow per Hour. | | Depth in Notch in Inches | Flow per Hour. | |
|---|---|---|---|---|---|
| | Gallons. | Pounds. | | Gallons. | Pounds. |
| 1 | 114 | 1,140 | 9 | 27,796 | 277,960 |
| 2 | 648 | 6,480 | 10 | 36,174 | 361,740 |
| 3 | 1,783 | 17,830 | 11 | 45,903 | 459,030 |
| 4 | 3,661 | 36,610 | 12 | 56,872 | 568,720 |
| 5 | 6,394 | 63,940 | 13 | 69,471 | 694,710 |
| 6 | 10,086 | 100,860 | 14 | 83,611 | 836,110 |
| 7 | 14,829 | 148,290 | 15 | 99,351 | 993,510 |
| 8 | 20,706 | 207,060 | | | |

N.B. 1 gallon = 10 lb.

Deduced from Thomson's Formula: Cu.ft. per min. = $0.305\ H^2 \sqrt{H}$ where $H$ = depth in inches.



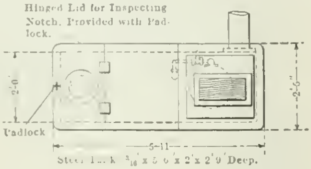
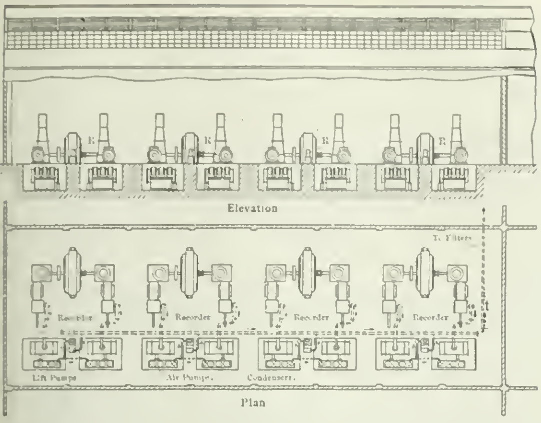

Hinged Lid for Inspecting Notch. Provided with Padlock.
2'-0"
2'-6"
Padlock
5'-11"
Steel Tank 3/16" x 5' 6" x 2' x 2' 9" Deep.

FIG. 10. RECORDER FOR 6000-KILOWATT TURBINE

$CO_2$ recorders, for the best average $CO_2$ of the whole station may be indicated by a knowledge of the average evaporation per pound of coal. In general-station work, long special tests are of little use as permanent aids to economy. Continuous records, when plotted on a large sheet in the form of curves and suitably intercalculated and plotted, show in time the trend of the combinations of factors and assist most materially in finding the conditions for the best commercial conditions.

In Great Britain it is usual pract in steam-engine working to apply aut matically the variable cutoff gear to t high-pressure cylinder of the compound gine, but the low-pressure gear is va able by hand only. Some engineers ne attempt to change the low-pressure ge but set it at seven-sixteenths of the stro, at which point they declare the best sults are obtained. Probably they not very far wrong, but as previo pointed out, the recorder showed tha



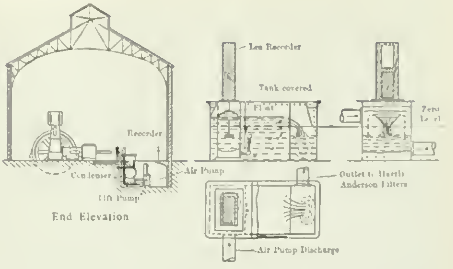
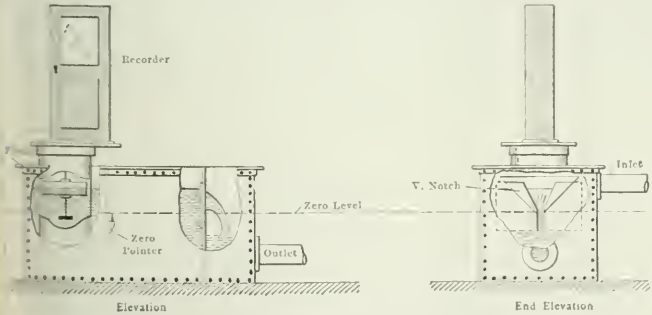


FIG. 11. RECORDER FOR FOUR 4000-KILOWATT TRACTION SETS

cutoff at three-eighths stroke was best for a certain engine at a certain load. An earlier cutoff in the second cylinder puts up the back pressure in the first cylinder and reduces the pressure difference between the two faces of the high-pressure piston. It may be beneficial to do this in one engine and not in another, at one load and not at another; with a certain degree of vacuum and not with one of another degree. We cannot know of our knowledge and reasoning what will best suit any engine at its varying loads, but we can find out by a few trials, and so, used to determine the unknown in a few minutes or even hours, an instrument like this should very soon give good returns on its cost.

It is most interesting and instructive to watch it, taking note of the variations that are made in the regime of an engine, for the movements of the pencil very quickly follow any change, and it does not require long for the changed rate of steam consumption to tell upon the stream of water available at the air-pump intake.

The instrument ought to prove of very great value in testing the effect of different temperatures of superheat. In varying the temperature of steam, the temperature of the mass of the cylinder metal must also vary, so that there will be a certain lag of the results behind the temperature curve. If possible, therefore, any tests involving temperature should be continuously progressive, so that there will be no great jumps and the performance curve will move steadily up or down as the temperature curve rises or falls. Such a set of parallel curves of temperature and air-pump discharge, if carefully undertaken, would prove most valuable in assisting to elucidate some of the less-known facts as regards superheat, both in reciprocating engines and in turbines. And there is also much more to be definitely known respecting the performance for good or ill of reheaters, intermediate receivers, jackets and cylinder coverings, which can be known by aid of the continuous recorder.



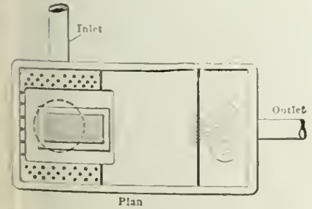


FIG. 12. THE ORDINARY SELF-CONTAINED APPARATUS

In a recent form of the instrument, an integrating gear has been added, so arranged that an index finger is driven by means of an interrupted toothed drum, the amount of interruption being suited to the position of the instrument pointer which carries the pinion that gears with the toothed drum. Thus, at a glance, the total gallons since zero reading can be read off, this total being the product of the hours by the mean rate of flow.

In Fig. 5 are shown two actual records from an electric-power station and from a cotton mill, and in Fig. 6 is shown the recorder itself detached from the tank and float chamber. The style of drum shown in Fig. 3 differs somewhat in detail from other drums, for in some drums the spiral is a cut in the surface of the drum, whereas, in Fig. 3, it is a wire soldered upon the drum. This is, however, a mere matter of detail. Fig. 7 is an actual record taken from a traction load at Manchester, Bloom street station. Fig. 8 is from a lighting load at the same station. A blank record paper is given in Fig. 9. Note the area of the rectangle representing 7000 pounds. In the full-size diagram, it measures about 9/16x3/32 inch.

In Fig. 10 is shown the arrangment for a 6000-kilowatt steam turbine at the Manchester corporation, Stuart street works. Fig. 11 shows the recorders arranged for the four 4000-kilowatt traction sets of the London county council, at Greenwich, while Fig. 12 is from a blueprint of the ordinary self-contained apparatus.

A very useful instrument this should be for recording the output of pounds engaged on the testing of bore holes and wells. It is often specified—too often perhaps—that a well shall be tested for yield by a prolonged pump test at so many gallons per hour. The recorder would show just what was the mean rate of pumping over any period of time, and what had been the stoppage periods during the time of the test, if any. But there is no further need of describing the uses to which the instrument can be put. Suffice that it has proved eminently satisfactory in steam-power houses and is very sensitive to changes, as may be told at once by watching its behavior when a change is made in the manner already described or in other ways.

# Ash-, Coal- and Coke-handling Equipment for Gas Plants

By J. Rowland Shays

Under the above heading many different types of equipment for this class of work, as manufactured by the many concerns who make a specialty of the work, might be mentioned, but as space is limited, attention will be called to only a few of these. The equipment manufactured by the Robins Conveying Belt Company, of Passaic, N. J., is that of the belt-conveying type. The company has several noteworthy installations in the middle West, two in particular: one at the plant of the Milwaukee Coke and Gas Company at South Milwaukee, Wis., and the other located at the plant of the By Products Coke Corporation at South Chicago, Ill.

With the belt-conveyer type of equipment there are certain conditions that it is necessary for the manufacturer to be acquainted with before he can figure intelligently on the job. The following are some of the conditions that are looked into: Desired length of conveyer; level or inclined, and if the latter the degree of inclination, or the number of feet which the load is raised; desired capacity per hour; class of material to be carried; average size; material, wet or dry, hot or cold; any strong chemical qualities; character of motive power, etc. These and other questions of similar purport confront the prospective customer, but they are only the means for an end.

One of the notable features of the installation at the plant of the By Products Coke Corporation is the main conveyer belt which carries the coal from the receiving docks to the storage bins. This belt is nearly a mile in length and in its travel passes through a concrete passageway under two railways and a highway. After passing these it leaves the passageway and rises at an angle of about 20 degrees to a hight of about 40 feet, traveling from this point on a trestle to the storage bins.

At this plant the coal is first unloaded from the vessels at the receiving docks by two Robins unloading towers which are shown in Fig. 1. The buckets in these towers have a capacity of $2\frac{1}{2}$ tons each, and the maximum speed at which they operate is 24 seconds per round trip. If the necessity warranted, these towers could unload at the rate of about 375 tons of coal per hour each. The towers are run by steam and require only one man at the levers. If for any reason it is necessary to stop the belt conveyer, the unloading of the boat may continue, the coal being placed on stack piles right at hand where it can be reclaimed later. The coal can be loaded on cars as well as on the conveyer by this same system.

From the unloading towers the material is carried on the belt conveyer to a traveling and reclaiming bridge, Fig. 2, about half a mile distant. The span of this bridge is 280 feet, cantilever 60 feet. On the bridge runs a 36-inch belt conveyer equipped with an automatic tripper by which coal is discharged to storage. Coal can be delivered from the bridge at the rate of 600 tons per hour.

The reclaiming of the coal is accomplished by a special counterweighted bucket which has a capacity of five tons of coal. With this equipment coal can be taken out of storage at the rate of 300 tons per hour. Only one operator is required to run this system. A unique feature of the bridge is that while the conveyer is stocking the bucket is free to take out of storage at the same time.

In the first part of this article the equipment for handling the coal between the docks and the storage pile has been described. Attention will now be given to the equipment for handling the coal and ashes in the power station of the gas plant.

In the various plants of the People's Gas Light and Coke Company, of Chicago, Ill., the machinery used for this purpose is that which is manufactured by the Link-Belt Company, of the same c
The plant located at Twenty-fifth a
Loomis streets, on the south side
the city, is probably one of the most up
date plants of its kind in the country.
was installed only about a year ago
has been in operation about six mon
The installation, embodying the Peck
rier system, might be classed as
bucket conveyer. This conveyer, w
doing practically the same work
the belt conveyer, has perhaps
wider field of application, owing to
fact that the buckets being made of
steel or malleable iron are better abl
withstand the abrasive action of the
ashes and cinders which would wear
a belt of any material in no time.

At the above-mentioned plant the
for the power station is unloaded from
cars into a Link-Belt hopper of such

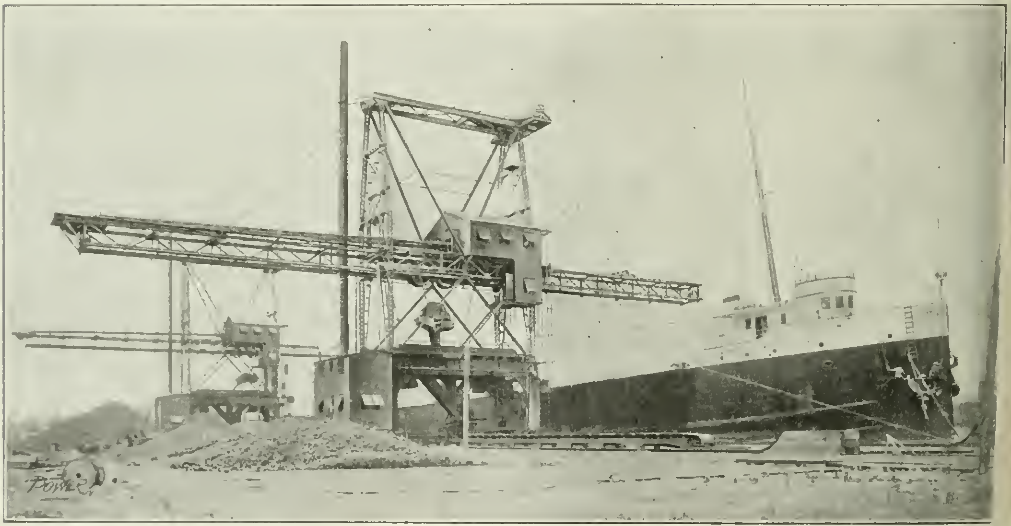


FIG. 1. UNLOADING TOWERS AT DOCK WITH CAPACITY OF 375 TONS OF COAL PER HOUR

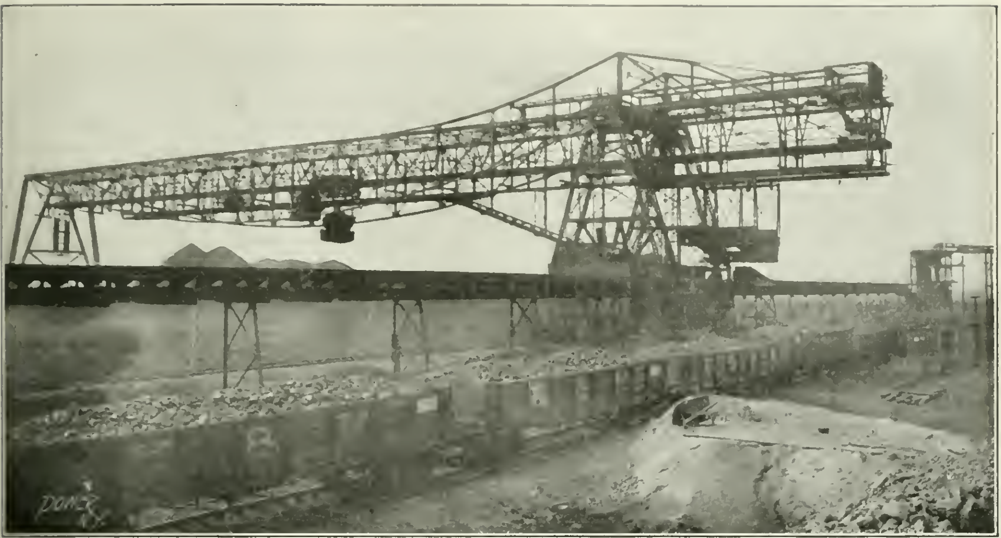


FIG. 2. TRAVELING AND RECLAIMING BRIDGE WHICH WILL DELIVER TO STORAGE 600 TONS OF COAL PER HOUR

pacity as will allow cars of the bottom type to unload. From this hopper, which measures 14 feet wide by 18 feet long, the coal is delivered to a Link-Belt reciprocating feeder which discharges to a crusher, the rolls of which are 30 inches in diameter and have a 24-inch face. This crusher is driven by a small steam engine independent of the rest of the installation. The rolls of the crusher are movable in order that fine coal not requiring crushing may pass through, the coal being fed to the carrier at this point. The carrier employs 24x18-inch Peck overlapping buckets and conveys the coal from this point to the storage hoppers over the boilers. The capacity of the hoppers is about 200 tons of coal, the coal being delivered to the grate through undercut gate chutes.

The ashes are quenched in the pit and raked into the same conveyer and are delivered by the system to a firebrick-lined hopper over the switch track at one end of the building. This hopper has a capacity of about 2000 cubic feet of ashes. The ashes and cinders from the gas retorts are first broken into pieces about the size of a man's head and are then carted to the conveyer, being sent through the crusher and reduced to about the size of a brick, after which they are delivered to the ash hoppers. This installation, as well as the installations of its kind in the various other plants, has proved a most economical and speedy method for doing the work.

Before closing the subject, one other equipment of an altogether different type from either of those previously described should be mentioned. This is the telpher system of conveying ashes, coal and coke. This system has been tried out very successfully in the East for different classes of work. An installation of this character has been in operation at the plant of the Worcester Gas Light Company, Worcester, Mass., for about seven or eight years. This equipment, manufactured by the J. M. Dodge Company, of Philadelphia, Penn., is designed for the handling of the coke by means of ordinary tub buckets which are filled from the conveyers in the retort house and are hoisted and conveyed by the telpher machine to the storage pile, water-gas house and boiler house, or to the screen house, the latter building being shown in Fig. 3. This plant, although of the early type, has proved a very efficient one, in spite of the fact that the buckets have to be filled by hand. It has a capacity of about 25 tons per hour. The telpher hoists the bucket at a speed of 100 feet per minute,

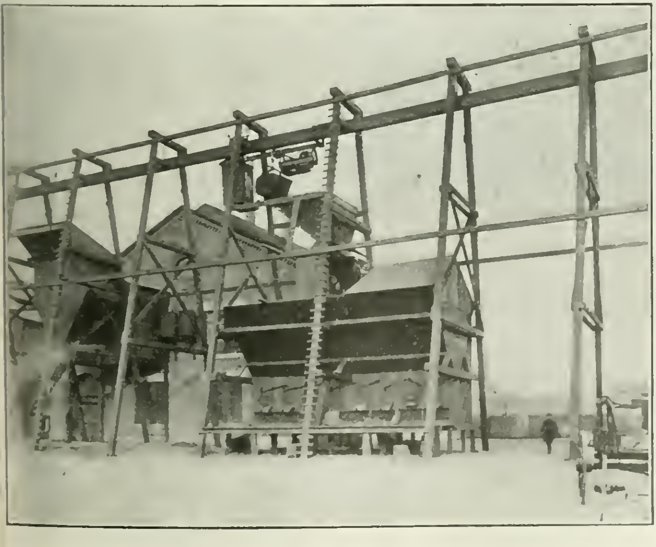


FIG. 3. SCREEN HOUSE AT WORCESTER GAS LIGHT COMPANY'S PLANT

the telpher itself traveling at a speed of 750 feet per minute. The bucket is dumped into a hopper on top of the screen house, the material passing through a crusher and over several screens of different sizes before it is deposited into bins from which it is drawn out at the bottom into baskets for retail distribution. The height of the telpher runway above the storage pile is about 50 feet.

The plant of the Lowell Gas Light Company, of Lowell, Mass., is also equipped with this system, which, however, is of a later type than that previously mentioned. This plant employs a clam-shell bucket, the capacity of which is $2\frac{1}{2}$ cubic yards. The bucket picks up the coke from a pile, and discharges it into storage, a screen house, water gas house, or boiler house as desired, in the same manner as described for the Worcester Gas Light Company. The hoisting speed of the bucket is 120 feet per minute and the traveling speed 1000 feet per minute. The capacity of this machine is about 50 tons of coke per hour and requires only one operator at the levers.

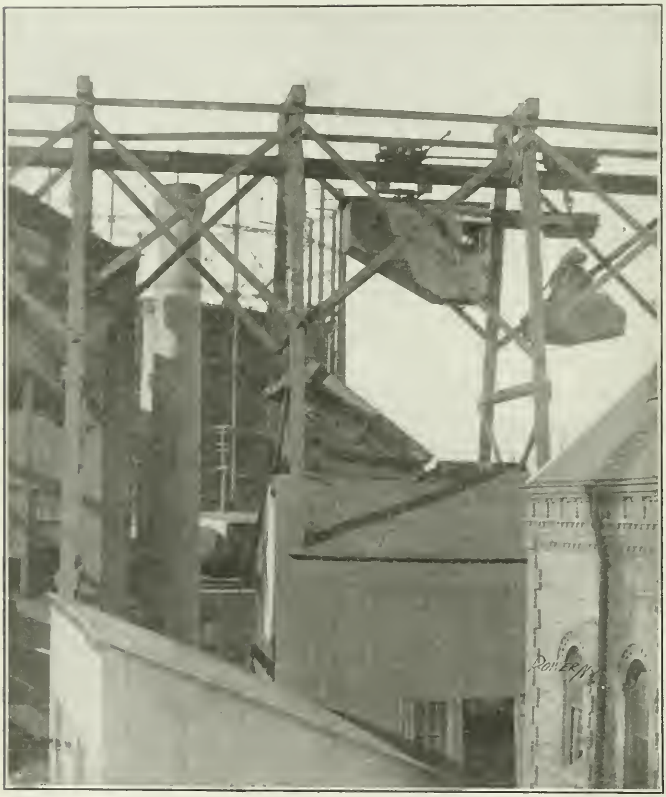


FIG. 4. TELPHER AT LOWELL GAS LIGHT COMPANY'S PLANT

## Significance of Drafts in Boiler Room Practice

"The Significance of Drafts in Steam Boiler Practice" is the title of Bulletin No. 367 issued by the United States Geological Survey. It was written by Walter T. Ray and Henry Kreisinger and is a record of the results of experiments made at Norfolk, Va., laboratory experiments relative to the flow of gases through boilers, steaming tests at St. Louis, Mo., and tests on locomotive by the Survey and the Seaboard Air Line Railway at Portsmouth, Va.

The experiments were made with the idea in view of getting a clear understanding of the conditions obtaining in the passage of air through fuel beds and boiler tubes. Observations were made of the weight of air passed through the beds of fuel in a given time and the data plotted on charts permitting future investigation and study from all points of view. In view of the probability that a gas is discontinuous, and that if so, "draft" as a motive cause is an impossibility, the term pressure difference is used throughout instead of draft.

Pressure differences as utilized in boiler practice are created in three ways, by chimneys, by exhaust fans and by pressure fans or blowers. In the experiments all three methods were used and the results tabulated.

In the laboratory experiments upon the passage of air through fuel beds layers of shot were substituted and the results tabulated in the same manner as with fuel beds of different thicknesses, and the power absorbed in passing different quantities of air through beds of varying thicknesses noted.

In substance, the bulletin shows that the pressure drop through any portion of the gas passage bears a constant ratio to the total drop if the resistance is constant. If the total pressure drop is constant the drop of pressure in any portion of the passage varies with the resistance in that portion.

If the resistance of any portion of the passage is constant, the weight of gas passing varies as some power of the pressure drop. The index of this power is approximately 2. If double the quantity of gas is passed, the pressure drop will be quadrupled, and if three times the quantity is passed the drop will be increased nine times. It is immaterial whether the pressure difference is forced or induced, for with gases there can be no pulling. Gases travel because of differences in pressure.

The bulletin is both interesting and instructive and may be obtained free by applying to George O. Smith, director United States Geological Survey, Washington, D. C.

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It may be affirmed, states a consular report, that the State of São Paulo has been the cradle of the utilization o hydraulic power in Brazil for generating electricity. That at present, howeve turned to account, is but insignificant i comparison with the immense undevelope resources which the State possesses in th numerous large waterfalls, mostly Stat property, and to a large extent still unexplored. The principal hydroelectric installations constructed in the State ar that of the São Paulo Tramway, Ligh and Power at Parnahyba, with a capacit of 8000 horsepower, and those of vario other companies, viz., Jundiahy, generati 1000 kilowatts; Sorocaba, 1000 kilowatt Rio Claro, 580 kilowatts; Mococa, 5 kilowatts; Piracicaba, 450 kilowatts. T important hydroelectric station in cour of construction by the Santos Dock Co pany at the Itatinga Falls, near Sant which should be completed in a year, w transform and transmit electric energy 3000 kilowatts, which will be used in t working of the cranes on the quay Santos and the supply of light and pow to that city.

# A Union with a Commendable Method

To the man who with every mention of a labor union associates ideas of arrogant demands enforced by lawlessness and violence we commend the following address delivered at a recent meeting of the Eccentric Firemen's Association by National President Timothy Healy. Here will be seen to be an organization which is striving to raise its members to a higher plane and to obtain for them wages and recognition commensurate with the importance of the service which they render by reasonable and rational methods, by educating them in their vocation, making them worth more in the work of the world, as well as by inducing employers to recognize that increased worth. The reasonable employer will heartily commend and coöperate with such a union.

The occasion was a public meeting of the union at which a presentation had been made to a prominent member and at which a number of visitors were present. Mr. Healy's remarks were, in part, as follows:

"Brothers, we have friends with us tonight who are influential and whose word will go a long way to help this organization and its members, and I believe that it is a fitting occasion, with these friends sitting here, to say a few words.

"I want to say that we are organized to uplift a class of men who have been abused in the past, and in some instances are abused today more than any other class of men in our great city. You all know that the fireman, up to a few years ago, with very few exceptions, had to work twelve hours a day and three hundred and sixty-five days in a year. He never got a Sunday or a holiday off, and couldn't even get permission to stay at home and attend to his sick family, or bury a dead relative. That is not right, it is not human, and it is not a proper way to treat any man.

"I believe that American citizens are entitled to better treatment, and always have believed that. Therefore, we have worked for and built up an organization that is in a position today to put every man in a better condition.

"We are not organized for the purpose of causing strikes, or causing trouble of any kind to an employer. We believe in meeting our employers man for man and in a business-like manner; putting the wrong right up to them.

"Many men in our day, men of large affairs, captains of industry, if you wish, are good men, good-hearted men, and I want to tell you, my friends, that I have met some of these men and when I have told them the conditions of the firemen's work they have said: 'Well, I never thought about the firemen, we will see if we cannot do better for them.' They never thought of the man who was working long hours under unsanitary conditions. It was properly brought to their attention that the fireman as an individual working in a plant has to depend on somebody else. The highest authority he can go to is his chief engineer. Well, I had as leave go to the devil as to some of the chief engineers, if I was working under them, but I thank God that they are not all that way. There are good and bad everywhere; and there are some good chief engineers in this city and some bad ones. But we are bringing them around gradually to our way of thinking, and we are doing great work. Nobody is losing anything by it. All that we want, men, is to have confidence in ourselves, and I am glad to say that the members of this organization are taking more interest and placing more confidence in the organization every day.

"I remember that on the floor of the organization once I begged the men to have courage; when they were dwindling away, when they didn't have any hope of anything being done for them by the organization. I said that the time would come when our men would be working eight hours a day, and some of them shut their eyes. I also told them later on that the time would come when the scale of wages for this organization would be three dollars a day. Well, they laughed at that. Still, now, we have in this organization some sixteen or seventeen hundred men who are getting three dollars a day, and we will have as many more in two years from now who will be getting the same.

"I recall that when I said we would work only eight hours word was brought to me that they said that I was crazy and some of the engineers appealed to the men to pull me off or they would lose their jobs. The idea of giving firemen eight hours a day! Well, it has all come around. They wouldn't dare to ask a man to work twelve hours today. He would be insulted by it, and I don't blame him.

"I can remember that I used to be at this organization on Saturday night and would get home at one or two o'clock at night. At that time we could not conduct our business as we do it now, and once in a while we would have a big fight. Well, as I say, I would get home at one or two o'clock in the morning, and then would go to my work at seven o'clock in the morning and stay until seven o'clock Monday morning. I used to work and work hard, I know what it is. Well, we don't have to do that now, thank God.

"All we want is a square deal, and we want an employer to give us a fair day's pay for a fair day's work, and reasonable hours, and we want our men to give him good service for the good pay and the reasonable hours that the employers are giving them. We stand for no man loafing on his job. We believe that a man who is working eight hours a day should be on his feet every minute of that eight hours. I am saying that right here, and we are going to carry it out. A man can always get something to do around a boiler room. If he is not firing, he can be cleaning, or sweeping up. I want to tell you that I have got no use for a fireman who goes slushing around a boiler room up to his knees in coal, and if I was an engineer employing such a man I would not keep him there a minute.

"My friends, when a man comes into this organization we promise him nothing—well, there are one or two things that we do promise him. We tell him this, that we will do the best we can for him. Fellows come around here and say that if we will give them jobs they will join the organization. No, we don't do business that way. We tell them that we will do the best that we can for them. We tell them that in case of death, if a man is not more than sixty days in arrears, we will pay a hundred and sixty dollars in cash, and on the death of the wife the family gets seventy-five dollars, and all this we do for the sum of seventy-five cents a month. Men often wonder how we do it, but we do it, just the same. We have a good financial system. Our expenses are high, but we find that we can do it, and we are doing it, and we are going to continue to do it. That is one thing that we do for them.

"Another is, that we give them the best of advice. There is an office here, open every day, and if a man has any trouble of any kind, and God knows there are a whole lot of them in trouble, we want them to come here, and they come. They come and tell us their stories, and there is no man who ever hears of it afterward. Women come here and tell us their stories, sometimes about their husbands. We listen to their stories and advise them what to do, and what is told here to us is just as secret as if it had been told in the confessional.

"In case of legal trouble, we have the best of legal talent. In case of any trouble, in case of family trouble, if a man is drunk and abuses his wife, we get him up here and we tell him what will happen to him if he don't change, and I am glad to say that we have changed many of them.

"Sometimes a woman is left a widow. Just a few weeks ago I saw a woman who had five children, the widow of a good member of this organization. It took me five weeks to get them fixed. She could keep two of them at work, that is all. When the authorities learned that she had seven hundred dollars of insurance coming they wouldn't take the children, but I got the matter fixed after a hard fight. Sometimes, too, people go to hospitals, and we help them out in that matter. If a man is in Bellevue and wants to change to the 'island,' we attend to it. Then we go out to Ellis island. I have been out there twice in three weeks, and there is one man here tonight who has been helped in that way. We help our members out in every way we possibly can.

"Now, I will come down to the best thing that we do, but I am afraid that it is not appreciated.

"About four years ago I got it into my head that we should do something, should make some attempt to educate the young men started in this business. A young man who starts in firing, if he has anything in his head at all, can get on in the city. These men who are with us tonight all served their time and they are now holding good positions. The same opportunity is open to you, and there is a better opportunity today than there ever was before.

"We started a school here and invited you to come to it. We told you that we had good instructors here and that it would cost you nothing. This school, this class, was held every Monday night. Questions were put to you on the blackboard, and matter was run off on the hektograph machine, given you to take home and study during the week, and then come back for more information.

"Now, that school has not been attended as it should be, and I hope that when it opens on the first of September it will be better attended.

"We told you at the time, and we tell you now, that instead of running around the city, when you have a chance to advance yourself, or when you want a license, running around with twenty or fifty dollars in your hands to find somebody who has influence at police headquarters, that was not the way. That has been going on here for a long time, but I am glad to say that it is pretty well rooted out. Any man who is going to a get a license as an engineer, should get it on his merits, and if you will attend this school of ours, if we can't in six months knock enough into your head for you to pass on your merits, such as the examinations are—they are not as strict as I would like to have them—if you can't learn enough to do that in six months, then you had better go back to shoveling coal.

"If you go down to headquarters and fail to pass the examination they will put you through, of course that tells the story; but if you think you are all right, and you are all right, and you pass our examination, I will get you a license, and you won't put up a nickel for it either, and there are many men sitting here tonight who know that what I am saying is so.

"I want to tell you that you can go tonight with thirty or forty dollars in your pocket and you will find some shark who will take it from you, and sharks have been taking it from you for years, because I am satisfied that very little of the money taken in that way ever goes to police headquarters. I know there are engineers who will tell you that they have influence at police headquarters and will get you through all right, and it will only cost you so much, and a 'sucker' will put it up. Many a time fellows have come to me and said to me that they knew Green or Brown, or whoever it might be, who could put them through, and I have gone down to police headquarters to inquire, and they would say: 'Green,' or 'Brown,' as the case may be, 'who is he?' And I would say that he was chief engineer in such and such a building and I would be told that he might be, but they would know nothing about him. There are thousands of engineers in this city, perhaps, who have been told the same yarn. I have been trying to help them for weeks and weeks to get a license, and couldn't get a chance, and at the same time they would be putting up their money for one of these sharks. The last case I know of, and God knows I was doing all I could for the man, and he is in a good position today, was a man whom somebody told that I was fooling with him, and he went and put up forty dollars with one of these sharks over at a saloon at the bridge.

"Now, these are facts, and I want to say to you men here tonight that if you want to get a license and you are intending to put up money, before you do it come and talk with us, anyhow. Be frank with us, and we will help you along. I want to tell you that I know some things. I am not knocking them, but I want to be frank with you, and there are some chief engineers in this city who would take your dollars from you, who would take it off your corpse, they are so greedy for money. I am not condemning them all, because there are scores of men in that position who are as honorable as any I have ever met or dealt with.

"Another thing: that piece of paper that you get at headquarters don't make an engineer out of you, and I am sorry to say that there are owners of those papers in this city today and the holders of them are not fit to run a wheelbarrow, much less a plant. They get licenses, and that is all they want. Many a time I wonder what the devil they ever got them for. They get the licenses and then they say: 'I am an engineer'—that is all. They are engineers. Why, there are some of those fellows who if they went to a plant like the one where Brother Chisholm was, where those big turbines are, would think those turbines were haystacks.

"They are engineers. They will never know any different, or any better, because they are engineers, and they don't want to learn, they know it all. Well, there is not a man in the business who knows it all. Take John Chisholm here, for instance, and in his line he is one of the best engineers in New York, without a doubt. Chisholm, do you know it all?"

Mr. Chisholm: "No."

Mr. Healy: "Molendo—there is no better ice machine man in New York than Mr. Molendo. Now, Molendo, aren't you still studying?"

Mr. Molendo: "Yes."

Mr. Healy: "He is studying yet, while these fellows that I have been speaking of know it all and won't study.

"We are told that there are too many engineers in New York. There are not half enough. There are modern plants going up every day and a lot of 'pikers' are going to take charge of them. They are not competent to run them. A man spends his time and his money in putting up a first-class plant and means to put in a first-class engineer, and he gets a bum engineer to run it. The next thing is that the Edison people are in there. Why, if there were good engineers to take charge of these plants they could beat the Edison people two to one in running them. It is not always the engineers, sometimes it is the assistant and sometimes the foreman, but as a rule it is the engineer's fault.

"Modern buildings, modern steam plants of every kind are going up so rapidly in this city and throughout this country that the engineers are unable to keep up with the pace, and I am convinced today that not only in New York, but throughout the United States, there are too few engineers. These fellows carry papers around, they are not engineers, and the papers don't make them engineers.

"Now, I am saying all this with the hope that some of you young fellows here will take hold of this school and will try to study and learn. I talked to you here sometime ago and I had a professor here from Columbia University and at that time I told you that I was working with John Mitchell and others to try and get a class of young fellows such as these to take a course in Columbia University. The professors are willing to give their time, to devote their time in teaching, and President Butler is anxious that it should be done and that there should be such a class. Ex-Mayor Low, who addressed you last winter, is anxious that it should be done and will do all he can to help. These men are practical men.

"The man who starts in with the shovel must be educated up, if we are going to have the proper material for engineer in this city and throughout the country because, while the college man has th theory, he has not got the practice, an both theory and practice are needed t make a good engineer or a good mechani in any line.

"Don't forget, my friends, the schoo that we have here. Don't forget us whe you are in trouble, when you want ad vice of any kind. Call on us. All of yo in this organization, every man of yo is on the same footing—the latest ma who comes into this organization is r ceived with fraternal friendship, and l is just as good as the president who si in the chair. We are all equal here, and we want to help one another.

"We realize that the young man starting in in the boiler room today is the engineer of tomorrow, and I believe it is our duty to educate him. This country today is ahead of all other countries on the face of the earth, when it comes down to mechanics, and if this country is to go ahead in the next few years, it is just such men as you are who are here tonight who will have to do it. Remember, that you are the men who go into the boiler room and generate the power and run the trolley cars, the trains and the electric-light plants, the ice plants, the elevators, and are engaged in everything that contributes to the comfort and the convenience of people who are better ated than you are and in different f life from yourself. We are en- d; however, as American citizens, to fair day's pay for a fair day's work. want to bring up our children as the lren of American citizens should be ght up, and give them at least a com- n-school education, so that when they to the time that they go into the ler room, we want them to find a good lace, and not find a hell hole like I found en I went into the boiler room many ears ago."

---

Plaster of paris is a good flux for use melting scrap brass. It melts at a red eat and dissolves the foreign matter in e metal and does not attack the crucible.

ATTENDANTS AT THE AMERICAN BOILER MANUFACTURERS' ASSOCIATION CONVENTION, DETROIT, MICH., AUGUST 10-12, 1909

## Detroit Meeting of American Boiler Manufacturers' Association

Commencing August 10, the three days' session of the American Boiler Manufacturers' Association of the United States and Canada, held at Hotel Pontchartrain, Detroit, Mich., was the twenty-first annual meeting of the organization. The members were warmly welcomed to the city by Mayor Philip Breitmeyer, and the response was by E. D. Meier, president of the association.

The morning session was taken up by discussion of topics relating to the construction and operation of boilers.

George Waystaff, of the International Master Boiler Makers' Association, addressed the convention and invited its coöperation with the society he represented.

Joseph H. McNeill, chief boiler inspector for the State of Massachusetts, assisted by J. A. Stevens, member of the Massachusetts Board of Boiler Rules, explained in detail the Massachusetts law. This was brought about by the discussion of the proposed boiler rules for the city of Detroit.

A motion was passed advising the city council to follow these rules as closely as practicable in the new ordinance.

In regard to the recent slight changes in the boiler rules of the Board of Supervising Inspectors, the sentiment was in favor of them in general, as tending toward better and safer construction. But that section of the rules relating to boilers on Western river steamers was severely criticized by the members having experience in this line. It was complained that where the old requirement limiting the thickness of river boiler plate to 0.30 inch had been extended to allow a thickness of 0.38 inch, there had at the same time been an additional provision made to the effect that no plate should be considered to have a tensile strength greater than 62,000 pounds, no matter what its real tensile strength might show on test. The effect of this rule, it was claimed, left the matter of allowable boiler pressure practically the same as before, limiting the tensile strength and annulling the benefits of the thicker plate. It was the sense of the convention that boiler plate should be stamped at the actual tensile strength found on test, and that the allowable steam pressure should be figured on that basis.

The convention also went on record as favoring its original specifications in regard to the sulphur and phosphorus content of boiler plate, insisting that plates should be furnished with not more than 0.03 per cent. sulphur, nor 0.04 per cent. phosphorus.

In executive session Chicago was chosen as the place of next meeting and the officers were all reëlected.

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The following is a useful glue for fastening leather to iron: Best ground glue two parts and acetic acid one part. Glue dissolves when acid is heated. Mix well together and apply.

POWER
AND THE ENGINEER

DEVOTED TO THE GENERATION AND
TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

John A. Hill, Pres. and Treas Robert McKean, Sec'y.

505 Pearl Street New York.
355 Dearborn Street Chicago.
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of Power solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "Powpub," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During 1908 we printed and circulated 1,836,000 copies of* Power.

*Our circulation for July, 1909, was (weekly and monthly)* 141,000.

| | |
|---|---|
| *August* 3 | 42,000 |
| *August* 10 | 33,000 |
| *August* 17 | 33,000 |
| *August* 24 | 33,000 |
| *August* 31 | 33,000 |

*This paper reaches 42,000 separate readers each month and 33,000 each week.*

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*

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## The Boilers of the "Maine"

Alarming items have appeared in the daily press regarding the boilers of the United States battleship "Maine." It is true that the "Maine" was ordered from Provincetown to the navy yard at Portsmouth instead of being allowed to accompany the fleet on its maneuvers; true also that her Niclausse boilers, which were of the old type and have never been a pronounced success, are to be replaced by others of the Babcock & Wilcox type. The boilers and piping of the "Maine" are old. She is due for a general overhauling. The contract for her new boilers was let some time ago, and she goes to get them installed in the natural course of events, and not as the sudden development of specially dangerous conditions.

## Power from Leverage

The misconception upon which most of the inventions which are expected to revolutionize steam engineering are founded is that power may be gained by leverage.

A lever is an elementary machine and no more energy can be taken out of it than is put into it. No machine can make energy any more than it can make coal. A small force on the long arm of a lever will balance a large force on the short arm, and in this sense a lever may be said to increase force; but energy is the product of force and distance. A man on the end of a bar twenty times as far from the fulcrum as the load is can lift twenty pounds for each pound that he pulls, but if he does not move the load no work is accomplished, no energy expended. If the load moves, his end of the bar moves twenty times as far, and the product of his pull and the distance through which it is exerted equals the product of the load and the distance through which it is moved. The bar has delivered at the load end just as much energy as was put into it at the other end. If the man were strong enough to lift the weight directly, and lifted it only as far as it is raised per stroke by the bar he would do as much work and only as much as he does per stroke when the bar is used.

Imagine a steam cylinder to be substituted for the man. With a leverage of ten to one the piston would have to move ten inches to move the load an inch. Increase the leverage to twenty, and a piston of the same area could lift twice as much, but it would have to make twice as long a stroke, and take twice as much steam, to move it the same distance. Or, a cylinder of half the area could handle the same load, but, the stroke being doubled, would require the same amount of steam to move the load the same distance as would the larger cylinder with the lesser leverage and half the stroke.

It does not cost anything to exert a force. You can get force by piling up cobble stones, and they will go on exerting force upon the area that supports them forever. Steam exerts a force against a stationary piston, but until the piston moves no steam (except such as is condensed to supply radiation) will be used.

When force is exerted through space energy is developed, or applied or produced or transferred. The word "produced" should be used here with qualification. We produce energy in a steam engine by burning coal under the boiler and expanding the steam in the cylinder, but the energy was in the coal to start with. The boiler and engine are simply apparatus for transforming it into a form for useful application. It is as impossible to create energy as it is to create matter.

Power is the product of force and spac divided by time, the amount of energy developed per unit of time. A weak man a small pump or engine can do as much work as a strong man or a larger machin if given the time to do it in. A man o an engine is powerful because he or i can do a lot of work quickly. A strong man can be made no more powerful b giving him a lever. He can lift a greate weight but he does it more slowly.

The lever is one of the most useful de vices in the service of the engineer, b it cannot create energy or power, and a soon as this is generally understood ther will be fewer perpetual-motion machin and engines which are to save thre quarters or more of the steam by using at a greater leverage.

## Use of Cylinder Oil

We have had an inquiry for practic information regarding the amount of cy inder oil to be used, per horsepower a per hour, for steam engines of differe styles and capacities. As far as our ow observation goes, this is a factor whi varies through wide limits, and we wou appreciate notes and contributions, relat to the subject, from the experiences our readers, not only those who are do exceptionally well, but those whose pr tice represents the average, or below.

Such information should include, if p sible, the style, size, horsepower and sp of the engine, the rate of feed in dr per minute (sight feed, positive feed, et the gallons used per month, the kind price of oil used, and anything which be upon the use or saving of the oil.

As far as practicable, we would like receive contributions of this nature the Practical Letters department, where the request is made not to pub contributors' names, the particulars quested may be sent to us with full idence that they will be published in collated form, with no mention of names or localities.

## Compound Engines

Engines were first compounded for economical reasons and while it was not generally known why more work could be got from a given quantity of steam when expanded in two cylinders than when only one was used, the fact was accepted and compound engines became common. One of the stock arguments in favor of the addition of a low-pressure cylinder to an engine already installed was that the power of the engine could be largely increased and the number of pounds of steam used per indicated horsepower-hour very materially decreased. As the low-pressure cylinder is really the determining factor in the power of an engine, the purchase of a new low-pressure cylinder was really the purchase of a larger engine.

Little or no effort has been made toward the economical use of steam by simple engines already installed and compounding by the addition of high-pressure cylinders. This, of course, would not increase the power of the engine but it would decrease the steam consumption per horsepower-hour. Had it been well known that in many cases of simple engine installation the addition of a small cylinder to the one already in use, making the engine compound, would reduce very materially the steam consumption per horsepower-hour, the use of the compound engine, either condensing or noncondensing, would have been very much increased; but, as in this country the compounding of engines already installed was made in the line of adding a low-pressure cylinder to the one already installed for the purpose of getting a greater output of the engine as a whole, the question of how much can the power of a simple engine be increased by the addition of a low-pressure cylinder, making it a compound engine, has been frequently asked. It is a question that comes to the owner when an increase of power is needed, to the engineer who is running an overloaded simple engine and to the educational committee of the engineers' associations during the winter months when time is given to the discussion of educational topics and engine- and boiler-room problems. One of the handy rules for estimating the horsepower of an engine is: Square the diameter of the cylinder and divide by 2. This rule will give the exact indicated horsepower that the engine will develop when the product of the mean effective pressure multiplied by the piston speed equals 21,000. As the mean effective pressure in compound engines is referred to the low-pressure cylinder, this rule will apply equally to the compound engines with any number of cylinders, and it will be found upon examination that these conditions fall well within the limits of ordinary practice in steam-engine operation. This being true, the extent to which the horsepower of an engine will be affected by changing it from a simple to a compound by the addition of a low pressure cylinder may be readily calculated.

As one-half of the square of the cylinder diameter in inches in the simple engine will give the horsepower of the single cylinder, treating the proposed low-pressure cylinder in the same way will give the power of the engine as a whole, and the difference between these two minus the loss of power in the high-pressure cylinder, from back pressure, will determine the possible increase in the power of the engine by compounding, with the same mean effective pressure, i.e., if the ratio of expansion is not increased which, however, it usually is. Leaving the clearance and condensation aside, no more power can be got from the same quantity of steam expanded in two or more cylinders than if expanded in one, but with the compound engine greater weight of steam may be used expansively than with the simple engine. Hence more power may be developed by a compound engine than by a simple one, how much depending upon the steam pressure and the cylinder ratio.

## Low Pressure Steam

"But what shall I do about heating my building?" asks the engineer or manager, when he is approached with a proposition to shut down his steam plant and put in motors or gas engines.

"Oh, you can put in a little boiler over in the corner and run it at a pound or two pressure. That will give you all the heat you need and anybody can look after it."

This kind of specious argument has deceived many a man who did not know enough about the physical properties of steam not to be misled by the implication that it would take a lot less heat to make the steam at the "pound or two" of pressure than at the pressure carried for power producing purposes. To one who does not know, the inference is natural that it would take a great deal more heat to make a pound of steam at one hundred and twenty pounds than at two pounds, especially if he knows that the temperature of the higher-pressure steam is over three hundred and fifty degrees, against less than two-twenty for the lower-, but he who is acquainted with the steam tables knows that the difference is less than forty heat units in a total of nearly twelve hundred. To make a pound of water at thirty two degrees into steam of seventeen pounds absolute pressure, about two pounds gage, requires 1153.1 British thermal units. To carry the pressure up to one hundred and thirty-five pounds, absolute, would require only 38.5 heat units additional, or 1191.6 in all, so that the little boiler which is to be squeezed into a corner and run by the janitor is sure to require almost as much, and is likely to require quite as much, coal as a boiler would to make the same quantity of steam at the higher pressure.

When the steam is made at the higher pressure and expanded to the lower, some 150 of the 1191.6 heat units put into it are converted into work and the rest are voided at two pounds pressure and are just as good for heating or manufacturing purposes as though they had been put into newly made steam at that pressure.

If the engine is run condensing and the expansion carried to two pounds absolute, twenty-six inches of vacuum, 270-odd of the heat units will be converted into work, leaving over 900 to be voided in the exhaust, which in this case goes to waste in the overflow from the condenser. The folly of running an engine condensing and letting this large number of heat units escape in order to rescue the comparatively small number converted by the use of the condenser, and then running a separate set of boilers to furnish steam at low pressure for heating and processes, is too apparent for discussion, and yet many mills are run that way today and many engineers who ought to know better are putting in condensers, gas engines, motors or some means of power production which sacrifices the exhaust, and requires the manufacture of steam specially for heating and manufacturing processes, at a cost no less than that at which it could be made with a pressure and potency for the development of power. The cheapest and most efficient power-producing apparatus yet suggested is a steam engine used as a reducing valve between a high- and low-pressure steam system.

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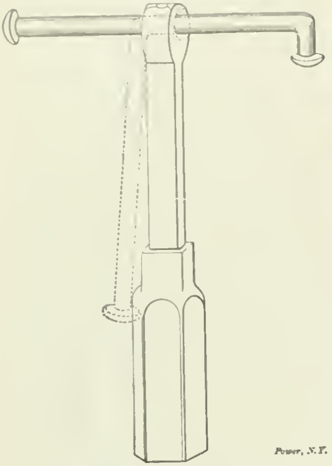
An interesting experiment to determine whether the strength of iron and steel was affected by magnetism was carried out at the Technical Institute of Belfast with the following reported result: Bars of mild steel and wrought iron 8 inches long by $\frac{1}{2}$ inch to 1 inch in diameter were used, part of which were magnetized by being saturated in a solenoid. When tested, the elongation of the magnetized parts decreased 3 to 16 per cent., and the average breaking load seemed to be increased.—*The Engineer.*

---

The mica produced in the United States during 1908 amounted to 972,064 pounds of sheet mica and 2417 short tons of scrap mica, with a total value of $260,000. In 1907 the production of sheet mica was 1,060,182 pounds, of scrap mica 3025 tons, and the total value was $370,000. The average price of sheet mica in the United States during 1908 was 24.1 cents per pound, as compared with 33 cents in 1907.

## New Socket Wrench

A new socket wrench, illustrated and described herewith, is manufactured by



NEW SOCKET WRENCH

the Frank Mossberg Company, Attleboro, Mass. Its length makes it convenient for use in places difficult of access, and the length of the handle furnishes sufficient leverage. When the wrench is not in use the handle can be folded down so as to lie flat with the body, as shown by the dotted lines. The wrench thus requires little room in the toolbox.

With different sizes of sockets the wrench is particularly adapted for removing or inserting spark plugs, the special socket being of suitable length and size of opening to take in all standard spark plugs.

As a part of the tool equipment for special machines the wrench may be furnished with any required assortment of sockets.

## The "Barco" Flexible Joint

"Barco" flexible joints are made to meet the requirements in places where a flexible conveyer is required. They are designed to be used for steam, air, water, gas, oils and other liquids, either under pressure or suction, and are fitted with screw or flange joints as required.

As will be seen in Fig. 1, the "Barco"

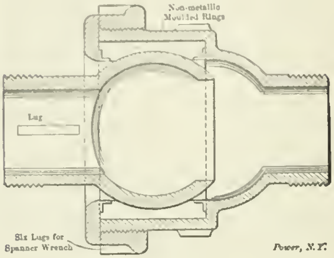


FIG 2. JOINT ASSEMBLED

flexible joint consists of but three metallic parts, the body, the ball and the ring. It has two hard, nonmetallic gaskets, which prevent contact of metal with metal at any point, making it impossible for the ball to grind itself in spots and the joint to become leaky. The gaskets permit of easy taking-up for wear and are reversible and renewable.

They are not affected by steam, heat, air, pressure or liquids and consequently have a long life. In small sizes these joints are made of bronze, and larger sizes of malleable iron: the standard joint being designed for pressures up to 200 pounds. Special high-pressure joints can be furnished if desirable. Fig. 2 shows a joint assembled. They are made by the Barco Brass and Joint Company, 56 North Jefferson street, Chicago, Ill.

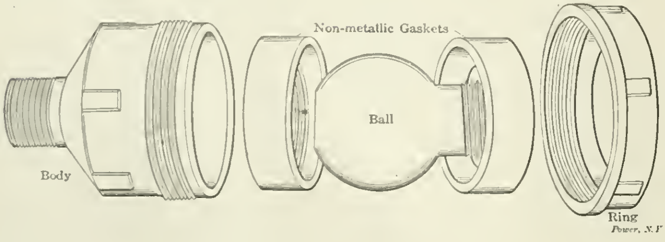
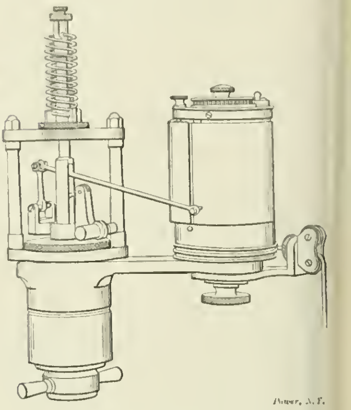


FIG 1. PARTS OF "BARCO" FLEXIBLE JOINT

## Crosby Outside-Spring Indicator

The Crosby standard indicator with outside spring is illustrated herewith. It differs somewhat from the standard indicator of the inside-spring type, mainly in the location of the spring, which is placed above the central mechanism and will, therefore, remain cool under all conditions of use.

As shown in the illustration, the spring is easily attached to or removed from the indicator, being supported by two columns and a cross piece. This indicator, as in the case of other indicators manufactured by this company, is provided with reducing motion and the necessary attachments for producing good work. It is made by

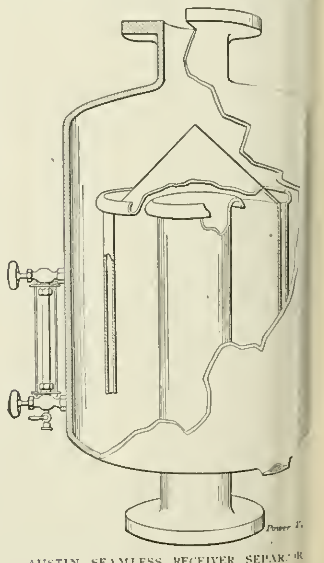


CROSBY OUTSIDE-SPRING INDICATOR

the Crosby Steam Gage and Valve Company, 97 Oliver street, Boston, Mass.

## Austin Seamless Receiver Separat

The Austin all-steel welded seamless r ceiver separator is a pressure-resistin rivetless separator for installation in hig pressure steam lines. This separator manufactured by the Austin Separat Company, 157 Woodbridge street, Detr Mich. The accompanying illustration r resents a sectional view of the verti type recently completed. It is construc



AUSTIN SEAMLESS RECEIVER SEPAR

of open-hearth steel plate welded into vertical, horizontal or angular shapes, and no seams, rivets or bolts are employed. It is claimed that it has an efficiency of 99.81 per cent. dry steam.

## Book Reviews

TABLES OF THE PROPERTIES OF STEAM AND OTHER VAPORS, AND TEMPERATURE-ENTROPY TABLE. By Cecil H. Peabody. Eighth edition, rewritten. John Wiley & Sons, New York, 1909. Cloth; 133 pages, 6x9 inches. Price, $1.

TABLES AND DIAGRAMS OF THE THERMAL PROPERTIES OF SATURATED AND SUPERHEATED STEAM. By L. S. Marks and H. N. Davis. Longmans, Green & Co., New York, 1909. Cloth; 106 pages 6¾x9 inches. Price, $1.

The steam tables in use among engineers up to this time have been based chiefly upon the experimental work of Regnault. For some years there has been growing a realization that these tables leave a good deal to be desired in the way of accuracy. While probably correct enough for rough engineering experiments, such as ordinary boiler and engine tests, they develop serious discrepancies under attempts to apply the checks and interrelations deduced from fundamental thermodynamic principles; and the errors indicated by these discrepancies are of appreciable importance in careful, scientific testing of steam-using apparatus.

The fundamental quantities for saturated steam are, at any temperature $t$, the pressure $p$, the heat of the liquid $q$, the heat of vaporization $r$, and the specific volume $s$; and of these, the volume $s$ is given, not as experimentally measured, but as derived from $r$ and $p$. It is in the total heat, $H = q + r$, that the largest error has been found. Instead of Regnault's straight-line formula, various curves have been proposed at different times, mostly based upon a new interpretation of Regnault's experiments. Decidedly the best thing that has been put forward in this line, however, is the formula of Davis, presented at the New York meeting of the American Society of Mechanical Engineers, in December, 1908. The rate of change in the total heat above 212 degrees Fahrenheit is deduced from published throttling experiments, by working backward with the recently determined values of the specific heat of superheated steam; and the resulting curve agrees better in form with the plot of Regnault's results than does his own straight-line relation. Below 212 degrees a number of experiments have been made in the last few years, quite sufficient to fix the value of $H$ or $r$ very closely. It is interesting to note that no one has attempted the difficult task of repeating, and possibly bettering, the direct measurements of total heat by Regnault above 212 degrees.

The two new steam tables which have just appeared are essentially alike in the numerical values given for the various quantities, in spite of minor differences which may be of considerable interest from a scientific point of view. Both follow the Holborn-Henning (1908) determination of the relation between pressure and temperature. Peabody uses Davis' formula for total heat, with only the adjustment of decreasing each value by 0.3 or 0.4 B.t.u., due to taking $H$ as 1150.0 instead of 1150.4 B.t.u. at 212 degrees. Below 212, with independent interpretation of experimental data, there is some difference, Peabody's value of $H$ at 32 degrees being 17 B.t.u. smaller than that of Davis'.

In regard to the heat of the liquid $q$ there is an essential difference; Peabody adheres to his own interpretation of Regnault's work, as set forth in his edition of 1907; Marks and Davis adopt Dieterici's formula, supporting the choice by a recomputation of Regnault's data. The writer has already expressed preference for the Dieterici curve* (especially for extension into the higher ranges of pressure); but up to the limit of Peabody's table, at 428 degrees Fahrenheit, or 336 pounds absolute, the difference is of little practical importance. At 300 degrees it is +0.2 B.t.u.; at 360, −0.3 B.t.u.; at 420, −1.7 B.t.u.; the plus sign means that Peabody's value is larger.

To show how much the new tables differ from the old, the accompanying brief tabular comparison may be of interest. Over the range of common technical application, the agreement between the new tables is very close; and having shown this practical numerical equivalence, it is in order to consider manner of presentation, convenience for use, and range of conditions covered.

The first two tables are the same in both books; they give the properties of saturated steam, Table 1 with temperature as the "argument" or base, Table 2 with integral values of pressure in the first column. The Marks and Davis table has the advantage of a wider page, which makes room for three more columns. The added columns are, (a) pressure in another unit besides pounds, namely, inches of mercury below 212 degrees, atmospheres above 212 degrees; (b) total heat $H$, following $q$ and $r$ as their sum, while Peabody has room for only the parts $q$ and $r$; (c) total entropy, following the entropy of the liquid and that of vaporization. Further, the value of the external work is omitted by Marks and Davis (a departure from common practice), and there are two columns for internal energy, the first, the usual "inner latent heat," the second, the internal-energy portion of the total heat. It appears that all these additions are in the direction of greater convenience in use.

After these two primary tables, the two books differ widely. Peabody's Table 3, with Centigrade temperature as the argument, gives parallel columns of the quantities in Tables 1 and 2, in French and in English units; this will greatly facilitate the reading of reports in foreign books and periodicals. In Tables 4 to 11 the properties of liquids other than water are set forth in brief, as in the preceding edition. Tables 12 to 15 may be classed as miscellaneous, while Number 16 is the big "Temperature-Entropy Table," of which more will be said presently.

In the Marks and Davis book, Table 3 covering 44 pages, as against 14 pages for Tables 1 and 2 gives in very convenient shape the important properties of superheated steam. The argument is pressure, ranging by single pounds from 1 to 250, and by increasing intervals to 600 pounds. The head of the column is degrees of superheat, ranging by tenths up to 200, and by wider intervals to 600 degrees. For each pressure and amount of superheat are given four quantities, namely, temperature $t$, specific volume $v$, total heat content $h$, and total entropy $n$. In completeness and in range covered, this goes far ahead of any table that has as yet been published, and marks a decided advance in the readily available quantitative knowledge of superheated steam. The upper temperature limit of this table, for steam of the pressures used in boilers and engines, is from 800 to 1000 degrees Fahrenheit; and in the supplementary Table 4, data are given for carrying total heat and entropy 1200 degrees higher, or to 2000 degrees of superheat—this belonging to the range of conditions within the cylinder of a gas engine. The miscellaneous tables in this book include the thermal properties of water for every 10 degrees from 20 to 600 degrees (and beyond by estimate), also a number of useful conversion tables. Both books contain short tables of four-place common and Naperian logarithms, which will be convenient for classroom work.

COMPARISON OF STEAM TABLES.

| $t$ | Tab. | $q$ | $r$ | $H$ | $s$ |
|---|---|---|---|---|---|
| 32 | $P_1$ | 0.0 | 1091.7 | 1091.7 | 3395 |
| | $P_2$ | 0.0 | 1071.7 | 1071.7 | 3308 |
| | M | 0.0 | 1073.4 | 1073.4 | 3294 |
| 120 | $P_1$ | (88.15) | 1030.5 | 1118.5 | 204.8 |
| | $P_2$ | 88.0 | 1024.4 | 1112.4 | 203.0 |
| | M | 87.91 | 1024.4 | 1112.3 | 203.1 |
| 212 | $P_1$ | (180.9) | 966.3 | 1146.6 | 26.66 |
| | $P_2$ | 180.3 | 969.7 | 1150.0 | 26.78 |
| | M | 180.0 | 970.4 | 1150.4 | 26.79 |
| 300 | $P_1$ | (270.6) | 903.6 | 1173.4 | 6.388 |
| | $P_2$ | 269.8 | 908.9 | 1178.7 | 6.462 |
| | M | 269.6 | 909.5 | 1179.1 | 6.46 |
| 360 | $P_1$ | (332.5) | 860.1 | 1191.7 | 2.954 |
| | $P_2$ | 331.6 | 861.8 | 1193.4 | 2.960 |
| | M | 331.9 | 861.8 | 1193.7 | 2.957 |
| 420 | $P_1$ | (395.1) | 816.0 | 1210.0 | 1.516 |
| | $P_2$ | 394.0 | 810.1 | 1204.1 | 1.499 |
| | M | 395.4 | 809.0 | 1204.4 | 1.510 |

In column headed "Tab.," $P_1$ refers to Peabody's tables of 1907, $P_2$ to Peabody's tables of 1909, M to Marks' and Davis' tables. The values of $q$ in parentheses are from Regnault's formula, Tables $P_1$ and $P_2$ are the same in this quantity.

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*Journal, American Society of Mechanical Engineers, May, 1909, page 669.

Marks and Davis carry all the quantities for saturated steam (in Table 1) up to 600 degrees Fahrenheit, and some of them to the critical temperature, 689 degrees. While this is wholly extrapolation it may yet be made with enough possible correctness to be quite serviceable up to a pressure of 1500 pounds per square inch.

Finally, we have to consider the special tables or diagrams, worked out with a view to the quick solution of many thermodynamic problems. Peabody's Table [illegible] has temperature and pressure in the first two columns, as determinants for the horizontal lines, while each column is headed by a value (constant) of entropy. It is a little misleading to call this a temperature-entropy table and to print the temperature in blackface type as the principal determinant. Really, each horizontal line simply follows a constant-pressure line of the Mollier diagram, and only up to saturation is the temperature a coincident determinant with pressure. For superheated steam it is necessary to use the oddly spaced values of pressure in the second column in order to locate a particular condition in the table. At each "point," as located by temperature or pressure and by entropy, are given the quality, the heat content, and the specific volume of the steam. The table extends from 1.52 to 1.83 of entropy, and runs up to 300 pounds of pressure and to 300 degrees of superheat.

Marks and Davis give two diagrams: Number 1 is the Mollier diagram, with entropy as abscissa, heat content as ordinate, and curves drawn for various particular values (each constant) of pressure and of quality. By "quality" is meant, in this connection, proportion of steam $x$ in a mixture of steam and water, temperature rise $t$ above saturation (or degrees of superheat) with superheated steam. On the sheet with Diagram 1 is printed a table showing the saturation temperature for the various constant-pressure lines drawn. Diagram 2 has pressure as base (to a varying scale) and heat content as ordinate, and curves are drawn for constant values of quality and of specific volume. It is a disadvantage of this system that all the quantities cannot well be plotted on one diagram. The range covered in Diagram 1 is from 1.30 to 2.10 of entropy, with pressure at 600 pounds and 600 degrees of superheat as the upper limits.

The tabular method has the advantage of leading to more precise results, although involving troublesome interpolation in many cases. Only after much practice, to give thorough familiarity, will it be anything like so easy to "find the place" in the table as on the diagrams. The Marks and Davis diagrams are printed in two colors; while this makes for convenience, it introduces an element of inaccuracy, in the difficulty of securing perfect "registration" or matching of the two impressions. The probable error in use of the diagrams is about one-half of one per cent., or about 5 B.t.u. in total heat readings—this with reasonably skilful interpolation, which in most cases must be estimated by eye. The simple expedient of using the Peabody table without interpolation involves about the same amount of error.

The last 20 pages of the Marks and Davis book are devoted to a "Discussion of Sources," which will be found very valuable by anyone who wishes to go into the matter of the origins of the steam table.

It cannot be said that the properties of steam have reached the stage of expression where they are no longer subject to correction; but it is safe to claim that the corrections yet to be made are relatively small. In the older tables and formulas there are discrepancies rising as high as 1½ per cent. In these newer tables the greatest degree of uncertainty, up to the limit of experiment at about 250 pounds pressure, is not more than one fifth of one per cent.

R. C. H. HECK.

STEAM PIPES; THEIR DESIGN AND CONSTRUCTION. By William H. Booth. The Norman W. Henley Publishing Company, New York. Cloth; 187 pages, 6x9 inches; illustrated. Price, $2.

The author has selected a subject upon which literature is lacking, and it is a pity that his book should have been spoiled in the making.

The subject is divided into seventeen chapters, the first of which treats of "The Duty and Object of Pipes," and condemns duplicate pipe systems. The "ring main" is stigmatized as a nuisance, "with its myriad of costly valves, its maximum of condensation and its minimum of safety." Chapter II deals with the "Flow of Steam," giving various formulas for velocity, loss of pressure, weight delivered, size of main required, loss by globe valves and elbows, etc. No addition to existing information is here offered, and Professor Carpenter's latest and valuable contribution to the subject is not included. On page 5 the author credits the Napier formula to Rankine and gives the quantity in "pounds per second per *unit of area.*" This should be definitely stated as per square inch. If any other unit is used, the 70 of the formula must be changed accordingly. On page 6, the (3) intended to designate the third formula is run in with and made a part of the equation, while the fifth formula is numbered (1). An alternative method of writing formula (1) given on the same page, applies to that one of the two formulas so numbered which, to be consecutive, should be numbered (5).

Chapter III deals with Materials. The = sign in the formula for pipe thickness on page 24 should be +. This chapter treats fully as much upon the dimensions and design of fittings as of the materials of which they are made. The 8 threads to the inch used by Americans for sizes above 2 inches "seems coarse to English engineers and is not so good as our Whitworth 11 threads for light (tight?) work."

On page 53 the author returns to the subject of pipe thickness and gives over again as "another very fair formul*æ* for cast iron up to 200 pounds per square inch water *power*," the formula which he has given twice before.

On the same page, "a good formul*æ*" for thickness of flanges is given with an × instead of a + for the last term. The formulas for diameter and number of bolts are so run together with the explanation of the notation that the items of the first two lines of the definition appear as factors of the formulas.

Chapter IV treats of "Expansion." The calculation of variation of length with changes of temperature is explained and different methods of providing for it illustrated. The reference to Fig. 15, at the bottom of page 57, should be to Fig. 20. On page 68, the expansion between 32 and 42 degrees is mentioned, when 212 is meant for the higher limit. There follows a short chapter on the "Strength of Pipes," which might well have been included i the former treatment of the subject. Th next chapter treats of "Anti-Primin Pipes" and "Outlet Valves." "Pipe Joints" are disposed of in four pages, and littl is made of the loose-flange type. Matte pertinent to this chapter is, however, in cluded in that upon "Materials." Suc ceeding chapters treat of "Supports, "Erection and General Arrangements, the latter considering the relative pos tions of boilers and engines, or the static plan. The author describes with apparen approval in the chapter devoted "Valves," a cast-iron body, good for 2 pounds, fitted with a seat of "high-pre sure bronze" fixed into the body by stu to avoid the warping of the seat by d ferential expansion such as occurs whe seats are tightly pressed into cast ir The chapter on "Drainage" is largely voted to the description of a proprieta expansion trap.

The chapter upon "Junction Pieces a Flanges" gives dimensions and weights tees and other fittings, and the flange tab of the Babcock & Wilcox Company. British Electric Traction Company. American Standard of 1902, James Rus & Sons and the Crane Company. A ref ence to the report of the standard c mittee on this subject, which appeare the moment of going to press, is contai in an appendix.

The chapter upon "Separators, Exh Heads and Atmospheric Valves," inst of treating generally of their design, vantages and use, is devoted to desc tions of several of those upon the ma

The author is well known as an a cate of superheated steam and one to his chapter upon this subject with anticipation of finding some uptodate consideration of the effect of superheated steam upon valves and fittings, but of the twenty pages which it contains, one is devoted to a consideration of the effect of superheating upon the size of pipe required, with the conclusion that "on the whole, for a given power, the steam pipes may be less in size than usually provided;" while the other nineteen pages are devoted to pipe coverings.

After a short chapter upon "Weights of Pipe," the book concludes with a chapter upon "The Kinetic Theory of Gases."

## International Brotherhood of Stationary Firemen in Tenth Annual Convention

The tenth annual convention of the International Brotherhood of Stationary Firemen was held at Yonkers, N. Y., during the week beginning Monday, August 16. The headquarters were at the Getty house, and the business sessions of the convention were held in Teutonia hall.

On Monday morning at half-past ten the delegates assembled at the Getty house and, headed by the Eccentric Firemen's Drum, Fife and Bugle Corps, composed of members of New York City Local No. 56, marched to the convention hall, where the opening ceremonies took place.

Interrational President Timothy Healy called the meeting to order and, after speaking briefly, introduced Mayor Warren, of Yonkers, who welcomed the visitors to the city. His Honor was followed by John Mitchell, ex-president of the United Mine Workers of America, who spoke most interestingly. Addresses were also made by John N. Parsons, postmaster of Yonkers, and other prominent leaders in the field of labor.

At the conclusion of the opening formalities, the convention went into executive session.

There were many social events connected with the convention, the most important being a visit to "The Uplands" at Mount Kisco, the summer home of Mrs. J. Borden Harriman, wife of the New York banker. Mrs. Harriman has shown much interest in the welfare of the workman, and through International President Timothy Healy she extended an invitation to the entire delegation and friends to dine with her. The courtesy was readily excepted. Automobiles and carriages were in waiting at the station, and the company enjoyed a pleasant ride of three miles to "The Uplands," where they were warmly received by Mrs. Harriman. The west terrace was tastefully decorated with Japanese lanterns, and four large tables were spread on the lawn.

Mrs. Harriman, Mr. Healy and Mr. Mitchell were seated together at the head table, Mr. Healy being upon Mrs. Harriman's right hand and Mr. Mitchell upon her left. During the dinner, Mrs. Harri-

IN THE UPPER LEFT-HAND CORNER, MRS. HARRIMAN WITH TIMOTHY HEALY AT HER RIGHT AND JOHN MITCHELL AT HER LEFT; IN THE CENTRAL VIEW, THE LAWN PARTY AT "THE UPLANDS;" IN THE LOWER VIEW, DELEGATES TO THE INTERNATIONAL BROTHERHOOD ANNUAL CONVENTION man's eleven-year-old daughter, Ethel, assisted by several of her girl companions, entertained the assemblage with several prettily arranged tableaux, accompanied by a medley of patriotic songs, closing with the "Star Spangled Banner." The guests were delighted with the performance and heartily cheered the efforts of the clever little artists.

Before the departure of her visitors Mrs. Harriman addressed the company, and told them how pleased she was by their visit, and warmly pressed the hand of each. Mr. Healy and Mr. Mitchell responded for the firemen, with feeling.

Other features of entertainment included a trip to Coney Island on Tuesday, where a clambake was served, followed by an entertainment. On Thursday evening President Healy held "open house" at his residence. The home and grounds were decorated with flags and lanterns. There was an abundance of good things to eat and drink, and the New York "Bunch" gave a fine outdoor entertainment.

The convention came to a fitting conclusion by the delegates participating in the fourteenth annual picnic and games of the Eccentric Firemen's Local Union No. 56, at Celtic Park, Long Island City. There was an excellent program of games and races of all kinds, some of the leading athletes of the country being among the contestants.

During an intermission between the dances, Mr. Healy invited to the platform William J. Reynolds, national vice-president of the National Association of Stationary Engineers, and Frank Martin, of Jenkins Bros., and presented each a handsome gold medal, emblematic of the organization, in consideration for their many kindnesses toward its members.

The following international officers were elected for the ensuing two years: President, Timothy Healy, New York; first vice-president, L. S. Smith, Newark, N. J.; second vice-president, N. A. James, Washington, D. C.; third vice-president, A. Beavers, San Francisco, Cal.; fourth vice-president, J. J. Cunningham, Boston, Mass.; fifth vice-president, P. J. Timon, Millinocket, Me.; sixth vice-president, William Kitzmann, Columbus, O.; seventh vice-president, J. Holtzmann, Minneapolis, Minn.; secretary-treasurer, C. L. Shamp, Omaha, Neb.

The next convention will be held at Milwaukee, Wis., in August, 1911.

## Phoenix Association's Outing

Phœnix Association No. 24, N. A. S. E., of New York, held its nineteenth annual outing on Sunday, August 22, at Donnelly's Boulevard hotel, College Point, Long Island. The usual large attendance that Phœnix always draws was present, and when dinner was announced over three hundred seated themselves at the tables.

A match game of baseball between the engineers and the "Bunch" was played, the "Bunch" wining by the score of 12 to 10, Herbert Self and Arthur Vincent, officiating as umpires.

The program of races attracted universal attention, the sport being greatly enjoyed. Many of the contests were close and exciting. The first and second in each event received a very neat medal.

## Business Items

On August 18, 1909, Judge McPherson of the Federal court of Iowa, rendered a decision in the case of Warren Webster & Co. vs. C. A. Dunham Company, to the effect that the use of Dunham radiator traps in vacuum-heating systems does not constitute an infringement, in view of the prior art.

The "Selden" and "Zena" packings, manufactured by Randolph Brandt, 72 Cortlandt street, New York, are helping to build the Panama canal. After trials during the past year a large order has been placed for these packings for use in the ice and refrigerating plants of the canal zone.

"Oxoilnx" belt dressing, manufactured by the F. S. Walton Company, Philadelphia, Penn., is attaining a wide sale abroad, one firm in Russia alone ordering four barrels a month. If "Oxoilox" makes belts pull like chains, as the manufacturers claim, it is not surprising that it is attracting such wide attention.

Frank Beemer, who has been general superintendent of the Standard Roller Bearing Company for a number of years, has resigned, and has been elected vice-president and general manager of the Becker Steel Company, Germany. This company manufactures high-carbon tool-steel tubing, chrome-steel tubing and high-speed steel and various other crucible-steel products. Its United States offices is in the Land Title building, Philadelphia.

Harry H. Atkinson, for five years president and New England manager of the Philadelphia Grease Company, recently severed his connection with that company and established a lubricating-grease business under the style of the Economy Lubricating Company, with headquarters at First and L streets, Boston, Mass. The product of the new company, of which Mr. Atkinson is the proprietor, is known as "Economy" grease, which is stated to be a pure oil lubricant.

The Dornfeld-Kunert Company, Watertown, Wis., some months ago installed a 60-horsepower Economic gas producer and Nash gas engine at the B. Hoffman Manufacturing Company's plant, Milwaukee, Wis. This plant replaces a Corliss steam engine and is said to be giving excellent results as regards economy and reliability. The steam plant averaged 4000 pounds of coal per day, while the new equipment is doing the same work for 550 pounds per day, including all standby losses.

At the recent annual meeting of the stockholders of the Wheeler Condenser and Engineering Company, held at its works, Carteret, N. J., J. J. Brown, M. Am. Soc. M. E., was elected vice-president and general manager. Mr. Brown entered the condenser field some fifteen years ago as southwestern manager for the Henry R. Worthington Company and later became its general sales manager. After the formation of the International Steam Pump Company he became its general western sales manager, with headquarters at Chicago, and resigned that position to take up his present work. The Wheeler Condenser and Engineering Company has recently introduced several important improvements in condensing apparatus, among which is the "dry-tube surface condenser," which has shown remarkable results in high-vacuum work. The company has also in hand new and improved types of rotative dry-vacuum pumps, centrifugal pumps, centrifugal jet condensers and cooling powers. The plant at Carteret is being enlarged and improved. Among these improvements is a new power house which will be equipped with several different systems of condenser for exhibition purposes, as well as for supplying the electrical energy which will be used throughout the shop.

## Help Wanted

*Advertisments under this head are inserted for 25 cents per line. About six words make a line.*

WANTED—Chief draftsman or engineer for engine works. Address "Corliss," Box 3, POWER.

WANTED—Good mechanical designers and detail draftsmen for machinery manufacturer located in Wisconsin. Box 98, POWER.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

AGENTS WANTED to sell Burgmann celebrated engine packings in territories not yet covered. See our advertisement on page 86.

WANTED—A first-class designer for open feed-water heaters. Man must be capable of taking entire charge of this business. Box 99, POWER.

EXPERIENCED ENGINEER wanted to introduce first-class steam turbines, rotary air compressors and high lift centrifugal pumps to important firms. Offers to be sent to Box 300, POWER.

WANTED—New York and Boston representatives by Eastern slow-speed steam engine builder. One of these offices has cleared $4500 yearly on commission basis. Write fully. Box 1, POWER.

WANTED—Feed water heater designer and draftsman. One who has had experience in designing successful open-type cast iron heaters. Advise age, experience, education and compensation desired. Box 97, POWER.

## Situations Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line:*

WANTED—Position as chief engineer; aged 37; married and sober; experienced with water tube boilers, Corliss engines, steam turbines and high tension transmission. Box 4, POWER.

CHIEF ENGINEER wishes position in railway or light plant as chief or superintendent. Technical education; five years with present employer. Best of reasons for changing. Box 2, POWER.

POSITION WANTED as master mechani or chief engineer. Thorough experience i electrical and mechanical steam engineering familiar with all kinds of printing machinery Very best references. Address Box 96, POWER

AN EXECUTIVE POSITION by a technical publicist with engineering education an training, reputation and good address. Experience includes responsible positions in on of the large electrical manufacturing companie and the U. S. geological survey, and independen work. Box 95, POWER.

POSITION WANTED by strictly sober an reliable engineer with three years' experienc in machine shop, one year fireman, two yea as assistant, one year as engineer of ocea liner, one and one-half year assistant to th chief. References. Address: "Engineer," 5 Catharine Street, Saratoga, N. Y.

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WANTED—Work, by an engineer, mecha ical and electrical, 12 years' shop practice, years chief and superintendent in electric light, dredge, ice-ammonia compression. A kinds of boilers, engines, pumps, d.c. and a. generators, installing and operating, flue g analysis. Ten years in South America. Spea Spanish. Spanish country preferred. Addre W. B. Kelsey, 328 Main St., East Aurora, E Co., New York.

## Miscellaneous

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# The Steam Turbine in English Power Houses

## Some Reasons for the Popularity of the Steam Turbine in Electrical Work, Favored by the Attitude of the British Board of Trade

### BY JAMES A. SEAGER

History in English electric-power supply appears to be repeating itself. Eight or ten years ago the steam turbine was a comparative newcomer and was challenging the older-established reciprocating engine. This was largely due, as far as Great Britain is concerned, to the steady work C. A. Parsons and his assistant engineers have put into the development of the turbine for commercial purposes; and it was soon recognized that, given a good vacuum, the steam turbine was a serious competitor of any form of power-producing plant at that time on the market. The steam turbine is now a firmly established portion of a modern power-house equipment, particularly of the larger sizes, and most of the firms which formerly made reciprocating engines are now producing turbines, either under the Parsons patents as licensees, or in conjunction with the Continental types of steam turbine, such as the Zoelly and Bergmann.

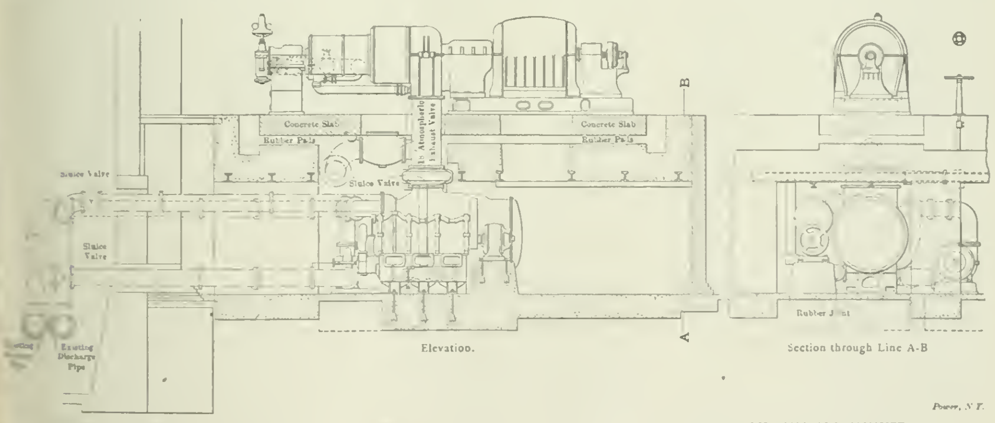
Just at the period, however, when the steam turbine has reached an acknowledged position in English power-house practice it is being put into competition, in theory at any rate, with a new application of an old form of motive power, the large-cylinder gas engine. This competition owes its rise to the successful performance of large gas engines on the Continent, particularly in Germany, working on blast-furnace gas. At present, in England, it appears that such an application will be limited in extent, as the blast-furnace area is not extensive, but directly it is proved that producer gas can be produced of a perfectly uniform quality and at an economical rate in large quantities, it is probable that the gas engine will proceed to take the place as a vigorous newcomer which the steam turbine occupied some years ago, inasmuch as any objection which was based on any irregularity of turning moments has been to a large extent dissipated by practical experience in the parallel running of alternators.

### STEAM-TURBINE PRACTICE AT ITS MATURITY

As steam-turbine practice in Great Britain has now reached what may be termed its maturity in power-house work it may be interesting to summarize the reasons for the popularity of the steam turbine in electric-power supply. The first of these is, of course, its excellent steam performance when running condensing. The competition between electricity and other forms of illumination and power in Great Britain is of the very keenest nature, and unlike America, where frequently the competition is between crude oil and steam application, the English problem resolves itself into a question of the most efficient utilization of the calorific power of coal.

Also, large reciprocating engines offer excellent steam performance, as evidenced in mill work and marine practice. This had to be paid for in increased capital expenditure, due to the large bulk of metal used in construction and also the large floor space required by this plant; and in spite of the fact that municipalities own a large proportion of the electric power-supply systems in Great Britain, the English Board of Trade has of late years been extremely careful as to the amount of sanction it has given to the raising of loans for extensions to electrical machinery. The turbine, however, satisfied the need for a steam unit giving the best possible performance at the lowest possible price.

The attitude of the Board of Trade has given emphasis to another point of economy with regard to the steam turbine. Many of the smaller power houses in Great Britain were put down without any idea as to the ultimate extent to which electricity supply would grow. In many cases they were situated in the center of a residential area in which ground space is valuable and room for farther extensions very limited, while owing to the anxiety of some borough surveyors to make the building architecturally impressive, cosiderable money was sunk in capital expenditure in building, which might have been otherwise employed. Under these circumstances the advent of the turbine was particularly useful in af-



GENERAL ARRANGEMENT OF A WILLANS & ROBINSON 2000-KILOWATT TURBO-GENERATOR, 1200-REVOLUTIONS PER MINUTE fording a means of extension of plant capacity without interfering with the original dimensions of the building, the older reciprocating units being cleared out as required in order to make room for the turbine sets. This practice has been most extensively adopted in Great Britain.

### Another Point in Favor of Turbo-driven Sets

Another most important point in favor of turbo-driven sets in Great Britain is the fact that in a large number of instances the load is to a very great extent a lighting load. The use of small motors has of late years improved the diversity factor of English power houses for small- and medium-sized towns, but where these are chiefly residential, as, for example, in the south and west of England, the peak load assumes an enormous importance in the daily operation of the power plant. Electric heating, which in many American power houses fills up the daylight hours to a considerable extent, has not made the progress in Great Britain up to the present which was at first anticipated, and it will probably take some years before the inertia of the British public in this respect is overcome.

It is therefore evident that a steam unit of the utmost flexibility in operation is required, and there again the steam turbo-driven set, whose limits in overload are generally regulated by the electrical, and not the mechanical, portion of the gear, has proved extremely valuable. Many of the specifications now issued provide for a considerable period of running at 50 per cent. overload, while for momentary overloads from 80 to 100 per cent. has been obtained. The value of this has been not only that the plant can work at good efficiency throughout the day on normal loads, the same plant being on peak loads forced up to an overload capacity, but the same amount of spare provision had not to be made, inasmuch as should one plant break down, it is possible for the other units to take to the work without undue risk for, at any rate, a short time of running.

Yet another advantage, which is perhaps of more importance in Great Britain than America, where very stringent conditions as regards nuisance are imposed on electricity-supply undertakings, is the fact that the turbine performs its work with an absence of vibration and, to a great extent, of noise. Reference has previously been made to the fact that many English power houses are situated in the midst of a residential area, whose residents would strenuously object to anything approaching the nature of earth tremors or audible hum, and the amount of precaution which has been taken to overcome this feature with reciprocating engines in many British power houses would seem almost incredible to anyone unacquainted with British conditions. There is at least one case where an English power house was seriously threatened with a legal injunction against running an expensive plant on account of vibration, and turbine practice has received a considerable stimulus by reason of this fact.

Two other features may be said to complete the list of advantages which may be claimed for the turbine from the point of view of the practical power-house operator. The first is the great decrease in the amount of repair necessary as contrasted with reciprocating engines of the same order of magnitude. With the automatic system of forced lubrication and the thinning of the tips of the rotor blades to prevent stripping, it can almost be said that the turbine as nearly approaches the automatic-power generator as is possible to conceive. The nearest approach to this was previously obtained by the entirely inclosed high-speed vertical engines which have been such a feature in English power practice, but even this required periodical overhauling to adjust brasses, examine piston rods and attend to valve gear. The mechanical motions attendant on the steam turbine are very much more in full view of the operator than the boxed-up portions of the inclosed engine, and it is a very significant feature that some of the prominent engine builders whose names have been associated with the high-speed inclosed type of engine are now building turbines of large power. The second of these two features is the fact that the turbine can take steam at a high degree of superheat, fully utilizing its work, and delivering the steam to the exhaust in a very high state of cleanliness. This involves that on the one hand superheaters either of the integral type found in the Babcock & Wilcox sets, or the separately fired type found in several power houses, may be used without any fear of excessive deterioration in the engine house, due to the dryness of the steam, and, secondly, the water consumption of the power house is limited to a small amount of makeup feed with the abolition of expensive and complicated oil-eliminating plants. Both these features have been largely appreciated by British engineers.

### Exhaust-steam Turbines

The latest word in English turbine practice has been the introduction of exhaust-steam turbines, either as auxiliaries to the reciprocating steam units in a power house, or as the motive power of an electricity-generating station utilizing the waste power in industrial processes. There are already cases in Great Britain where, as in the works of B. Samuelson & Co., Limited, of Newport Iron Works, Middlesborough, the exhaust steam from works processes has been utilized to drive a large power turbine coupled to an electric generator. In this particular instance the electricity so produced is being fed into an extended system of power distribution, which has effected a considerable revolution in the manufacturing processes on the northeast coast, and it is very probable indeed that the possibilities of utilizing exhaust steam in this way through turbo-electric sets will be a big feature of future British practice in the iron and coal areas.

It may be interesting in order to illustrate the point above mentioned to give some examples of recent practice in British power-house equipment, the first being taken from a medium-sized power station, used principally for lighting purposes, and the second being an example of the large power houses in the metropolitan area. For the first instance the writer is indebted to the courtesy of H. A. Bolam, the borough electrical engineer of Weymouth, a seaside resort on the southwest coast of England.

### Some Interesting Results

The increase of business done has recently caused the Weymouth Corporation practically to double the capacity of the station. The original plant consisted of two 120-kilowatt, 460-volt generators, two steam balancers, each of 75 kilowatts, and a battery of 360 ampere-hours capacity. In the boiler house, three Lancashire boilers, 28x8 feet, were hand-fired, the waste gases being taken through an economizer of 96 tubes. Ejectors were fitted on each engine to obtain a vacuum the water being pumped from a tida backwater near the station. As the resul of a Board of Trade inquiry in February 1907, respecting an application for furthe borrowing powers, a 300-kilowatt Brush turbo-generator set has just been installed whose performance is worthy of attention. The maximum load which this se actually developed under test was 42 kilowatts. With 160 pounds power pressure and no superheat the steam consumption was 21 pounds at full load, 22.5 a ¾ load, 25 at ½ load, and 32 at ¼ loa It was anticipated that these figures woul be improved when the contemplated addition of superheaters was made to th boilers. The vacuum guaranteed by th makers is 28 inches at full load. Th actual vacuum obtained is 29 inches, wit out the use of vacuum augmenters any auxiliary devices. The condense which is of the surface type, of 800 squa feet surface, is situated beneath the tu bine set, the latter resting on a concret steel flooring, including 10x6-inch rolle steel joists resting on concrete piers inches thick. The floor of the conden chamber is thus 5 feet below the old fl level, the bed of the turbo-generator s on top of the joists, being 4 feet ab the old floor level. The chamber a contains a three-throw Edwards-Brush pump capable of dealing both with turbine and all the other sets in the s tion. This very compact arrangement auxiliaries has greatly decreased the fl space necessary for extensions. The pi between the center lines of the original sets was 11 feet. Between the last of the old sets and the turbo set the pitch is only 9 feet, and if a duplicate turbo set is installed the pitch between the two can be reduced to 6 feet.

Some further details of the test figures obtained on the Brush set may be interesting. When running noncondensing at full load the consumption of steam per kilowatt was only 37.6 pounds, a most excellent figure. The momentary variation of speed caused by throwing a load of 400 kilowatts instantaneously off the set was 7.67 per cent., the permanent variation being 2.82 per cent. No sparking occurred n the brushes either in throwing the load on or off, interpoles being fitted and oliated brushes, composed of alternate ayers of gauze and paper compressed and baked, being used in conjunction with arbon tips. After six hours on full load nd ½ an hour on 25 per cent. overload, e temperatures obtained, with air at 57 egrees Fahrenheit, were: Armature, 114 egrees Fahrenheit; polo tips, 122 degrees ahrenheit; interpoles, 140 degrees Fahrnheit; shunt, 109 degrees Fahrenheit; mmutator, 118 degrees Fahrenheit. The xcitation for full load is only 1.4 mperes, the auxiliary plant requires 6 mperes for the centrifugal pump giving 10 gallons per minute, and 3 to 5 amperes r the air pump. Although an automatic pass is fitted on the turbine it has not t been found necessary in practice. The rbine is so free from vibration that though it is running at 2500 revolutions r minute a Frahm's tachometer fixed it is not sufficiently sensitive to record e speed, unless the bolts securing the trument are specially slackened to inease vibration.

In the boiler house the problem of ising additional steam for the new set first appeared to offer an opportunity thermal storage, but after consideration it was decided to adopt mechanical stokers. With hand firing, using small washed coal, each boiler had been able to develop 6000 pounds of steam per hour. A Meldrum and Clayton sprinkler stoker was installed on one boiler and forced draft used. This boiler then developed [illegible] pounds per hour, and after three months a second boiler was fitted with a similar stoker, and a third is shortly to be similarly fitted. Natural draft is now used, the forced draft being retained as standby for emergencies. It is found that the sprinkler stokers give quite sufficient flexibility to meet the varying loads. The other extension necessary thus nearly to double the steaming capacity was the provision of another set of 96 economizer tubes.

### Another Interesting Example

The second example is to be found in the power house of the St. Pancras Vestry, London, where Willans & Robinson, Limited, of Rugby, recently erected a 2000-kilowatt steam turbine. This power house is situated in the center of a high-class residential neighborhood, and the turbine is therefore mounted on special rubber foundations which have been introduced to obviate any possible vibration. Due to troubles previously experienced in this locality on account of vibration from the reciprocating engines, although the contractors were prepared to guarantee that the turbine would run free from vibration on an ordinary concrete bed, it was decided in view of the importance of not incurring any risks in this direction to adopt the special Prache foundations illustrated in the figure and described herewith.

The turbine is bolted to a special slab of concrete, about 2 feet thick, reinforced with steel girders and supported by a series of circular rubber stools which rest on the ordinary concrete foundation built in the ground. The top of the floating concrete slab is level with the engine-room floor, but the edges do not come into contact with it, so that there is no connection between the concrete slab to which the turbine set is bolted and the foundation, except through the rubber. A trench is provided around the floating slab so that the rubber stools can be inspected. Each stool is about 4 inches in diameter and about 3 inches in hight when compressed by the weight of the turbine set. They are separately renewable, and can be withdrawn and reinserted by means of further compression by tightening up the box in which they are held by means of screws which are provided. As, however, the rubber stools have a considerable life, the frequency of their renewal is not high.

This turbine has a normal output of 2000 kilowatts with an overload capacity of 46 per cent. for three hours. It has a speed of 1500 revolutions per minute and runs with a pressure of 185 pounds of steam per square inch at the stop valve with a superheat of 200 degrees Fahrenheit. A three-phase alternator made by Dick, Kerr & Co., Limited, direct-coupled to the turbine, gives 5050 to 5300 volts at a frequency of 50 periods per second. An exciter giving a range of volts from 100 to 125 is direct-coupled to the alternator, and the power factor of the main set is 0.9. The condenser, of the Willans & Robinson type, gives a vacuum of 28 inches at full load and about 26 inches at overload, with a cooling water temperature at 70 degrees Fahrenheit; and a three-throw Edwards air pump running at 136 revolutions per minute is driven by means of a 17-brake-horsepower three-phase motor running at 1680 revolutions per minute through single-reduction gearing. A Gwynne circulating pump running at 437 revolutions per minute is driven by a 37-brake-horsepower motor and gives 3640 gallons per minute against 20 feet head, and the turbine is fitted with an automatic atmospheric exhaust and sluice valves to enable it to exhaust into the atmosphere when necessary.

It will be seen from the foregoing that the turbo-electric generator has in Great Britain reached a position of great importance in power-house practice, and the stringent conditions rendered necessary by the various causes operating in a densely crowded area, with a large proportion of residents closely adjacent to the power house, has brought about a degree of refinement in design which evidences to a very full extent the capabilities of the steam turbine.

## Fires and Accidents in Electrical Installations

By H. S. Knowlton

The multiplying applications of electrical service provide an ever present opportunity for accident and fire occurrence in installations where constant vigilance is not exercised. It is true that standards of construction are improving year by year, and with better work comes a decreased risk per installation; but the vast increase in the number of establishments which generate or use electricity, and the growing length of distribution lines and systems call for great care in construction and operation. The causes of electrical fires are in a general way familiar to engineers in many localities, but there is still much to be learned from recurring disasters. In a nutshell, most electrical fires are due to the failure or the destruction of insulation. Simple as this statement is, it affords a variety of situations that differ widely in detail, and new combinations of circumstances capable of making trouble are constantly coming forward. There is little doubt that many fires which are charged to electrical causes are due to other reasons. Nevertheless, the electrical fires are still frequent enough to justify coöperation on the part of all owners and users of power installations in the line of prevention. The same thing may be said about personal injuries received from electrical apparatus. In the following paragraphs some practical lessons of cause and effect will be stated on the basis of electrical casualties covering a somewhat wide range.

Careless work during construction is responsible for not a few troubles. A typical case, though perhaps somewhat extreme, is afforded by a short-circuit which occurred on a central-station distributing system one morning when several men were making repairs to a door frame in an archway passage of a building. The work was well under way when one of the men drove some nails into a casing containing the lead-covered cables of a 2000-volt alternating- and a 500-volt direct-current circuit. One nail was driven through the lead sheathing and rubber insulation of one of the 2000-volt wires and in contact with the wire itself, and the same thing happened to the 500-volt line. This established an electrical connection between the two circuits; the higher potential power was thrown into the direct-current mains, and between four and five times the normal voltage immediately was applied to a large number of motors in different parts of the city, with the capacity of the power plant behind it. Sixty-five electric motors aggregating about 300 horsepower were burned out, and 63 establishments put out of business temporarily. Fortunately no one was injured, but the money loss was considerably in excess of $10,000. Serious fires springing up in different localities might have followed upon such an extended burnout, but happily the damage was local in each case.

A small fire occurred in a retail-store show window on account of the brushes of a small motor making poor contact. The motor was used to drive the switching mechanism of an electric sign, and was run all night. During the night the contact became so poor that the circuit was broken; the springs failed to force the brush firmly forward against the commutator bars, and the motor stopped. It happened to stop in the position that left the switch for the sign lamps closed, and the continued radiation from the lamps of the sign, which was located in the window, caused the woodwork to ignite.

Injury to insulation by water is a frequent cause of electrical fires. In one recent case an arc lamp was located in a position where an overhead leak carried drippings of water into the lamp mechanism. This was not noticed until the insulation was so much reduced that the excessive flow of current burned out the lamp and the meter of the circuit on which it was running, the installation being one of low potential The fire did not spread farther as it was promptly discovered. Another arc-lamp trouble was caused indirectly by the failure to clean the equipment properly. A large amount of carbon dust accumulated around the hanger board and metal case of the lamp. The lamp was suspended so close to an adjoining gas pipe that a large rat, on investigating the latest wrinkles in illumination, managed to create a connection through his body between the grounded gas pipe and the lamp frame. The latter was heavily charged as a result of the long-standing accumulation of carbon dust, and the grounding of the arc circuit, which was of a high potential, immediately produced a blaze around the ceiling. The report gives no further mention of the rat, but the blaze was quickly discovered and extinguished.

The importance of installing direct-current motors so that inflammable matter cannot fall upon the commutator is illustrated by a fire which occurred in the picker room of a small factory. An employee was running about 60 pounds of hair through a picker operated by a one-half horsepower motor. Some of the hair fell upon the motor and became entangled with the brushes and commutator. An arc resulted, and fired the hair, the blaze extending to the rest of the shop.

In the power-house workshops, where direct-current equipment is in use, it cannot be too strongly emphasized that the one spot above all others where trouble can originate is at the commutator, and all combustibles should be kept well away from motors of this type.

In dealing with arc lamps operated on the series plan, it is important never to overlook the fact that an open circuit is capable of producing a good deal of trouble, since a break at any point brings practically the entire voltage of the generator at once to the spot, and a most vicious arcing is capable of taking place. Series lamps are short-circuited instead of being cut out in the manner of parallel-operated lamps; but an open circuit is highly provocative of fire risk. Thus, in one case a series arc lamp was installed so as to depend upon hook connections for its supply of current from the outside circuit. An occupant of the premises attempted to start this lamp by using a broom handle, and in so doing unhooked the lamp upon one side. The open circuit immediately established an arc, followed by a slight fire.

In drilling in power stations near the switchboard equipment or any exposed wiring, the greatest care is always necessary to avoid personal injury and the possible shutting down of the entire system. The use of bare-handled metal wrenches around busbar connections simply invites trouble. Any hand tool needs careful watching when working around live electric wiring. A representative case is that of two men who were working in a main power plant in the rear of a transfer switchboard installing wood partitions or barriers between the transfer switches and busbars of a 2200-volt alternating system. Their work was nearly completed and they were installing a top or cap board, using an angle brace to bore holes through it and into the partitions for the screws which were to fasten the latter together. While attempting to remove the angle brace, after having bored a hole, the chuck of the brace came in contact with one busbar, while the sweep of the brace touched a busbar of opposite polarity. Of course the result was a short-circuit which burned both men severely. A similar accident, but even simpler in its cause, occurred to a workman who was painting busbars in the operating room of a storage-battery station. The wire binding of the paint brush came in contact with two busbars of opposite polarity, and although these were of only 220 volts, the man was severely burned in the resulting short-circuit.

A fire which might have had serious consequences occurred in a lighting installation supplied with current from a 2000- to 110-volt step-down transformer located outside the building. The trouble was due to someone throwing an old loose piece of insulated wire up into the air, so that it crossed a 5000-volt arc circuit and the transformer primary lead. The transformer primary and secondary coils were fused together, and the current entered the building, burning out the lamps and fuses, and setting fire to the structure. One circuit was also found to be grounded. The night was wet and stormy, and the so-called insulation was consequently worthless when the wire was thrown across the two high-voltage lines. The incident illustrates the virtues of cleaning up all construction jobs, if nothing more.

The importance of using only the best qualities of supplies in electrical maintenance is illustrated by a small fire which occurred on account of using a crooked carbon in an arc lamp. The lamp could not feed properly with this carbon; a short arc was formed, with excessive flow of current, and the regulating coil became overheated and ignited, scorching the adjacent ceiling. The use of a fraye incandescent lamp cord also was the caus of a fire in a recent instance where window curtain was ignited by the flas of a short-circuit in the fiexible pair o wires leading to a portable lamp.

A somewhat unusual accident and fir occurred outside a power station locate on tide water, and connected with anothe plant by a submarine cable line. At th rear of the station boiler room were lo cated the coal bins, and between thes bins and the rear wall of the station wa a space about 5 feet wide which w planked over. Beneath this planking, in space about 5 feet high, was located wooden junction box in which conne tions were made between cables in t station and the submarine lines. T box was filled with compound and high tide was covered with several inch of water. While working on the juncti box in connection with some press wires, and while the compound was bei cut away to facilitate the freeing of t pressure wires, a man inadvertently dro a cold chisel into the negative pole o feeder, grounding it on an iron pipe, a causing a short-circuit which appare burned itself clear. As the tide was ris to a point where the box would soon submerged, the workman melted the co pound down around the conductors left them in what he supposed was a s condition until such time as the would permit work to be resumed. the rise of the tide water to the cabl short-circuit again occurred, igniting insulating compound and adjoining wo en stringers. The fire spread for a s distance beneath the coal shed befor was extinguished.

# Modern Machines for Pipe Threading

## Large Pipe Threading Machines Embodying the Latest Improvements and Some Examples of Hand Threading in Inaccessible Places

BY J. F. SPRINGER

The chief fundamental principles which are followed in the construction of numbers of the leading pipe-threading machines are not new. Thus, a hollow spindle, free to rotate but not free to move to and fro, constitutes a feature common to quite a number of machines. Also a die head olding the dies rigidly in position and not ree to rotate, but free to slide to and ro on ways, is another feature usually ound in combination with the nonsliding pindle. Indeed, these features may be rearded as belonging to the typical aparatus. Apparently all the very largest achines are constructed upon these prinples.

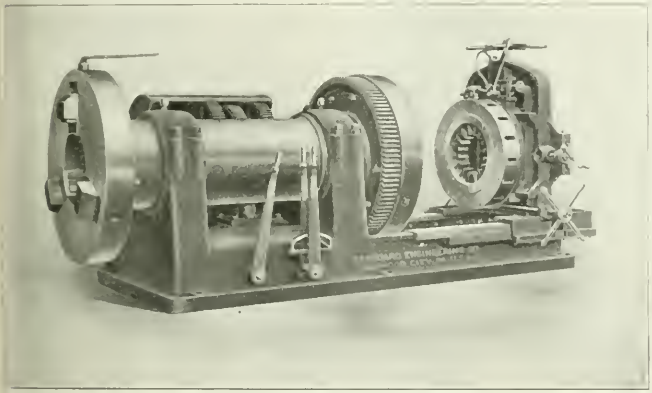


FIG. 1. LARGEST SIZE OF STANDARD-WIELAND MACHINE

### THE STANDARD-WIELAND MACHINES

Thus, upon examining the machines built y the Standard Engineering Company, llwood City, Penn., it will be found that ey do not depart from the regulation pe as far as these fundamentals are conrned. They differ, and differ somewhat dely, in certain other details, to which me reference will be made later on. In ig. 1 is a front view of the largest mane made by this company, which has capacity enabling it to handle 20-inch pe The entire bed, including the beargs for the rotatable spindle, consists of single casting. This is a construction ell deserving of consideration, seeing at it eliminates at once all possibility of ss of alinement between the bearings hich carry the spindle. The driving gear just back of the forward chuck, where should be to react effectively against the dies. That is to say, this gear should be, as nearly as possible, set up in the pipe by the cutting action of the dies. The operation and speed changes of the spindle are controlled by the levers seen in front. Upon the rear chuck are shown the jaws for gripping the flanges. This enables the fitting of flanges to be accomplished by the machine with the pipe kept clear.

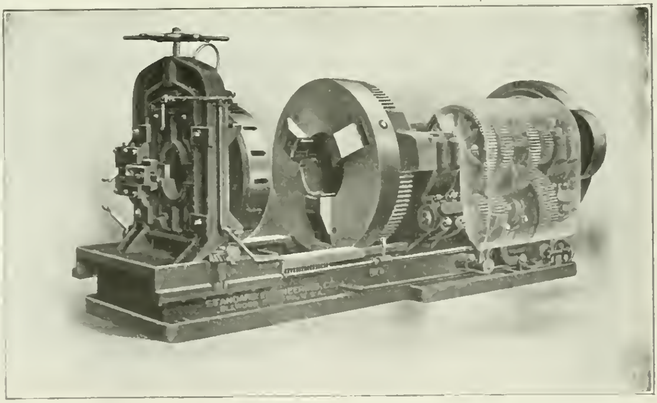


FIG. 2. REAR VIEW OF STANDARD-WIELAND MACHINE, SHOWING GEAR MECHANISM

Upon referring to Fig. 2, the gear mechanism is brought into view, through which six changes of speed may be secured. With the exception of the main driving gear back of the forward chuck, all gears are shielded by a guard. The rounding-up blocks are at the left, the upper one being controlled by the wheel at the top of the die bracket. The cutting-off slide disclosed in this view is controlled by a crank, better shown in Fig. 1. The spoked arrangement at the bottom operates the pinion-and-rack mechanism by which the die head with its chasers is fed onto the rotating pipe. So far there is no great novelty in this machine, but the method of operating the dies is worthy of special attention.

Refer for a moment to Fig. 15, page 265, August 17 number, showing the cam mechanism of one of Crane Company's machines. There is a cam ring and inside it the die holder. The one turns about the other. The apron has been lowered to a horizontal position and lying on it is seen one of the chasers. The cutting end is to the left. At the other end a groove may be observed. When the die is in the die holder, this groove coöperates with a cam rib. It will be readily understood that when the cam ribs are rotated about the die holder clockwise, they will operate to withdraw all the chasers simultaneously from the center. If now the cam ring with its ribs be rotated contrary to the hands of a clock, the dies will all be shoved in toward the center. Now there will be no difficulty in understanding that instead of a groove in the chaser and a cam rib coöperating, there may just as well be a tongue projecting from the chaser and coacting with a cam groove. The result will be the same. In the Standard Wieland machine, both methods are used in a single case, some of the dies being with projections, the others with grooves. When, in any machine, the cam ring is rotated to its proper position with the dies set at precisely the right distance from the center for the size of the pipe, it is necessary that the cam ring be secured in order to prevent movement of the dies when the machine is in operation. The method of locking used in this apparatus is very interesting and is covered by patent (1001).

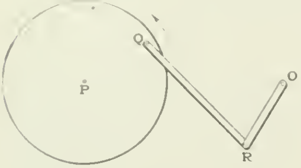


FIG. 3

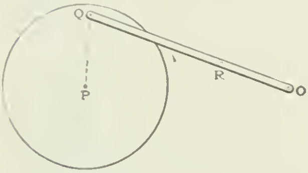


FIG. 4

When a locomotive driving wheel is turned by a crank shaft, there are two positions in every rotation called a "dead center." The movement of the piston rod is forever in a straight line. The pivot connecting the crank with the wheel is compelled to move around in a circle. Everywhere the movement of the piston-rod will exert a turning effect on the wheel, except when the pivots are both in line with the center of the wheel. If the wheel should come to a stop at either of the two possible positions, no forward or backward effort of the piston rod, however powerful, would turn the wheel. But the wheel can always move the piston, so that, if the wheel is driven, there is no dead center. But take the case where both pivots are compelled to move in circles. In Fig. 3 the two pivots *O* and *R* must move in circles about their respective centers *P* and *O*. An entire rotation cannot be made. When *Q* gets to the position shown in Fig. 4, where *O*, *R* and *Q* are all in a straight line, then if *OQP* is a right angle, no turning effort of the wheel will result in any motion at all. The wheel cannot move counterclockwise, because such a movement will require the distance from *O* to *O* to be increased, which is impossible. The wheel cannot move clockwise, because such an effort is exerted, and must be exerted, perpendicularly to *PQ*, that is, along *QR*. Such an effort will have no tendency to turn *R* about *O* as a center. In Fig. 5, where the angle *RQP* is not a right angle, motion counterclockwise is prohibited as before. An effort clockwise will be more successful, for such an effort will move *Q* in the direction of the arrow and will break the straight line *QRO*. However, if the angle *RQP* is not much removed from a right angle, a very little resistance will prevent this movement. Friction, or friction and a little weight, will be sufficient. The novel locking device of the Standard-Wieland machine depends upon principles of the kind described.

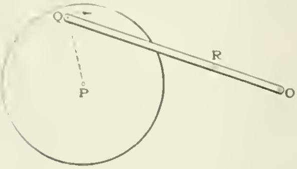


FIG. 5

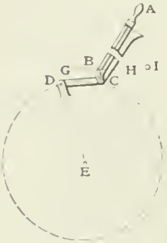


FIG. 6

Power, N.Y.

There is a lever *A*, Fig. 6, which has for the time being a fixed fulcrum or pivot *B*. The part *D* is secured to the cam ring, and so moves about a center *E*. The link *DC* is pivoted at *D* and *C*. If the lever *A* be moved clockwise, the cam ring will be rotated counterclockwise. And if then the lever be brought back to its original position, the cam ring will be rotated in a reverse direction. These movements of the lever expand and contract the dies. But *A* may be depressed to the point where *B*, *C* and *D* will lie in a straight line. As the angle *EDC* will not vary much from a right angle, the cam ring will be locked—not against the lever, but against any action or reaction set up by cutting the threads on the pipe. Now the locking occurs when *B*, *C* and *D* are in a straight line. Consequently, in order that the machine may be adapted to cutting threads on various sizes of pipe, a change of conditions must be possible. This is effected by adjusting the fulcrum *B* along a horizontal line *GH*. Every position of *B* means a different expansion of the dies when locked. Upon referring to Fig. 1, a thumb screw will be seen near the top of the die-head bracket. By turning this the fulcrum may be adjusted. Once set for a given size of pipe, the movement of the cam lever back and forth has no effect upon it. Consequently, there is no disturbance when the chasers are expanded after a cut to permit movement of the pipe.

Now, of course, it should not be left to the operator to determine the amount of depression of the lever necessary to secure the right line arrangement of the three pivots and consequent locked position of the dies. So a stop *I* is arranged to care for this automatically. However, when the fulcrum is displaced backward or forward, for the purpose of securing a new cutting gage of the dies, the necessary depression of the lever will vary. In order to secure automatically this variation in depression, the side of the lever which contacts with the stop is given a curved form. By consulting the figure, it will be seen that an adjustment of the fulcrum to the left will have the effect of increasing the distance from the axis of the lever from the stop. The block whos

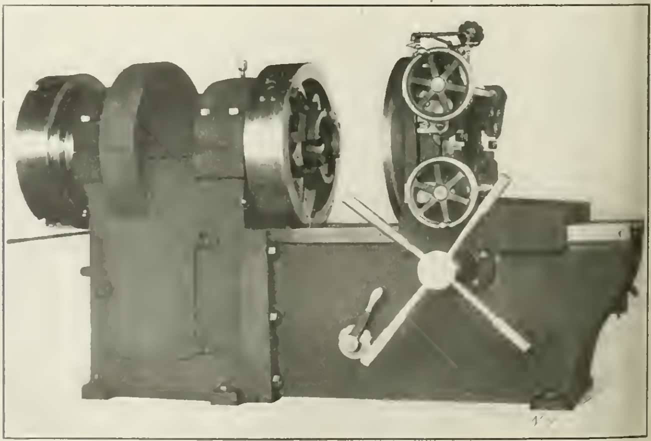


FIG. 7 THE MERRELL PIPE-THREADING MACHINE

position controls that of the fulcrum pin is firmly clamped when the machine is ready for the threading operation.

It will be noticed that there are radial openings around the rim of the cam ring. Eight of the sixteen openings permit the introduction of dies externally. Eight dies are introduced from within the die holder. In those positions of the cam ring permitting the placing of the dies in position, opportunity is given by means of the openings to clear all sixteen passageways without removal of the faceplate. Certain dies—all the upper ones and one horizontal—are provided with projections. The others have grooves. None fall out whatever the position of the cam ring. The upper ones are prevented by their location; the lower ones by stops.

### Merrell Pipe-threading Machines

A glance at Figs. 7 and 8 will show that the type of machine built by the Merrell Manufacturing Company, Toledo, Ohio, conforms to the usual practice of providing a sliding die-head bracket combined with a nonsliding work-holding spindle. The completeness with which all gears are covered will be noted. The bed is cast in two parts, and the bearings of the spindle are integral with the corresponding portion of the bed. A distinctive feature of this machine is the provision for cutting off pipe by the simultaneous action of tools from two opposite sides, which should effect a considerable saving of time. The rear view, Fig. 8, discloses a telescopic device for the transmission of oil, which is an uptodate and practical feature. The style shown in the figures is that of three sizes of machine having capacities ranging up to 12 inches.

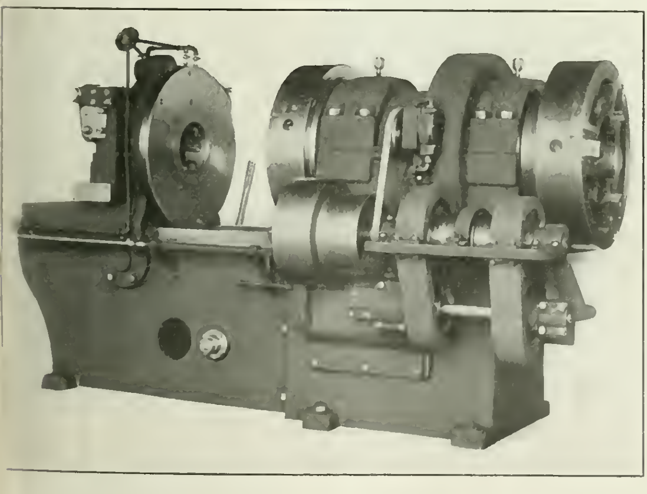


FIG. 8. REAR VIEW OF MERRELL MACHINE

### Bignall & Keeler Machines

One of the oldest manufacturers of pipe-threading machines is the Bignall & Keeler Manufacturing Company, Edwardsville, Ill. The fundamental mode of operation of its apparatus is the same as that adopted by a number of manufacturers—the pipe rotates on its axis but is fixed longitudinally, the dies are held in a fixed position relatively to each other, but as a group have a longitudinal motion. In fact, this mode of operation may be said to have become standard, having been adopted by so many makers.

Fig. 9 is a view illustrative of two of the largest machines made by this company These have capacities of 7- to 16-inch pipe and of 8- to 18-inch pipe, respectively. The great spindle with its two independent jaw chucks for securing the pipe is prominently in view, as are also the arrangements for supporting and rotating it. The advantage of placing the large gear which immediately imparts the drive to the spindle just back of the forward chuck has already been explained. The spoked wheel, seen at the bottom on the right, controls the sliding bracket to which the die holder and cutting-off mechanism are secured. By referring to the rear view, Fig. 10, the cutting-off device may be seen. The holding jaws are controlled by a right- and left-hand screw, seen near the top and controlled by the small handwheel. There is an oil pump located in the bed. The supply is transmitted to the hand by means of a telescoping pipe running along the side of the upper part of the bed This arrangement does away with a more or less inconvenient length of flexible tubing and yet permits the to-and-fro movement of the head. Referring back to Fig. 9, the hand lever and adjoining mechanism at the top will be noted. These arrangements are for the purpose of controlling the dies and call for some particularity of description.

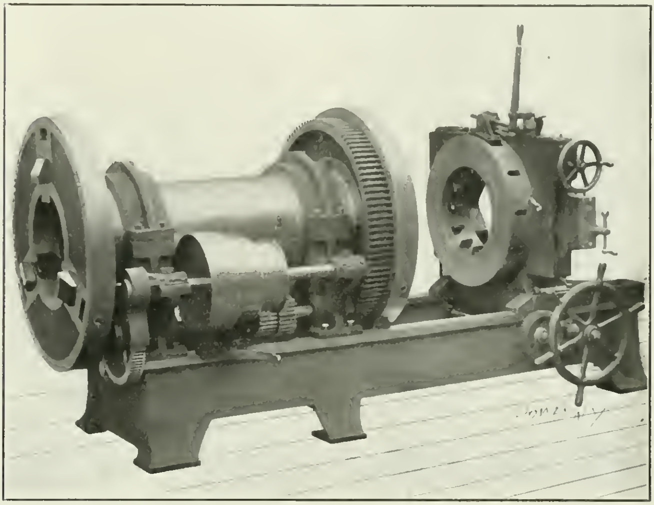


FIG. 9. LARGE BIGNALL & KEELER MACHINE

In Fig 11 are three views showing the Peerless adjusting mechanism, used on the Bignall & Keeler machines, in three different positions. The individual dies are arranged in radial guiding grooves not seen in the views Their outward and inward movement in these grooves is controlled by a cam ring, the exterior of which is in plain view. Secured to the cam ring and seen at the top is a bracket, and through this bracket passes a threaded rod having one end pivoted to the hand lever The length of rod between its connection with the lever and the bracket is controlled by the hand nut seen to the left of the bracket. The fulcrum of the lever is arranged on a bracket bolted to the head. In the view at the left, the lever is down in almost a horizontal position and is in line with the threaded rod. Further, the angle made by the axis of this rod with the radius drawn through the center is a right angle, or nearly so. It will be remembered from an explanation already given, that in consequence of these conditions the cam ring will be locked from rotation. The dies are therefore held in a fixed position suitable for cutting the thread. Although the cam ring is locked from rotation by any movement originating from the dies or itself, the lever is not locked, but may be moved and so rotate the cam ring.

By lifting the outer end of the lever to the position shown in the middle view, the cam ring is given a movement clockwise, which operates to withdraw the dies radially. The work may now be inserted or withdrawn or the cutting-off operation be performed. By swinging the lever a little farther in the same direction to the position shown in the right hand view, the slots in the cam ring are brought into line with the grooves in the head, when the dies may be slipped out. It will readily be understood, upon considering how nearly alike are the positions of the lever in the two figures at the right, that the latter position must not be allowed to occur through any inadvertence of the operator. Dependence is, however, not put upon his attentiveness. Upon looking closely at the three figures, a pawl will be seen on the main casting of the head. A stop on the rim of the cam ring cooperates with it to limit the expansion of the dies when it is merely desired to remove the work and the like. By throwing the pawl back, however, the position necessary for the removal of the dies may readily be had.

Returning now to the upper view, where the fixed position of the cam ring and dies is shown, it may readily be seen that by adjusting the hand nut the position of the cam ring is altered. That is to say, the cutting gage of the system of dies may be changed. This is of service for three purposes. First, as the dies are used and reground they become shorter and need to be adjusted differently to secure the same cutting gage. Second, expansion and contraction of the dies enable different gages of thread to be cut. This possibility of using the same set of dies for different sizes of pipe would, however, not be possible if the number of threads per inch changed with every gage. In the Briggs standard, the ½- and ¾-inch pipe have precisely the same number of threads, 14 per inch. The sizes from 1 to 2 inches have likewise the same number (11½). From there on, the number remains fixed at eight. The third advantage of being able to adjust the fixed position of the cam ring relates to the desirability, which sometimes occurs, of cutting the thread a little deeper or a little shallower than standard. It is to be observed, however, that such adjustment can be made only within limits, as the variation of the distance between the pivot centers of the end of the lever and of the bracket on the cam ring disturbs the right-angle relationship before referred to and which can only be varied slightly. The possibility of slight variation depends upon friction of the parts.

### The Toledo Machines

So far those machines which maintain the chasers fixed radially in the die head during the operation of cutting the threa have been considered exclusively. In al these machines the full length of threa is on the dies, and necessarily so. In an machine, and irrespective of the manne of securing the taper thread, there must b a longitudinal movement relative to th die head and work, and a rotational mov ment relative to these same element Rotation is necessary between dies an work in order to cut. A reciprocato movement is necessary to provide for th

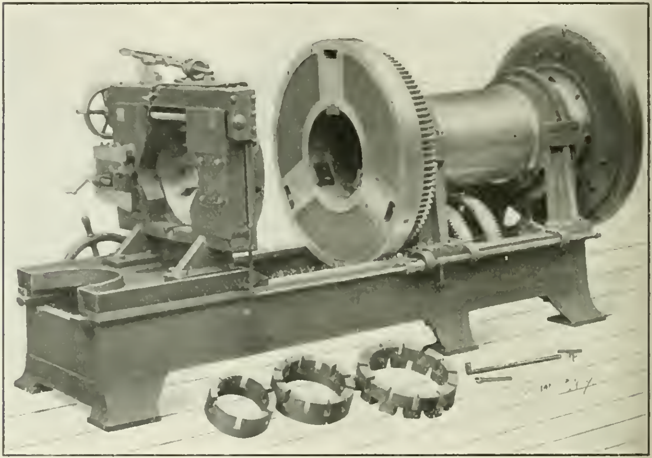


FIG. 10 BIGNALL & KEELER MACHINE FROM THE REAR

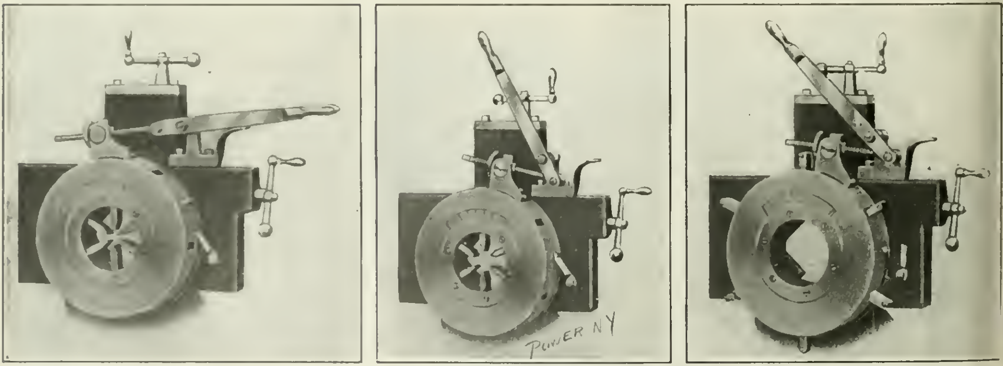
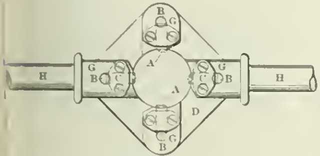


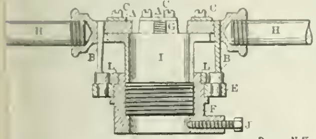
FIG. 11. PEERLESS ADJUSTING MECHANISM

progress of the operation. But these movements are susceptible of accomplishment in a variety of ways. And they have been variously accomplished in actual practice. In the Loew machines and in one type of the Crane devices, reciprocation between die head and work is secured by advancing the work itself along the axis of the machine. In the Curtis, one type of the Crane, and nearly all other styles, the die head itself advances on the work. Relative rotation is secured in the Loew and Curtis and one or two other machines by revolving the die head. But up to the present point all the machines described have agreed in this—the dies remain fixed in the die holder during operation.

The machines of the Toledo Pipe



IG. 12: VOSPER DIE STOCK FOR CUTTING TAPER THREADS



13. LONGITUDINAL SECTION THROUGH VOSPER DIE STOCK

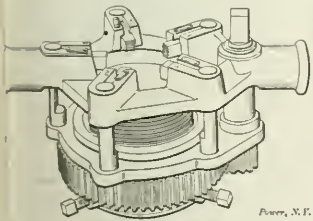


FIG. 14. TOLEDO PIPE THREADER

reading Machine Company automat- lly expand the chasing tools during op- tion. It is thus that the taper is se- ed This method is of recent date, United States patent having been is- l in 1904. As the taper is not secured the tapering of the face of the chasing . but by its radial withdrawal, it is sequently possible to reduce the length the cutting face to any convenient lgth—a mere thread or two. The cut z V runs over practically the whole the thread groove throughout its spiral iding on the pipe from beginning to e. This is not the case at all with the d chaser. It has not only a separate V f every loop of groove along the whole d ance threaded, but several of them. When the operation is just finishing, all the V's are working at once, with the result that a slight bur may be left at the point where each ceases working. The Toledo device effectually meets this difficulty. Further, in the matter of lubrication, it is quite evident that a short cutting face is much more easily cared for than a long one.

Let us now consider the mode of operation of this distinct device. The principles are well shown in Figs. 12 and 13, the original patent office drawings, although some deviations in construction have, as is usually the case, been adopted in practice. In the front elevation, Fig. 12, *D* represents the die holder, *G* being guides integral with it. In these guides, the chasing tools *A* are free to move radially. The clamps *B* complete the guiding arrangements. It will be seen that two of the guides are prolonged and arranged to receive the spokes or levers *H*. This arrangement may be well seen in Fig. 13, which is a longitudinal section through two of the chasers and the operating handles *H*. The head is extended at *I* in the form of a tube exteriorly threaded. A device *F*, for holding the pipe to be threaded, is provided with one or more set screws *J*, and is interiorly threaded to receive the exteriorly threaded portion *I*. It will now be seen that both the rotational and the reciprocatory movements of the dies and the pipe may be obtained by simply operating the levers *H*. As the longitudinal movement of the dies is precisely in accordance with the thread of the engagement between the die holder and the pipe holder, it will be seen that this thread must have exactly the pitch which it is desired to cut upon the pipe. At first, it might be thought that this requirement would operate to limit the use of a single machine very greatly. But upon referring to the standard specifications, it will be found that the pitch for all sizes from 1 to 2 inches inclusive, is precisely the same, namely that of 11½ threads per inch, and that beginning with 2½ inches and on up to 18 inches the pitch is uniformly that of 8 threads per inch. The provision for expanding the dies remains to be explained.

FIG. 15. THREADING A WELL PIPE

Back of each tool the die holder is pierced and a movable pin arranged in the hole. This pin receives the thrust of the die during the progress of the work. By suitably tapering the contacting surfaces of pin and chaser, the latter may be permitted to recede radially by simply pushing the pin up through the hole. In Fig. 13, these pins are represented by *B*. Their rear surfaces where they contact with the die holders are parallel with the axis of the pipe. Their forward surfaces, as also the contacting surfaces of the chasers, are tapered 1 to 32. The lower ends of these pins are arranged in holes in a ring *E*. This ring is arranged so as to be free to revolve between the flange *K* and a threaded sleeve *L*. The pins *B* have a shoulder which prevents them from passing through the holes in the ring *E*. It will be observed now that, as the die holder, together with its dies, is drawn toward the pipe holder by the operation of the levers *H*, the pins *B* will be pushed

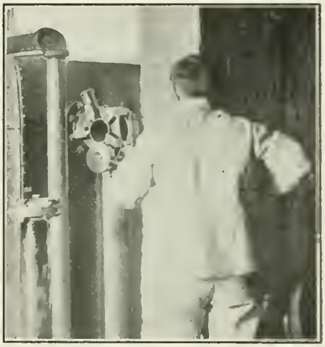


FIG. 16. IN CLOSE QUARTERS

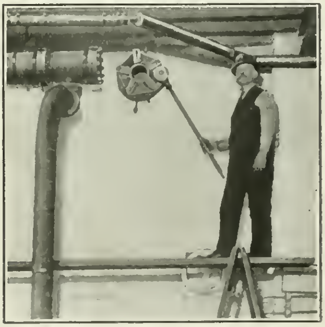


FIG. 17. THREADING A PIPE NEAR THE CEILING

upward, permitting radial recession of the chasing tools. It is not difficult to see, then, that with the pipe held in the holder *F* the operation of the die holder will carry the pins *B* and the ring *E* with it. The pins will not only revolve but project more and more above the die holder. The pressure of the pipe will cause the dies to press against the pins. The result will be that a thread will be cut of the required pitch and having the taper of 1 to 32 relative to the axis.

In Fig. 14 is an example of Toledo construction. This is a machine having a capacity of 2½ to 4 inches. There are five chasers. The sockets for operating levers are seen at either side. A further means of operating this device is through the gear and pinion. The gear constitutes part of the pipe holder. By operating the square end of the pinion by means of a ratchet handle, as in Fig. 15, the pipe holder will be revolved relatively to the die holder and the ring *E*, Fig. 13. The tapered pins, five in number, may be seen in Fig. 14, and below the dies the downward projecting tubular portion of the die holder, smooth within and threaded without.

The device is strictly portable, and the 4½- to 8-inch machine weighs but 155 pounds, while the largest size made, threading 9-, 10- and 12-inch pipe, only weighs 225 pounds. Capacities run from 1- to 12-inch pipe. It will be noticed that the narrow cutting tools are on the outside. This permits of easy lubrication and removal of chips. Apparently no power-driven machines of this type have as yet been constructed.

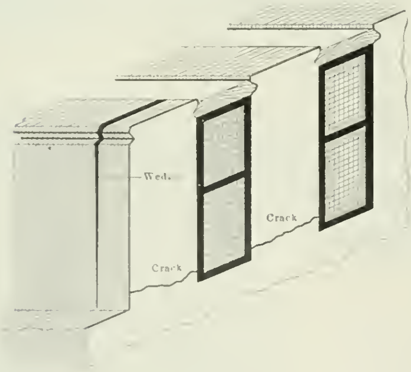


FIG. 1

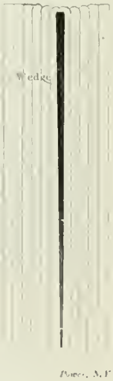


FIG. 2

If it is desired to cut a thread with a slightly larger diameter at the beginning, this may readily be done by operating the machine for a suitable number of turns before inserting the pipe. For an undersized thread, the operation is the reverse. Screw the machine onto the end of the pipe before permitting the recession of the dies to begin. This may be done by simply omitting to secure the pipe in the holder. When the required number of turns has been made, screw up the set screws to hold the pipe, when the tapering action will at once begin.

The illustrations, Figs. 15, 16 and 17, manifest very clearly the readiness with which pipe may be threaded in almost any situation. Practically any place where there is room for the machine itself will be a possible location, for the ratchet handle requires but little space for its operation.

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# Loose Armature Teeth and Field Winding Leads

By G. W. Nelson

The following experience with loose armature teeth may be of benefit to someone and save a serious burnout: Vibration of the teeth of the armature core between the coil slots caused them to break off opposite the bottom of the slots and pull out as a field magnet pole passed them, wedging them between the pole face and armature.

One afternoon, while busy in the switchroom of the power house, the helper came running in and said that there was an unusual noise in one of the generators, which was a 3500-kilowatt 2300-volt machine. He said that it sounded like "tearin' off a yard of pork." Going out to investigate, the machine "tore off another yard" for my benefit, and I noticed something fall on the floor close by me. It was a small iron pellet which proved to be a small piece of armature laminations rolled up into a compact ball.

The machine was shut down at once, the loose teeth were tightened with a hardwood wedge and the laminations bent over as shown in the sketch, to prevent the wedge working out. The wedge was made slightly narrower than the width of the tooth (between the slots), and the corners rounded to prevent injury to the insulations when driving in.

There was a fine, reddish powder, like iron rust, around the loose laminations and on close examination of the armature face two more places were found with slight indications of the same red dust and, although the laminations seemed tc be tight, very thin hardwood wedges werc driven in the teeth and the tips of thc laminations on either side slightly burrec to hold them in place, as indicated ii Figs. 1 and 2. New slot wedges wer also put in.

Except in the first instance, where som of the teeth came out, it has never bee necessary to use a wedge thicker than 1/1 to 3/32 inch. At the slightest indicatio of a "rusty spot" on the armature fac one of these wedges is put in, also slot wedges, and there has been no trouble with loose teeth.

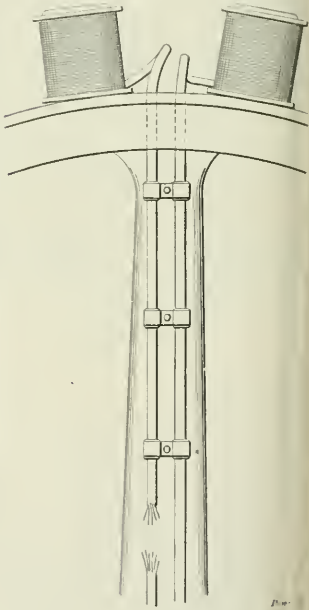

FIG. 3

In the same station a loose lead the field winding was the cause of a l out in one of the generators. The were not clamped tightly enough to vent creeping, and when the lead cre enough to push the end of the wi free from the body of the coil, as r sented in Fig. 3, all the strain was centrated on one of the soldered joi the lead close to the collecting ring. his joint gave way and the cable, whicl was of 300,000 circular mils, pulled free one clamp and was heavy enough to brea the next.

Whipping out against the armatur the loose end of the lead cut through t insulation where it first struck, short-circuiting and burning out six armature turns.

The insulation on the end connections in several other parts of the armature was also damaged.

The lead was spliced, new and heavier clamps put on and the cable was wrapped with twine below each clamp, as shown in Fig. 4, the twine being liberally painted with quick-drying armature varnish as it was wound on. These shoulders prevent any creeping of the lead.

A fiber block was bolted to the rim between the two end field coils to hold the winding in place (see Fig. 5). The studs were locked with a piece of sheet iron bolted on with the fiber and bent up against the leads, as shown in the sketch.

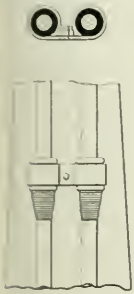

FIG. 4

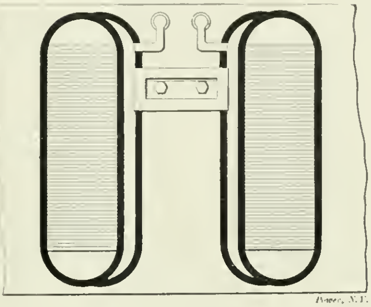

FIG. 5

After this costly experience, the leads f the other generators in the station were rengthened in the same manner.

## Heating Surface in Feed Water Heaters

By Sterling H. Bunnell

In the usual feed-water heater, as ap- to noncondensing plants, the entire aust from the main engines is passed gh the heater tubes. As the quantity at in the exhaust steam of a non- nsing engine is from ten to twenty s the quantity of heat required to heat tire amount of feed water necessary ply the boilers furnishing steam for ine, the circulation in feed heaters r such conditions is very brisk.

A technical magazine recently quoted ain tests of a closed feed-water heater illustration of the influence of velocity steam through the tubes on the terminal temperature of the water. These tests, which were published in the catalog of Ilden & Brooke, of Manchester, England, indicated that with the quantity of steam equal to one-half the weight of the water being heated, the terminal temperature of the water was raised to 190 degrees Fahrenheit. With the quantity of steam nearly reduced to that theoretically required to heat the water to the same temperature, the final temperature was 175 degrees. The weight of the steam in this case was about one-sixth the weight of the water passing through the heater in the same time.

Other figures obtained several years ago are cited, in which 24 square feet of tube surface heated 6800 pounds of water from 55 to 203 degrees, giving the equivalent of 9½ horsepower of heater capacity per square foot of tube surface, which is about three times the commercial rating of 3 horsepower per square foot, the heater in this case being arranged so that the steam passes successively over six sets of tubes, evidently giving the water a long travel on the inside of the same tubes.

It has long been recognized that the quantity of heat transmitted through metal plates is governed by no simple laws. In the engineering literature of twenty years ago were reported numerous experiments by different authorities, the results varying widely and proving nothing but that the rapidity of heat transmission depended entirely upon the flow of the heating substance to and from the heating surface.

It seems to be a fact that the time of heat transmission through metal tubes of ordinary thickness is practically zero, and that the quantity of heat transmitted depends entirely upon the speed with which particles of the substances from which and to which heat is being transmitted can be brought in contact with the surfaces and removed to make way for other particles. The reason is therefore evident for the improved heating effect of long tubes as compared with short tubes. In passing through the short tubes, as in some forms of feed-water heater, the water travels as a solid mass, the external surface alone coming in contact with the tube walls. In longer tubes, particularly if curved, the tendency is for the water to be agitated during its passage, bringing the particles in contact. This effect is very evident in the case of the double-tube condensers used in refrigerating plants, in which the outer tube confines a thin film of water in contact with the inner tube in which the gas is condensed. The rapid passage of the water through the concentric space between the tubes forces its thorough circulation, and the quick transmission of heat from the gas within to the water without the inner tube.

I have observed several times the surprising heating effect of a coiled tube as compared with a straight tube. In two or three instances, old refrigerating coils which happened to be lying around a small shop in the country were worked up into feed-water heaters for neighboring steam plants. In these cases the passage of feed water through sixty or more feet of pipe in a coil, even though the pipe was iron, produced a remarkably high terminal temperature, very close to that of the exhaust steam. The effect is better with coils of small diameter than with larger coils, for the evident reason that the water passing around the curve of small radius is more thoroughly stirred up.

Three or four years ago the Griscom-Spencer Company conducted a careful series of experiments, at first in an engineering laboratory and later in its shops, upon the transmission of heat through the tube walls of the coils of small radius used as heating surface in the Reilly multicoil feed-water heater; these coils are of copper pipe wound to a diameter of about 4 inches. It was clearly shown that the time of transmission of the heat was practically zero, that the quantity of heat that could be transmitted per square foot of surface was limited only by the impossibility of getting enough water through the tube without excessive friction to take away the heat as fast as it could be supplied to the exterior of the tube by the condensing steam; and that the amount of heat transmitted per square foot of surface of tube could be increased so enormously that a capacity of 10 to 15 horsepower per square foot could be obtained in practice.

While the heating surface of these small coils of copper tubing is thus extremely efficient, however, it seems to be not desirable to attempt to secure the maximum heating effect which is obtainable, one-quarter to one third of the maximum being considered advisable in order to leave a good margin for falling off due to slow circulation or the collection of air in heaters badly connected.

The fact is, however, that the transmission of heat through copper surfaces appears to be limited only by the condition of circulation without and within the tube, assuming the surfaces to be clean, of course.

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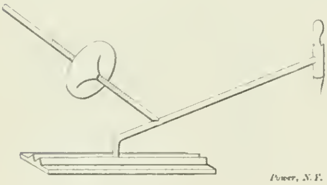
It is stated that according to the latest statistics, the total peat bogs of Sweden would be capable of producing 10,000 millions of tons of air-dried peat, suitable for fuel. This quantity, as compared with the present import of coal, would be sufficient for a period of 1500 years.

# Principle of Planimeter Operation

## Showing That the Planimeter Is a Device of Simple Construction and Its Principle of Operation Is Not at All Difficult to Understand

BY M. R. WELLS

The writer well remembers with what awe he listened to his big sister some years ago when she made her first visit home from college and had some wonderful things to tell her little brother. I was then just at the point in school where I had learned to find the area of a rectangle or square (which I thought required great skill), and consequently when she told me that there was an instrument which would read off directly the area of any figure regardless of whether it were round, square or any other shape, I nearly dropped off my chair. I imagined that it must be a machine full of all kinds of wheels and intricate mechanism and never did get over this idea until several years later when I saw the actual planimeter. I was certainly struck with its simplicity as regards looks, but in spite of that, its principle was still a mystery to me. Even when at college later on and able to give the calculus proof for the planimeter, the matter was not clear to me until one night, while lying awake, I studied the whole thing out in the dark. My course of reasoning seemed to make the matter clearer to several of the boys at college and may be of interest to some others who have perhaps used the planimeter for years and who yet would be unable to make one or tell just what was wrong with it in case it failed to give correct readings.



Power, N. Y.

FIG. 1

In starting, let us consider a planimeter similar to the one shown in Fig. 1. It will be seen that this consists of a rod or wire having a tracing point at one end while the other end is bent down and slides back and forth in a straight groove. At right angles with this first rod, is a second rod upon which is a knife-edged roller which is free to roll and also slide along the rod. Along this rod are graduations which indicate any movement of the roller along the rod and not that due to revolving. With this type of planimeter it will be seen that the diameter of the roller has nothing to do with the accuracy of the instrument.

### Area of Rectangles

Referring to Fig. 2, let line *F B* represent the tracing arm, *F G A D* the groove in which one end of the tracing arm slides, and *A B C D* the rectangle whose area is be found. The lower side of the rectangle has been taken as lying on the groove for the present in order to make the case more simple. It might be well, for the sake of any who may not have used a planimeter, to state briefly the method of using most of them. The tracing point is placed at any convenient point on the edge of the figure whose area is desired. It is quite customary to press the point hard enough into the paper to make an impression which will indicate when the entire outline has been traced. The recording disk or roller is then usually set at zero and the outline of the figure traced in a clockwise direction. When completely around, as indicated by the dropping of the tracing point into the indentation made at starting, the disk will have moved a certain distance along the rod and the graduations will show the area which this movement corresponds to. Let us follow this procedure with the rectangle, starting at a point *B* and stopping at *C*. It will be evident that the roller will have traveled along the line o2', while the mark o on the graduated scale (where the roller was started) will have traveled along the line oo', which is parallel to the line *B C*. It is thus clear that the roller will have moved two graduations along the rod in tracing from *B* to *C*.

In going from *C* to *D* the roller will move a certain distance, which does not count since there will be an equal and opposite movement in going back from *A* to *B*. In going from *D* to *A* it will be seen that the roller will simply revolve on the rod and will not move along it, since the path of the roller is parallel to the line which is being traced. In going from *A* back to *B* the movement of the roller will be equal and in the opposite direction to what it was when going from *C* to *D*. To sum up, let us see what the final position of the roller is upon the rod. Going down one of the sides was just counteracted by going up the other. Across the bottom caused no movement of the roller, hence the only permanent or final movement along the rod was caused while going across the top, and is equal to o'2'.

Now the following points may be noted,

Angle θ always equals angle φ, therefore,

$$\sin\theta = \sin\phi = \frac{o'2}{oo'}.$$

Movement of roller along rod (reading) equals

$$oo' \times \sin\phi = oo \times \sin\theta.$$

Since *F B*, the planimeter arm, is of ; constant length, *C*, the hight of the rec tangle equals

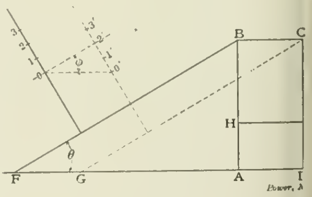
$$C \times \sin\theta,$$

and the width of rectangle *B C* equals oo

The area of the rectangle is equal t the hight times the width or, from th above,

$$Area = C \times \sin\theta \times oo.$$

This is the same as the movement of tl roller multiplied by a constant *C*, hen to find the area of any rectangle havi one side along the groove, it is only ne essary to multiply the movement of tl



Power, N

FIG. 2

roller (in other words the reading) b constant *C*. The method of determin the value of *C* will be given later.

For the second case where the fig does not rest upon the groove, take rectangle *B C I H*, In tracing from *I* *C*, as was found before, the movemen the roller will indicate the area of large rectangle *B C D A*; the moven in going from *C* to *I* will be just cour acted in going from *H* to *B* and h need not be considered; in going fro to *H* the movement will correspon the area of *H I D A*, but since tracin the opposite direction from that v recording the area of the large recta the area below the line *I H* will be b tracted, and hence the final or resu nt reading will be the difference, or the ea of *B C I H*, the figure traced.

### A Combination of Rectangles A Irregular Figures

By similar procedure, it may be s wn

that the instrument is all right for a combination of rectangles having different dimensions, as in Fig. 3. If not perfectly clear to the reader, it may be well to trace the first rectangle, starting from *A*, and then, without lifting the tracing point, go over the second, noting that the line shown dotted will be retraced and since in the opposite direction the second time might just as well not have been considered. By adding one rectangle at a time it will be clear that the instrument will properly indicate the area regardless of the number or size of the rectangles.

In Fig. 4 the area of the rectangles shown is the same as that of the irregular figure. By making the rectangles narrower and narrower, it will be seen that their combined outline can be made as close as desired to the outline of the irregular figure, hence the planimeter works equally as well on any irregular figure as on rectangles.

### How Scale is Indicated

To determine the constant *C*, previously referred to, simply assume a rectangle whose hight is equal to the length of the tracing arm and whose base rests upon the groove. In tracing across the top (and thus indicating the entire area), it is evident that the tracing arm must stand at right angles to the groove, and hence the rod upon which the roller moves will be parallel with the groove. For this reason the roller will stand still and the rod simply slide in it, or in other words, the movement of the roller with respect to the rod will equal the width of the rectangle. Now the area of the rectangle is equal to the hight times the width, or, from above, the length of the tracing arm times the movement of the roller. Hence it is evident that the graduations upon the roller rod should be such that the distance between any two fixed points or marks should equal whatever that distance represents divided by the length of the tracing arm. For instance, if the arm is 6 inches long, the distance on the scale which represents 3 square inches must be ½ inch.

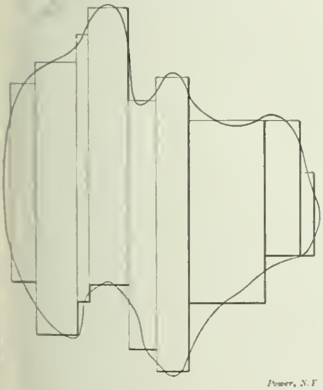


FIG. 4

### Variations in Design

The operation of this simple type of planimeter has probably been made clear to the reader, but since it is seldom used in this form, let us consider the form shown in Fig. 5. Here it may be seen that the only radical difference is in the roller position, the axis being parallel with the center line of the tracing arm instead of at right angles. Neither does it slide along the rod but rolls, the reading being shown on a scale which revolves with the roller. The edge of the roller is not sharp, as was true in the first case, and hence slips over the paper when the movement is parallel with its shaft, but rolls when the movement is at right angles. A little thought will show that a point upon the circumference of the roller will move a distance corresponding to the sliding motion of the roller in the first case.

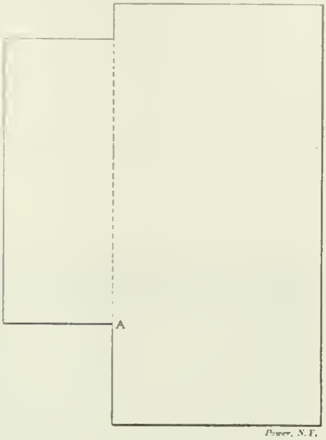


FIG. 3

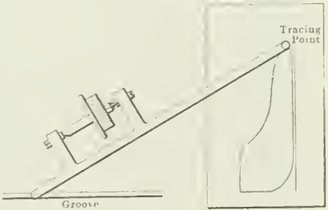


FIG. 5

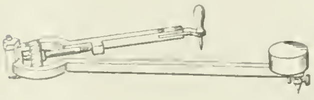


FIG. 6

By the same procedure as in finding the first constant, it will be evident that the circumference of the roller multiplied by the length of the tracing arm, must equal the area indicated by one complete revolution of the roller.

As the next step, consider the form shown in Fig. 6. The only material difference between this and the style shown in Fig. 5, is that the one end of the tracing arm follows an arc of a circle instead of the groove or straight line. Going back to the Fig. 5 type, consider the groove as being divided into several short, straight sections, as shown in Fig. 7. Dotted lines separate the irregular figure into portions, each of which can be traced while only one corresponding straight groove is being used. Tracing the figure portion by portion and remembering that the dotted lines can be neglected on account of being retraced, will show that the planimeter is correct regardless of the shape of the groove, the only essential being that the end of the tracing arm shall return over the same course it followed in going out. Thus it is plain that an arc can be used, and in many cases is more convenient than a groove.

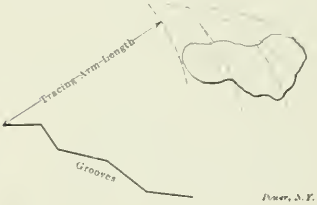


FIG. 7

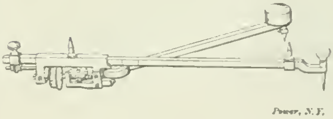


FIG. 8

For use in determining the average hight of an indicator diagram, the groove type has this advantage. By placing the card with one end resting upon the line of the groove and with the atmospheric line at right angles to it, tracing can be started from a point at the farthest end from the groove. Set the scale at zero and, instead of reading the scale after having traced the diagram, simply move the tracing point along a line parallel with the groove until the scale again reads zero. The distance necessary to bring the scale back to zero then indicates the average hight of the diagram and does away with the necessity of dividing the area of the diagram by the length, as must be done when using the instrument shown in Fig. 6.

Fig. 8 illustrates a planimeter, the length of whose tracing arm can be varied so that the instrument may be made to read directly in square centimeters, inches or feet. If, by means of the points shown, the length of the tracing arm is set equal to the length of an indicator card, the average pressure can be read directly when certain indicator springs are used. For instance, if the circumference of the roller is 2½ inches and one complete revolution indicates 100, the reading would be correct for a 40-pound spring (100 ÷ 2½ = 40). If an 80-pound or 160-pound spring has been used, it is easy to multiply the reading found by 2 or 4 as the case may be

## Automatic Engine Lubrication with Gravity Feed

By Romyn Hitchcock

For various reasons, gravity feed in marine work has not hitherto proved entirely satisfactory. Although used to some extent, it does not feed with regularity and requires considerable supervision. Depending primarily for regularity of action on a constant level of oil in the supply tank, this condition has not been realized in practice. Furthermore, the distribution of oil to the different parts has been only approximately, or somewhat erratically, controlled by various forms of feed regulator.

The Mille apparatus, invented and constructed by M. Mille, one of the chief engineers in the service of the *Campagnie Général Transatlantique,* is particularly adapted to marine use, being practically unaffected by the rolling and pitching of a vessel. It has been in constant use on the French liner "La Lorraine" during the past two years, with such satisfactory results as to attract considerable attention from engineers. The distribution of oil from a main supply tank is automatically maintained uniform for every part of an engine and subject to regulation for each part independently as may be desired. Thus, for momentary or longer demands the general supply may be instantly increased, as, for example, when the speed is increased beyond the normal rate. Or, the supply to any part of the engine may be temporarily or permanently changed by turning a milled head, without affecting the delivery to other parts. Changes in the viscosity of oil, resulting from temperature variations, lead to automatic adjustment of the rate of flow whereby proper feed continues. Or, when a different quality of oil is introduced a readjustment of the apparatus suffices to continue the lubrication regularly.

The Mille apparatus is based upon the principle that the rate of delivery of a siphon varies with the hight of level of the liquid above the opening of the short arm. This relation is maintained constant for any desired rate of flow by mounting the siphon on a float in the main oil supply tank, with means to change the vertical adjustment to increase or lessen the rate of flow. Obviously the rate of delivery is irrespective of the level of the oil in the tank. The actual rate of delivery, however, is not determined by the size of the siphon tube, but the outflow from the tube is controlled by interchangeable terminal caps or plugs having specially bored openings of suitable diameter, which are screwed on to the long end of the siphon. It is most important that these caps should be properly designed and bored, but when so constructed they insure a free and regular flow of oil. Thus the supply of oil from the feed tank is hydrostatically regulated.

On the "La Lorraine" the main supply tank is shown in Fig. 2 and in section and plan in Fig. 4. The tank *A* may have one or more floats *B* which have free vertical movement along guides *C*, as best seen in the plan. The tube *D* is attached to the float and moves easily through the fitting *E*, opening into a glass tube *F* which is protected by the metal sight tube *G*. At the top are adjusting screws, the milled head *H* serving to raise and lower the siphon by means of screw threads on the tube *I*, which is connected to the siphon *J* at the junction *K*. The short arm of the siphon is graduated above the float and an index shows how much it is raised or depressed. The open end is protected by the strainer *L*. The long arm of the siphon terminates in one of the interchangeable caps *M*. These caps are numbered to indicate their specific rates of delivery. The tube *G* is provided with a two-way cock *N*, whereby oil in the tube *F* may be directed either through the connection o directly to the principal distributing apparatus, or it may be drawn into a measuring glass through the spout *P*, to determine the actual rate of delivery. The glass tube *F* is also provided with graduations whereby, by closing the cock *N* for one minute, the hight of the oil accumulating in the tube idnicates on the scale the quantity delivered by the siphon in one hour. An air tube extends from *Q* to the top of the tank.

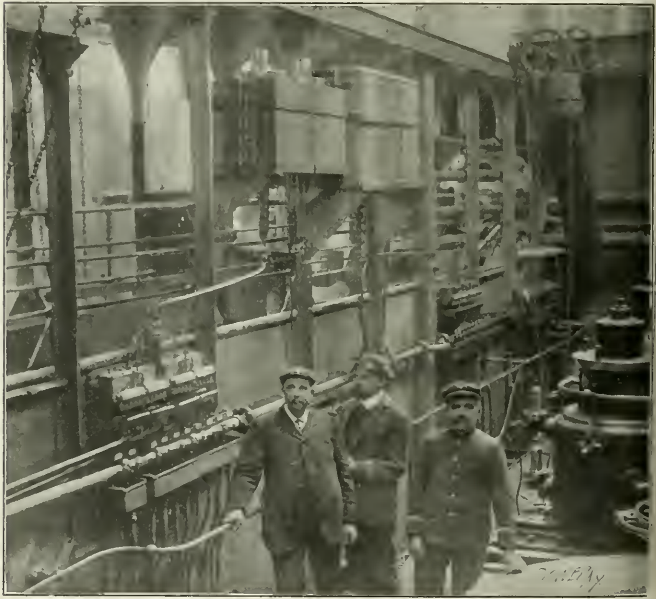


FIG. 1. GENERAL VIEW OF INSTALLATION

On the other side of the float is a device termed the valve of increase, *R*, governed by the graduated head *S*, the object of which is to supply an additional quantity of oil to the siphon when it is desired temporarily to increase the ra of flow. Other arrangements about tl tank need not be particularly describe Considerable variations of temperatu may be prevented by the use of a stea coil *T*. The tank is filled either throug *U* or *V*, and the cover *W* permits of tl easy removal of the float and of the wir gauze cylinder *X* which is covered wi flannel.

The distributor is an important fe ture of the apparatus, since upon this d pends the adjustment of the supply the different parts, the constancy of fe being insured by the automatic regulati action of the siphon of the supply tar The distributor is shown in Fig. 3, as stalled on the "Lorraine," and in det in Fig. 5. It consists of two body cha bers *A* with covers *B* bolted down, whe by the chambers are completely sealed except for the air tubes C which are open above. The glass tube D of large diameter is protected by the metal tube E which is secured to the flange F, while the cover G carries a gauze cylinder H.

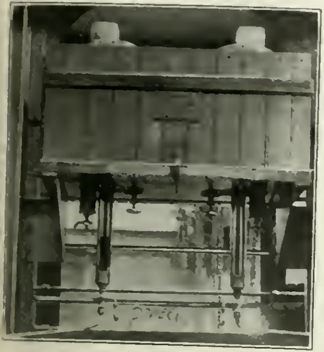


FIG. 2. MAIN OIL TANK

il from the float siphon is received gh the cock I and enters the cham- A through the tube D.

m the distributor to each part of ngine the rate of delivery of oil is lated by siphons fixed in position, leading from each chamber, the prin- e f action here being that the de- l ry of a siphon is uniform at constant tn erature, when the level of the liquid i c nstant. Since the flow of the feed t k siphon is constant, and at a rate pre- ermined to exactly correspond to the t al oil consumption, it is obvious that t condition of constant level in the dis- t utor is maintained. The two siphons J are attached to the covers K, their rt arms plunging into the oil and be- i inclosed within strainers L, the long branches terminating in the closed troughs M. The siphons may be opened and closed by means of valves N. When the apparatus is first charged, air is allowed to escape through the plug openings O.

As in the case of the main feed siphon, the specific rate of delivery of oil to different parts of the engine is determined by delivery plugs, or caps, with definitely determined openings. The delivery tubes P are screw-threaded to receive the bored caps Q. From these the oil is carried to the different parts, as shown in Figs. 1 and 3. At the lower part of Fig. 3 are shown the remaining parts of the apparatus formerly used, with needle-valve regulators. In some cases the oil passes to secondary distributors which are of virtually the same construction as the primary apparatus.

In practice the level of the oil in the distributor may not be quite constant; but changes of level, due to variations in temperature, viscosity of oil, etc., are self-corrective. In further explanation of the practical working of the apparatus, the proportions of the regulating plugs or caps should be considered, and the possible range of adjustments.

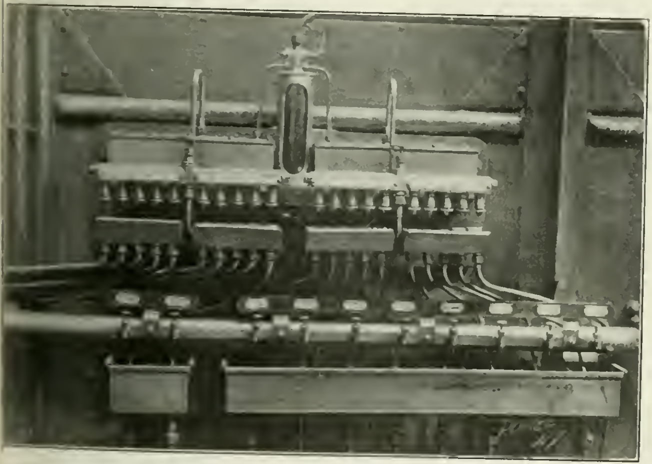


FIG. 3. PRINCIPAL DISTRIBUTOR

Consider first the float siphon. The series of delivery plugs provided is numbered 1 to 10, and corresponds to the delivery of 1 to 10 kilograms of oil an hour. Now the rate of delivery of the siphon may be changed, at constant temperature, in the ratio of 1 to 2, while the head of the valve of increase, S in Fig. 4, is so graduated that each division corresponds to a known rate of feed. By these two adjustments the rate of delivery can be made to meet any conditions, and the actual rate may be determined by either of the two methods already described. On the "Lorraine" the temperature remains practically constant at 40 degrees Centigrade and the heating coil is not much used, except at the time of filling the tank.

The delivery plugs of the distributor are numbered 1 to 22 for each terminal. These correspond to deliveries of 25, 50, 75, 100, 150, 200 and up to 1000 grams an hour. If the total quantity of oil required for the engine at normal speed is known, the float siphon is adjusted to deliver that amount. The different distribution plugs being chosen properly to feed the various parts, it is only necessary to add together the amounts delivered by all the plugs, as shown by the numbers stamped upon them, to know the necessary delivery of the float siphon. The required rate of flow may then be obtained by actual measure of the rate of delivery of the float siphon in the manner indicated.

Some may be inclined to ask whether in practice the desired regularity can be attained. Experience has shown that the apparatus really does meet with the requirements of practical service. The normal level of oil in the distributor at the mean temperature of the engine room, 30 degrees Centigrade, corresponding to the rate of delivery indicated by the numbers on the plugs, is about the middle of the tube D in Fig. 5. The delivery

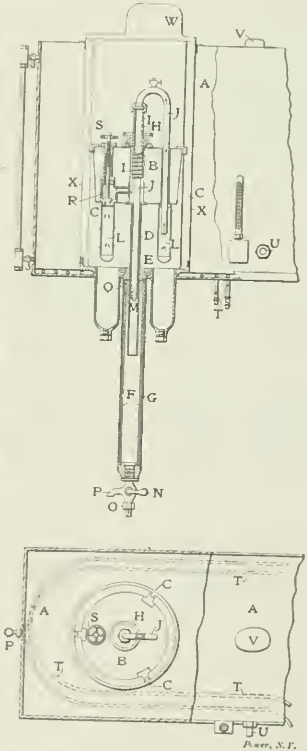


FIG. 4. PLAN AND VERTICAL SECTION OF MAIN SUPPLY TANK

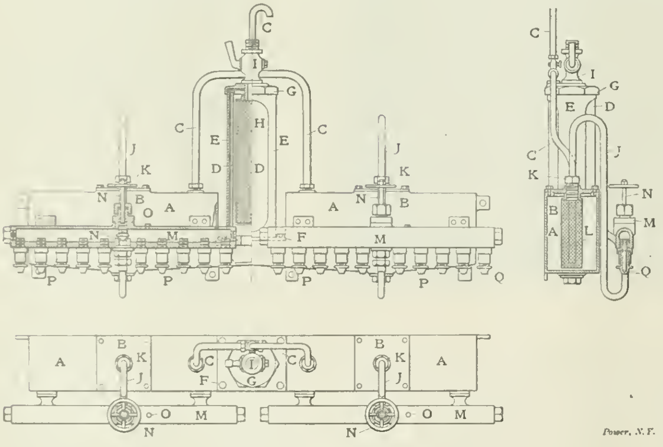
of the plugs varies at constant temperature in the relation of 1 to 3, according to whether the oil level is at the bottom or top of the tube. Such wide latitude of variation permits all exigencies to be met, not only such as changes of speed, or of quality of oil, but of abnormal functioning of parts.

The fact is that the level of the oil in the distributor automatically changes according to the viscosity of the oil and differences of temperature, for, the feed being uniform, if the temperature in the distributor rises, whereby the viscosity of the oil decreases, the oil flows away more freely through the regulating plugs, consequently the level in tube *D* is lowered until a point is reached at which the decrease in head corrects the excessive rate of flow; so also with reversed conditions.

Charging of the apparatus in the first place is a simple operation, after which it is always ready for use. In starting give a turn, if necessary, to the plugs *Q* in Fig. 5, open the oil cock *I* and valves *N*. The plugs *Q* would be closed only for a prolonged stop. The general lubrication may be increased at any time, as at starting, without disturbing the adjustments at the distributor, by any means that will raise the level of the oil in the distributor. This may be done by turning the milled head *H*, in Fig. 4, thus lowering the float siphon, or by opening the valve of increase *R*. When the engine is running regularly the siphon is returned to the normal position or the valve of increase closed. When the speed of running is increased the same procedure follows, and the proportionate feed to the different parts is not thereby changed.

The most important feature of the system is that it permits the delivery of the quantities of oil required by the different parts in a perfectly regular manner under all conditions of working. Considerable economy in the consumption of oil has been commercially shown. On the "Lorraine" the chief engineer has made systematic records of the Mille apparatus in comparison with the method heretofore used, and the saving of oil during a round trip of about fourteen days was 505.8 kilograms, or approximately 12 per cent. of the total oil used. This comparison was made with a most efficient competitive apparatus, and it is said that the actual saving will ordinarily vary between 15 and 30 per cent. in oil consumption alone, while the service of supervision is materially decreased, owing to the centralized and easily managed control of the rate of delivery.

This apparatus is protected by patents in a number of foreign countries and in the United States.



Power, N. Y.

FIG. 5. DISTRIBUTOR IN PLAN AND ELEVATION

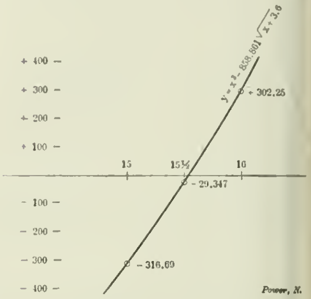
## Diameter of Steam Headers

By Franz J. Denk

The table on page 397 gives the size of steam headers for horsepowers ranging from 100 to 10,000, for velocities from 4000 to 8000 feet per minute and for boiler pressures from 125 to 300 pounds per square inch. Usually the velocity of saturated steam is not higher than 6000 feet per minute for reciprocating engines, but when the steam has a steady flow through the line, as in the case of a turbine, or when used for boiling or heating purposes, as in a rubber factory, the velocity of the steam may be increased considerably and become as high as 8000 feet per minute. This is the reason that in the accompanying table steam velocities of 7000 and 8000 feet per minute are taken into consideration.

The computation of the size of the steam headers is based on the following reasoning:

As the largest boilers made are rarel over 750 horsepower, a battery of boiler is necessary to develop any greate amount. Smaller pipes lead from eacl boiler into one main header, and in computing the sizes of these headers th friction of the steam upon the sides of th pipe must be considered; therefore th diameters of the headers given in the tabl are smaller than they would be, when th computation is based on equal areas. . a unit a boiler developing 600 horsepow is taken.



Power, N.

DETERMINING INSIDE DIAMETER

In the Babcock & Wilcox book "Stea it is stated on page 101, that the ratio flow under similar conditions is found dividing some power of the diameter the diameter increased by a constant,

$$W \propto \frac{d^3}{\sqrt{d + 3.6}}.$$

This gives the formula,

$$d^3 = C \sqrt{d + 3.6}$$

for the actual inside diameter of the st header. The value of $C$ is,

$$\frac{d_1^3}{\sqrt{d_1 + 3.6}} \times \frac{V}{V_1},$$

where

$d_1$ = Actual inside diameter of boiler branch in inches,

$V_1$ = Volume of steam delivered one boiler,

$V$ = Volume of steam delivered by the set of boilers.

Suppose there are 12 boilers develo 600 horsepower each, with steam of pounds pressure and 6000 feet velo The size of one boiler branch does need to be more than 6 inches. There

$$d_1 = 6.06$$

$$\frac{V}{V_1} = \frac{12\ V_1}{V_1} = 12\ x$$

$$C = \frac{6.06^3}{\sqrt{9.66}} \times 12 = 858.861$$

Substituting this value for $C$ in the ua-tion gives,

$$d^3 = 858.861 \sqrt{d + 3.6}$$

or

$$d^3 - 858.861 \sqrt{d + 3.6} = 0.$$

DIAMETER OF STEAMHEADERS FOR DIFFERENT HORSEPOWERS, PRESSURES AND VELOCITIES.

FIGURED FOR SATURATED STEAM AND STANDARD PIPE.

| Velocity Ft. p'r Min. | Press. Lb. per Sq. In. | Horsepower. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 100 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1,000 | 1,100 | 1,200 | 1,300 | 1,400 | 1,500 | 1,600 | 1,700 | 1,800 | 1,900 | 2,000 | 2,500 | 3,000 | 3,500 | 4,000 | 4,500 | 5,000 | 5,500 | 6,000 | 6,500 | 7,000 | 7,500 | 8,000 | 8,500 | 9,000 | 9,500 | 10,000 |
| 4000 | 125 | 3 | 4½ | 5 | 6 | 7 | 8 | 8 | 9 | 9 | 10 | 10 | 10 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 14 | 15 | 15 | 16 | 18 | 18 | 20 | 20 | 20 | 20 | 20 | 22 | 22 | 22 | 22 |
| | 150 | 3 | 4 | 5 | 6 | 6 | 7 | 8 | 8 | 9 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 12 | 12 | 12 | 12 | 12 | 14 | 14 | 15 | 15 | 16 | 16 | 18 | 18 | 18 | 18 | 18 | 18 | 20 | 20 | 20 |
| | 175 | 3 | 4 | 4½ | 5 | 6 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 9 | 10 | 10 | 10 | 10 | 12 | 12 | 12 | 12 | 12 | 14 | 14 | 14 | 15 | 15 | 16 | 16 | 16 | 18 | 18 | 18 | 20 | 20 | 20 |
| | 200 | 2½ | 3½ | 4½ | 5 | 6 | 6 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 9 | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 12 | 12 | 14 | 14 | 14 | 14 | 15 | 15 | 16 | 16 | 16 | 18 | 18 | 18 | 18 |
| | 250 | 2½ | 3 | 4 | 4½ | 5 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 9 | 9 | 9 | 9 | 10 | 10 | 12 | 12 | 12 | 12 | 14 | 14 | 14 | 14 | 14 | 15 | 15 | 15 | 16 | 16 |
| | 300 | 2 | 3 | 3½ | 4 | 4½ | 5 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 9 | 10 | 10 | 12 | 12 | 12 | 12 | 12 | 12 | 14 | 14 | 14 | 14 | 14 | 15 | 15 |
| 5000 | 125 | 3 | 4 | 4½ | 6 | 6 | 7 | 7 | 8 | 8 | 9 | 9 | 10 | 10 | 10 | 10 | 10 | 12 | 12 | 12 | 12 | 12 | 14 | 14 | 14 | 14 | 15 | 15 | 16 | 16 | 18 | 18 | 20 | 20 | 20 | 22 | 22 |
| | 150 | 2½ | 3½ | 4½ | 5 | 6 | 6 | 7 | 7 | 8 | 8 | 8 | 8 | 9 | 9 | 10 | 10 | 10 | 10 | 12 | 12 | 12 | 12 | 12 | 14 | 14 | 14 | 14 | 15 | 15 | 16 | 16 | 16 | 16 | 18 | 18 | 18 |
| | 175 | 2½ | 3½ | 4 | 5 | 6 | 6 | 6 | 7 | 7 | 8 | 8 | 8 | 8 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 10 | 12 | 12 | 12 | 14 | 14 | 14 | 14 | 15 | 15 | 16 | 16 | 16 | 18 | 18 | 18 |
| | 200 | 2½ | 3 | 4 | 4½ | 5 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 9 | 9 | 9 | 9 | 10 | 10 | 12 | 12 | 12 | 12 | 14 | 14 | 14 | 14 | 14 | 15 | 15 | 16 | 16 | 18 |
| | 250 | 2 | 3 | 3½ | 4 | 4½ | 5 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 9 | 9 | 10 | 10 | 10 | 12 | 12 | 12 | 12 | 14 | 14 | 14 | 14 | 14 | 15 | 15 | 15 |
| | 300 | 2 | 3 | 3½ | 4 | 4 | 4½ | 5 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 9 | 10 | 10 | 12 | 12 | 12 | 12 | 12 | 12 | 14 | 14 | 14 | 14 | 14 |
| 6000 | 125 | 2½ | 3½ | 4½ | 5 | 6 | 6 | 7 | 7 | 8 | 8 | 8 | 8 | 9 | 9 | 10 | 10 | 10 | 10 | 12 | 12 | 12 | 12 | 12 | 14 | 14 | 14 | 15 | 16 | 16 | 16 | 16 | 18 | 18 | 20 | 20 | 20 |
| | 150 | 2½ | 3½ | 4 | 4½ | 5 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 9 | 9 | 10 | 10 | 10 | 10 | 12 | 12 | 12 | 12 | 14 | 14 | 14 | 14 | 15 | 15 | 15 | 15 | 16 | 16 | 18 |
| | 175 | 2 | 3 | 4 | 4½ | 5 | 5 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 12 | 12 | 12 | 12 | 14 | 14 | 14 | 14 | 15 | 15 | 15 | 15 | 16 |
| | 200 | 2 | 3 | 3½ | 4 | 4½ | 5 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 9 | 10 | 10 | 10 | 12 | 12 | 12 | 12 | 14 | 14 | 14 | 14 | 14 | 15 | 15 | 15 |
| | 250 | 2 | 2½ | 3 | 3½ | 4 | 4½ | 4½ | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 9 | 9 | 10 | 10 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 14 | 14 | 14 |
| | 300 | 1½ | 2½ | 3 | 3½ | 4 | 4 | 4½ | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 9 | 9 | 10 | 10 | 12 | 12 | 12 | 12 | 12 | 12 | 14 | 14 | 14 |
| 7000 | 125 | 2 | 3 | 3½ | 4½ | 5 | 5 | 6 | 6 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 9 | 9 | 10 | 10 | 10 | 12 | 12 | 12 | 14 | 14 | 14 | 14 | 14 | 15 | 15 | 15 | 16 | 16 |
| | 150 | 2 | 3 | 3½ | 4 | 4½ | 5 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 9 | 10 | 10 | 10 | 12 | 12 | 12 | 12 | 14 | 14 | 14 | 14 | 14 | 15 | 15 | 16 | 16 |
| | 175 | 2 | 3 | 3½ | 4 | 4½ | 4½ | 5 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 9 | 9 | 10 | 10 | 10 | 12 | 12 | 12 | 12 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| | 200 | 2 | 2½ | 3 | 3½ | 4 | 4½ | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 9 | 9 | 9 | 10 | 10 | 10 | 12 | 12 | 12 | 12 | 12 | 12 | 14 | 14 | 14 |
| | 250 | 1½ | 2½ | 3 | 3½ | 3½ | 4 | 4½ | 4½ | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 9 | 9 | 9 | 9 | 10 | 10 | 10 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| | 300 | 1½ | 2 | 2½ | 3 | 3½ | 3½ | 4 | 4½ | 4½ | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 12 | 12 | 12 |
| 8000 | 125 | 2 | 3 | 3½ | 4 | 4½ | 5 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 9 | 10 | 10 | 10 | 12 | 12 | 12 | 12 | 14 | 14 | 14 | 14 | 14 | 14 | 15 | 15 |
| | 150 | 2 | 3 | 3½ | 4 | 4½ | 5 | 5 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 8 | 8 | 9 | 9 | 10 | 10 | 10 | 12 | 12 | 12 | 12 | 12 | 14 | 14 | 14 | 14 | 14 | 14 |
| | 175 | 2 | 2½ | 3 | 3½ | 4 | 4½ | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | 7 | 8 | 8 | 9 | 9 | 10 | 10 | 10 | 10 | 12 | 12 | 12 | 12 | 12 | 14 | 14 | 14 |
| | 200 | 1½ | 2½ | 3 | 3½ | 4 | 4 | 4½ | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 8 | 8 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 12 | 12 | 12 | 12 | 12 | 12 |
| | 250 | 1½ | 2½ | 3 | 3 | 3½ | 4 | 4 | 4½ | 4½ | 5 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 8 | 8 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 10 | 12 | 12 | 12 |
| | 300 | 1½ | 2 | 2½ | 3 | 3½ | 3½ | 4 | 4 | 4½ | 4½ | 5 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 8 | 8 | 8 | 9 | 9 | 9 | 9 | 9 | 9 | 10 | 10 | 12 | 12 |

Substituting $x$ for $d$ and considering the whole equation to be a function of $x$, we have when $f(x) = y$.

$$x^3 - 858.861 \sqrt{x + 3.6} = f(x) = y$$

Assuming different values for $x$ and figuring out $y$, a curve can be plotted as shown in the accompanying sketch.

$x = 16$ $y = + 302.25$
$x = 15.5$ $y = - 29.347$
$x = 15$ $y = - 316.69$

The value of $x$ for which $y$ will equal zero, is the inside diameter of the header. In the present case $x = 15\frac{9}{16} = d$. The next higher commercial size of pipe is 16 inches inside diameter, which is shown in the table.

Up to and including 800 horsepower the table may be used to determine the size of the boiler branch necessary to convey steam of a given velocity, pressure and horsepower. The diameter of these branches is figured with the following formula:

$$A = \frac{Q}{V} = \frac{82.8 \times H.P. \times f}{V},$$

where

$A$ = Area of pipe in square inches,
$Q$ = Quantity of steam,
$f$ = Volume of one pound of steam at boiler pressure in cubic feet,
$V$ = Velocity of steam in feet per minute,
$H.P.$ = Evaporation of 34½ pounds of water from and at 212 degrees Fahrenheit per hour.

It should always be kept in mind that the table gives the smallest size of steam headers, sizes just large enough to carry steam with the specified properties. It is left to the judgment of the designing engineer to increase this diameter, if necessary, that is, in case the header shall be used as a receiver.

*Example*—What is the diameter of a live-steam header which has to convey steam from a set of boilers developing 6000 horsepower at 125 pounds gage pressure, velocity of steam 6000 feet per minute?

Locate the column headed by 6000 horsepower; then follow the horizontal line opposite 125 pounds pressure at 6000 feet velocity to the column under 6000 horsepower and find 16 inches, the size of the steam header.

Assuming 10 boilers at 600 horsepower each, the table shows at the same time, proceeding as above, that the diameter of each boiler branch does not need to be more than 6 inches.

Generally boilermakers furnish larger outlets on the boilers than necessary (in this case 10 inches), but this does not affect the size of the header, which is figured for the actual size necessary, as in a pipe with a diameter larger than necessary the velocity of the steam is low. After entering the properly sized header, the steam will flow with its specified velocity.

# Lubricators and Lubricatio

## Interesting Discussion of These Features of Steam and Gas Engine Work, with Descriptions of Several Leading Types of Lubricator

### BY W. H. WAKEMAN

Fig. 1 illustrates one of the best sight-feed single-connection lubricators in use at the present time. A small brass pipe is connected into the main outlet just above the steam chest cover, then curves upward, where a union is provided, after which a still smaller pipe in the form of a graceful right-angle bend supplies a connection into the vertical condenser containing a head of water for floating oil through the sight-feed glass into the steam chest. The union in this case is made by inserting a small pipe into a larger one as shown, then a stuffing-box nut filled with suitable packing is screwed onto the larger pipe, the same as if it were on a valve stem. The only trouble with such unions, as they are furnished for this service, is that the smaller pipe is too short, hence the piping is never straight at this point, because one part does not enter the other far enough to secure a stiff joint.

Single-connection lubricators when placed on pumps as illustrated are not always satisfactory in appearance for the following reasons: Pressure in the steam chest varies greatly, and as these variations are communicated directly to the oil, the drops feed irregularly and frequently stick to the glass. Water is sucked out of the condenser, air collects in the highest part of the piping and oil fills the sight-feed glass. A remedy for the three latter objectionable features is secured by shutting all valves on the lubricator before the throttle valve is closed, when the pump is to be shut down, and by not starting the lubricator until after the pump is in full operation again.

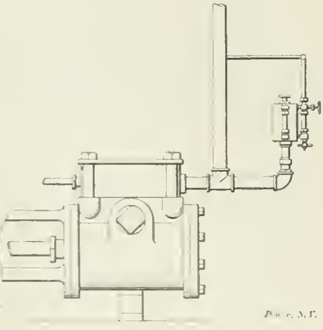


FIG. 2

Another objection to this arrangement is that the lubricator is heated to a high temperature by radiation from the steam-chest cover and other parts. While this may do no special harm to the machinery, still it results in burned fingers and blistered hands, unless special care is taken to prevent it. As a general rule, it is necessary to tighten the filling plug of a lubricator so located with a small wrench, after the body is filled with oil, to prevent leakage, but when the same lubricator is placed where there is less heat, the plug may be easily tightened by hand. When a few drops of oil escape from a lubricator located as shown in Fig. 1 and fall on the steam-chest cover, they boil like molasses, which is another unpleasant feature.

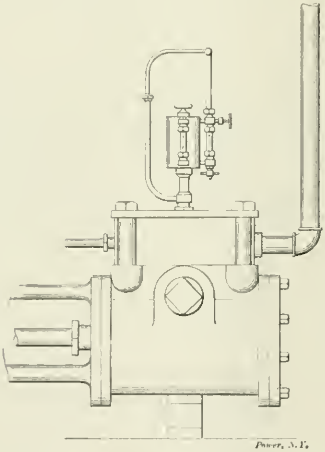


FIG. 1

Fig. 2 illustrates the lubricator shown in Fig. 1 after it had been changed by a very simple process to require two connections instead of one. The curved pipe which formerly supplied steam to be changed to water in the condenser was removed and the bottom hole plugged by driving a piece of brass rod into it. A straight horizontal pipe now connects the main steam pipe and the condenser, and no other changes were made in the lubricator. The main steam pipe is now fitted with a tee instead of an ell, in order to receive a nipple with an ell to support the lubricator and convey oil into the swiftly flowing steam.

The advantages of this arrangement are as follows: It is much more convenie to remove the filling plug before t body is filled with oil, also to replace after filling, because there is one less pi in the way. When this plug is screw on by hand it makes a tight joint, becau the whole device remains cooler, or, other words, there is less variation the temperature. If a few drops of escape, they will fall on the cold foun tion, and are easily wiped off, leaving steam-chest cover neat and clean.

In this case all outlets of the tee of equal size, therefore the horizontal ple and the ell which supports the lul cator are as large as the steam pipe. bushing is used in the ell to provid suitable connection at this point. condenser connection is made by tap a hole into the steam pipe, without us a tee.

Fig. 3 shows improvements over preceding illustrations as follows: A ducing tee is used in the steam pipe, affording a smaller outlet to attach horizontal nipple through which oi delivered into the main pipe. A redu ell is put on the end of this nipple which the lubricator is screwed wit a bushing. This is desirable because use of a bushing in an ell usually re in the production of an angle in the pi that is either more or less than 90 de hence is not satisfactory. This is imperfect workmanship on the thre bushings.

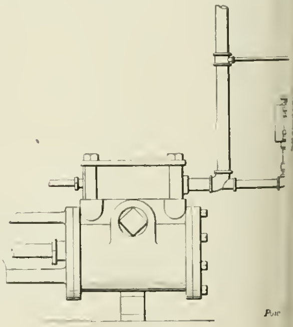


FIG. 3

The condenser connection is attached to the steam pipe by means of a te with a small outlet, thus holding by abou three times as many threads as when wa tapped directly into the pipe.

The result of my experience is t

though a force-feed oil pump is easier to fill than a lubricator, the latter gives better service when lubricating the steam cylinders of a duplex pump. While much water is used, the oil pump feeds satisfactorily, but when only a small quantity is required, giving the slide valves a slow motion, they do not get enough oil to lubricate them properly, hence they grate on their seats, and do not move easily. The rate of feed from a lubricator is not determined by the speed of the pump, hence when it runs slowly it receives practically the same amount of oil, and it is needed as badly then as when the speed is much greater.

The preceding illustrations show lubricators attached below the throttle valve, but in Fig. 4 oil is delivered into the steam pipe above this valve, hence its internal parts are thoroughly lubricated. All openings in the tee used are the same size. Two bushings are used to reduce the side outlet to a suitable size, the

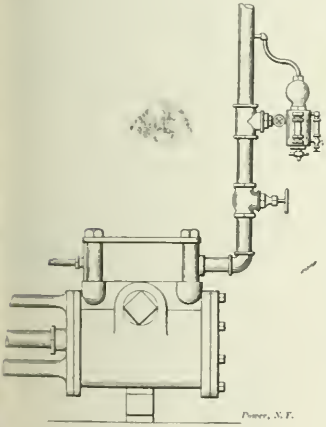


FIG. 4

atural result of which is that the lubriator does not stand plumb, owing to e fact that the inside and outside threads re not parallel. Of course the liability i securing an unsatisfactory job is u led by using two bushings instead of it presents an inferior appearance, there are more joints to make and p tight than are required when a ing tee with a side outlet for ½-inch is used. As a general rule it is not lt to secure such a tee, hence there no good reason why it should not be ed.

he curved condenser pipe is intended be artistic, but if straight it would real- appear to much better advantage.

Fig. 5 illustrates a single-connection bricator which can be attached to a orizontal steam pipe with little trouble. will work well in some cases, but in thers the sight-feed glass will fill with il and the whole operation prove unsatfactory for this service.

Fig. 6 shows a much better arrangement, as there are two connections which are entirely separate, with practically the same lubricator. In both of these cases there ought to be a valve in the main connection to shut off the lubricator at pleasure.

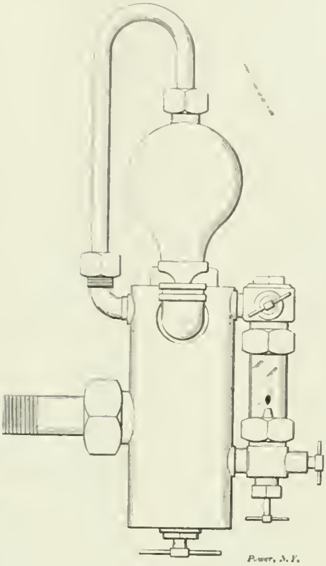


FIG. 5

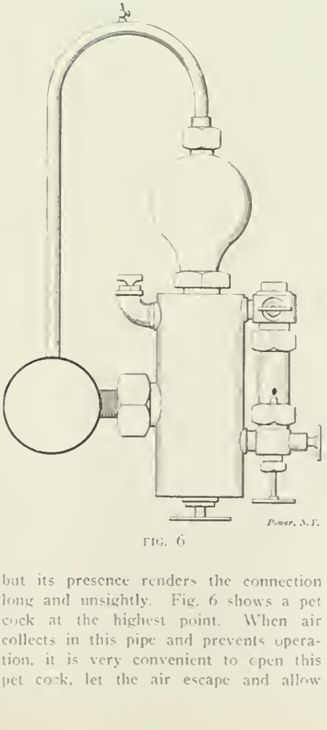


FIG. 6

but its presence renders the connection long and unsightly. Fig. 6 shows a pet cock at the highest point. When air collects in this pipe and prevents operation, it is very convenient to open this pet cock, let the air escape and allow steam to come in and condense to operate the hydrostatic feature.

Fig. 7 illustrates the internal parts of an ordinary lubricator. When all of the oil is floated out, the valves *A*, *B* and *C* are closed, the pet cock *D* is opened to let water escape, and the filling plug *E* is taken out to admit air. It is a good idea to hang a tin pail on *D* to catch the water, but some engineers simply open the pet cock and let all the water and whatever oil may be left run out on the engine-room floor, which is positive proof that their education along neat and clean lines has been sadly neglected.

Having closed *D*, oil is poured in at *E* until the body is practically full, when the filling plug is replaced, then *C* is opened and as there is a small space in the body that is not full of oil, water comes down from the condenser and fills it, after which *B* and *A* are opened in the order named,

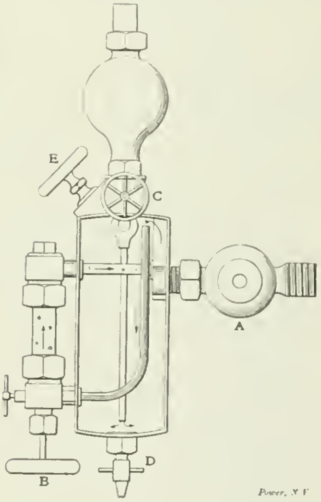


FIG. 7

and the lubricator is soon at work again, without disturbing the condition of the sight-feed glass. Why do we frequently find the sight-feed glass on a lubricator filled with oil and dirty water immediately after the body has been filled? Simply because the aforementioned plan is not carried out in detail. For illustration, engineers frequently open *A* as soon as they have filled the lubricator, and then open *B*, consequently the oil and water are forced backward, in the opposite direction from that indicated by the arrows, all pure water goes out of the sight-feed glass, and it is filled with a mixture that is far from transparent. If the lubricator is completely filled with oil, either valve may be opened first without annoying results, but if not (which is frequently the case), it makes a difference, as explained.

Fig. 8 illustrates a lubricator, the design of which is very simple and easily understood. Condensed steam is fed into the bottom of the body and as oil is lighter than water, it rises to the surface, goes out through the small pipe containing a double bend, rises through the sight-feed glass and is delivered to the center of the main steam pipe, where it is quickly atomized, saturates the steam and lubricates all internal parts. When oil is poured into this lubricator it goes directly into the body, hence if it is very thick in cold weather, it can be handled without inconvenience.

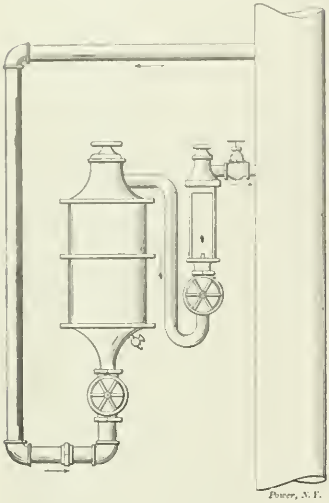


FIG. 8

However, when an oil becomes thick under these conditions, it may not be proof of superior lubricating qualities, but only show that its cold test is not very low. Another oil that does not become so thick may be more suitable for severe conditions. The claim has been advanced, and is apparently still believed in some quarters, that it is not more difficult to lubricate one engine than another, as they are all alike in this respect, but this is not true, because all are not built from the same plan, hence an oil that is excellent for one may be of little value for another.

The following incident illustrates this point: The valves of a certain Corliss engine were not thoroughly lubricated, although one of the best brands of cylinder oil in the market was supplied by a good sight-feed lubricator. Investigation of the matter showed that this engine used steam at about 70 pounds pressure without superheat. A very heavy brand of mineral oil was used in the steam chest and cylinder, hence it was not atomized, but went into the steam pipe and came out of the exhaust pipe without doing the work for which it was purchased. Instead of spreading under the valves it was probably pushed before them without cleaving to the polished seats and thus keeping the two metal surfaces apart. An old-fashioned engineer once described the process of lubrication by saying that when a good oil is used in a suitable place, it supplies thousands of very small round balls, which operate in a similar manner to the modern ball bearing. When the oil is fresh and in good order, these balls are perfectly round, but they wear out of proper shape as the oil is used many times over, until finally they become too flat to roll properly, and then the oil is worn out and ought to be thrown away.

Fig. 9 illustrates a sight-feed lubricator of unique design, but it proves very simple and easily understood in practice. Water resulting from the condensation of steam comes from the highest connection to the steam pipe, and passes through the curved tube directly into the lower part of the body of the lubricator, entering the right-hand connection. It floats oil out through the sight-feed glass and thence by way of the curved tube into the steam pipe, as indicated by arrows. When the lubricator is to be refilled, water which has accumulated is drawn off through the lower left-hand connection.

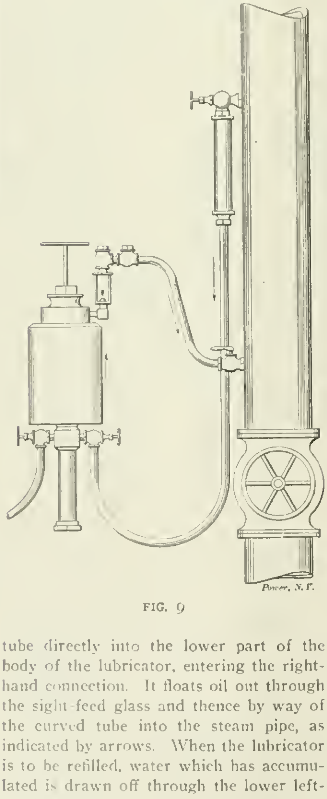


FIG. 9

Fig. 10 illustrates another lubricator that is devoid of all complication. Water coming down through the left-hand pipe is delivered directly into the body, where it displaces an equal quantity of oil, which passes up through the sight feed, and thence by the right-hand pipe into the steam pipe.

This sight feed is not a glass tube filled with water in some cases, or with glycerin in others, in order to give small drops and keep the glass clean, but is a glass disk set directly in front of the oil tube. Behind this tube a brass nickel-plated surface forms a bright background, hence when a drop of oil is formed on the sight feed and then slowly passes between the glass disk and this bright sur face, it can be seen plainly, and the rate o feed adjusted to meet existing conditions The first manufacturer who advertise this style of sight feed extensively claime that the rate of delivery could be deter mined at a distance of 50 feet. This is no impossible, but the background must b bright and clean, the oil a dark color t afford a suitable contrast, and the whol device located in a light place to make thi possible.

One reason why this kind of sight fee was never popular among engineers w because the lubricators to which it w attached (or at least a large majority them) were not fitted with a gage gla to indicate the quantity of oil left in tl body, therefore whenever a lubricator w mentioned which was known to have tl kind of a sight feed, it was not expect to have a gage glass, thus forming t objections to it. Of course a gage gla would be supplied at extra cost, if order but this formed an objection in the st mation of the steam-plant owner, he t was satisfactory to neither party ter-ested. Every lubricator should be ted with a gage glass, thus putting the all on an equal basis so far as this pc t is concerned.

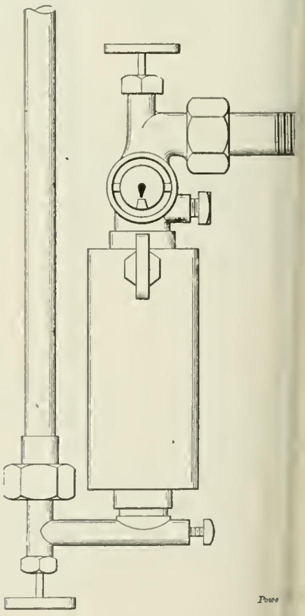


FIG. 10

As a general rule, both connectio for a lubricator should be made abov the throttle valve in order to secure equal pressure on all parts, but there may be special conditions which make it more convenient to connect one above and the other below it. It is possible to do this with almost every kind of a lubricator, but if not specially designed for this service they are a constant source of care and attention, for if the throttle valve is closed before the oil feed is shut off, no pressure will act on the condenser, and there will be little or no pressure on the delivery pipe. The effect of this depends on the conditions existing before the throttle valve was closed. If an automatic engine is used, the pressure will be the same on both connections, and the oil feed valve will be set with a comparatively large opening, consequently when the throttle valve is closed, the difference in pressure on the two connections will be great, hence the lubricator will be emptied in a few seconds, and while the oil goes into the engine it is practically wasted because it cannot be used to good advantage.

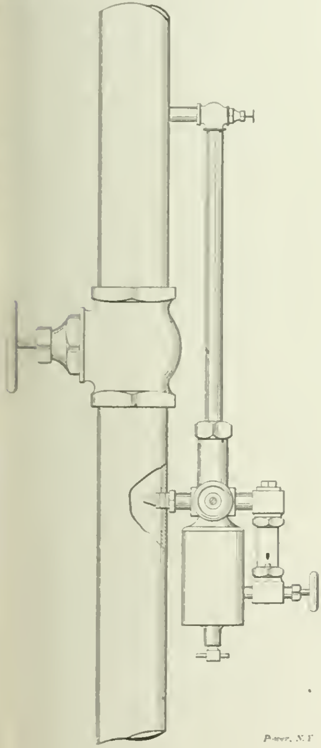


FIG. 11

If a throttling engine is used and the delivery connection is made above the governor, the aforementioned results may be expected, but if oil is delivered below the governor and the engine carries a light load, there will be much difference in pressure on the two connections while the engine is running, therefore the oil feed valve will be given only a small opening. Closing the throttle valve now only slightly increases the difference in pressure, consequently the oil feed is increased to a limited extent, but not so much as in the preceding case. The same results will be secured in the case of a direct-acting steam pump.

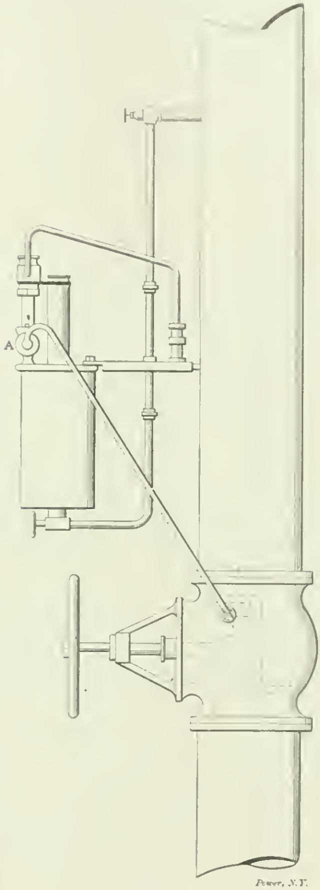


FIG. 12

Fig. 11 illustrates a lubricator designed for this service in which the delivery pipe is fitted with a reducing nozzle that prevents too rapid discharge of oil when the throttle valve is closed.

Fig. 12 illustrates a device that was designed to prevent waste of oil by shutting off the feed automatically when the throttle valve is closed. The highest connection into the steam pipe is for the purpose of supplying steam to the condenser in the usual way. When this is turned into water it is delivered directly into the lower part of the lubricator, and every drop so delivered displaces a drop of oil, which is floated out through a sight feed directly above the body. Passing through the upper bent pipe which pitches toward the steam pipe, the oil is delivered into the current of steam. Another bent pipe is attached to the oil-feed pipe at *A*, the other end of which is tapped into the throttle valve on the delivery side of the disk, as illustrated by the dotted lines. As long as the throttle valve is open, pressure is on all pipes shown, and the lubricator delivers oil in the usual way, but as soon as the throttle valve is closed, all pressure is removed from the small pipe and pressure in the lubricator closes a check valve at *A* and automatically shuts off the oil feed. When the throttle valve is opened again, the oil feeds as before, because the equilibrium of pressure is restored.

# Characteristics of Bituminous Coals and Low Grade Fuels

By C. M. Ripley

The exact definition of boiler efficiency is the ratio between the amount of heat transmitted to the water and the total amount of heat in the coal. The ratio between any two quantities is simply the first divided by the second. For instance, the ratio between two and four is two divided by four, or one-half.

Since some heat is always wasted up the chimney and by radiation, it can easily be seen that the heat transmitted to the water will be less than the total amount of heat in the coal. Therefore, the first divided by the second will be a fraction, less than one, and when changed to per cent., by pointing off two decimal points, the boiler efficiency will appear: 60 per cent., 70 per cent., or whatever it may be.

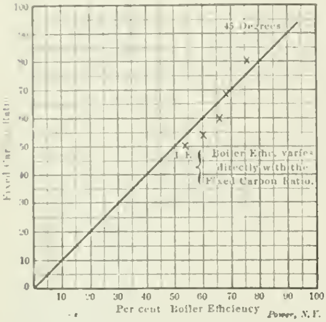
For example, where the boiler efficiency is 66⅔ per cent., the relations existing between the heat given to the water and the total heat of the coal would be as follows for one pound of bituminous coal: Total heat in coal, 14,500 B.t.u. (1); heat given to water, 9667 B.t.u. (2); heat wasted, 4833 B.t.u. (3).

From the definition of boiler efficiency, it would be the ratio between No. 2 and No. 1. That is, the boiler efficiency would be No. 2 divided by No. 1, which equals ⅔, or 0.666 or 66⅔ per cent.

With this in mind let us examine the figures presented by W. E. Crane on page 60 in the July 13 issue of POWER. These figures of Mr Crane were offered by him in a letter entitled "Fallacious Reasoning," in which he questioned the accuracy of my article on page 983 in the June 1 issue of POWER.

In my original article I stated that the volatile matter (i.e., the "gassy" matter) in bituminous coal amounts to from 30 to 40 per cent., and that for this reason it is difficult to get more than from 60 to 65 per cent boiler efficiency with bituminous coal, while with anthracite efficiencies of from 70 to 80 per cent can be easily obtained, because the gases easily escape unconsumed up the stack.

Mr. Crane wrote as follows: "In my work, anthracite egg showed an evaporation of water from and at 212 degrees of 9.15 per pound of coal. Clearfield, spread even and the fire kept thin, evaporated 9.81 pounds of water per pound of coal. Clearfield fired heavy and coked evaporated 10.63 pounds of water per pound of coal, and Georges creek 10.84 pounds."



CURVE SHOWING FUEL'S FIXED CARBON RATIO VERSUS PER CENT OF BOILER EFFICIENCY

By examining these figures we can find the relative efficiency of the boiler using the different kinds of fuel. Anthracite egg can be considered to have 12,000 B.t.u. per pound. If 12,000 B.t.u. will evaporate 9.15 pounds of water, we see that it takes 1311 B.t.u. to evaporate one pound of water when anthracite is used. Clearfield, however, may safely be said to contain 14,500 B.t.u. per pound, and this fuel evaporated 9.81 pounds of water per pound of coal. Dividing the 14,500 by 9.81 we find that it takes 1478 B.t.u. from bituminous coal to do the same work (i.e., evaporate one pound of water) that 1311 B.t.u. accomplished when anthracite was used. Thus it is seen that 167 more B.t.u. from bituminous were used than with anthracite, or 13 per cent. more heat was required to do the same work.

Another way of looking at it is as follows: A pound of bituminous coal evaporated 7.2 per cent. more water than a pound of anthracite. But a pound of bituminous contains 28 per cent. more heat than a pound of anthracite. These figures prove my statement of June 1, because evidently the anthracite shows the higher boiler efficiency—the bituminous requires 28 per cent. more heat to do 7 per cent. more work.

### Bituminous and Semibituminous Coal

Clearfield is not strictly a bituminous coal, it being classed as semibituminous. Authorities distinguish between these two as follows: Bituminous coal contains 30 to 42 per cent volatile matter; semibituminous contains but 20 to 25 per cent. volatile matter. Clearfield falls within this latter class and hence a higher efficiency would be expected from the boiler than if it had been a strictly bituminous coal—the kind I referred to in my original article.

When Mr. Crane fired the Clearfield heavy, and coked, it required 1364 B.t.u. to evaporate a pound of water; still showing a lower boiler efficiency than anthracite which only required 1311. When using Georges creek, Mr. Crane still used 1337 B.t.u. from the bituminous to do the same work that 1311 from the anthracite accomplished.

While these other methods of firing which were given later in Mr. Crane's letter do show a fairly close approach to the anthracite boiler efficiency, there are some points which should be borne in mind which may still farther favor the anthracite. These are as follows:

(1) Conditions in the boilers and combustion chambers may have been more favorable to the bituminous.

(2) Mr. Crane does not state whether or not the fireboxes in which he coked the bituminous coal were especially constructed with extended fronts. If this had been done it would have been possible to have consumed a larger portion of the volatile gases than would be possible in an ordinary firebox.

(3) Anthracite egg may have been fired deep, or the firebox and combustion chamber may have been designed especially for bituminous, which would hurt the record of the anthracite in that particular boiler.

The following table shows how the increase in volatile matter in a fuel will lower the amount of water evaporated. The figures in the left-hand column represent the amount of fixed carbon, and as the carbon decreases the amount of volatile matter increases. Volatile matter = 100 per cent. — fixed carbon (approximately):

TABLE NO. 1. (From Kent.)

| Per Cent. of Fixed Carbon in Coal, Dry and Free from Ash. | Heating Value in B.t.u. per Pound of Combustible. | Equivalent Water Evaporated per Pound Combustible. |
|---|---|---|
| 100 | 14,500 | 15.00 |
| 97 | 14,760 | 15.28 |
| 94 | 15,120 | 15.65 |
| 90 | 15,480 | 16.03 |
| 87 | 15,660 | 16.21 |
| 80 | 15,840 | 16.40 |
| 72 | 15,660 | 16.21 |
| 68 | 15,480 | 16.03 |
| 63 | 15,120 | 15.65 |
| 60 | 14,580 | 15.09 |
| 57 | 14,040 | 14.53 |
| 54 | 13,320 | 13.79 |
| 51 | 12,600 | 13.04 |
| 50 | 12,240 | 12.67 |

It will be noted from a study of Table 1 that the evaporation drops off quickly when the fixed carbon in the coal is less than 60 per cent. The volatile matter when equal to about 20 per cent. shows itself to be somewhat helpful in the evaporation, but becomes a detriment as its proportion becomes too large.

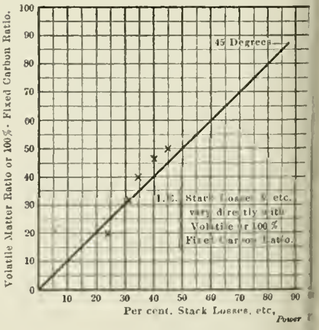
The following table is made up to cover the relation between the percentage of fixed carbon in coal and the evaporation, boiler efficiency and chimney and other losses:

TABLE NO. 2. (From Kent.)

| | | | | | | |
|---|---|---|---|---|---|---|
| Fixed carbon ratio | 97 | 80 | 68 | 60 | 54 | 50 |
| Evaporation per pound combustible | 12.2 | 12.5 | 11 | 10 | 8.3 | 7 |
| Boiler efficiency . . | 80 | 76 | 69 | 66 | 60 | 55 |
| Loss of chimney, radiation, imperfect combustion, etc. . | 20 | 21 | 31 | 31 | 10 | 45 |

It is instructive as well as interestin to note that the chimney and other losse are almost equal in percentage to the percentage of volatile matter in the fuel. Als that the boiler efficiency almost equals th fixed-carbon ratio.

The foregoing should remind everyon of the necessity of expert service in se ting the boiler and specifying the amou and arrangement of the grates. The e tended-front firebox is very valuable i burning bituminous coals and is sometim called a gas producer. The volatile matt leaves bituminous coal rapidly the fir few seconds after firing. Therefore t greater distance these gases have to pa over the fires, the more chance of perfe combustion. To my knowledge, even wi the specially constructed furnace, bit minous coal has never been able to gi as high a boiler efficiency as anthra properly fired, although it approache closely.



CURVE SHOWING FUEL'S VOLATILE MAT VERSUS PER CENT. OF STACK LOSSES, ET

### Old Methods Undesirable

It is my belief that the old wa of figuring boiler performance is mislea g, and for more than one reason:

(1) "Pounds of water evaporate is definite, but "per pound of coal", m ns very little.

(2) A pound of coal may contain from 7000 to 15,000 B.t.u.—a variation of over 100 per cent.

(3) A pound of coal may cost from 0.03 of a cent to 0.4 of a cent, depending upon the greatly varying price of coal. A variation such as this should in some way be accounted for in reckoning a boiler's performance.

By using the old style of reckoning one engineer could be evaporating as many pounds of water per pound of coal as his neighbor with the same-sized plant and yet the annual coal bill in one plant could be from 30 to 50 per cent. larger than in the other. I have in mind in New York City a striking example:

One building on Park avenue is buying a fuel for $2.20 a ton which has 12,000 B.t.u. per pound. A building across the street is paying $4.10 a ton for coal which has also 12,000 B.t.u. per pound. Thus the first building gets 11,000,000 B.t.u. for $1 while the second building only gets about 6,000,000 B.t.u. for the same price. There is a variation in plant efficiency which would not be discovered by the old method of "pounds of water per pound of coal."

### New Unit Suggested

Percival Robert Moses, a consulting engineer of New York City, has for some years judged the efficiency of a power plant on the following basis: How many pounds of water are evaporated for $1?

It will be seen that this original method includes not only a proper reckoning of boiler efficiency, but also includes the number of B.t.u. per pound of coal and also the cost of fuel. Mr. Moses in an interview with the writer stated recently that the work of the United States Geological Survey in calling attention to the great possibilities of low-grade fuel, would be likely to result in a more general acceptance of the new unit: "Pounds of water evaporated for $1."

The Geologival Survey in its latest report made public the conclusion that the most economical coal to buy is the cheapest, if grates and draft are properly designed. The office with which the writer is connected has been working along these lines in New York City for many years. A surprising amount of opposition is met by owners and engineers who claim that the old rule that "the best is none too good" should apply in the purchase of fuel. It is just as unreasonable to pay $4.10 a ton for coal when $2.20 coal would be good enough, as it would be to put tires of aluminum on a wagon or golden horseshoes on a horse. As an iron horseshoe is not only cheaper but better than one of gold, so also is low-grade fuel not only cheaper per ton but better in the long run from the standpoint of economy.

The engineers who are responsible for the economical operation of their plants should do well to recommend the employment of some reputable consulting engineering office and learn what savings could be effected in their plant by low-grade fuel, and what changes, if any, are necessary in grate surface, type of grates, draft, combustion chamber, method of firing, cleaning fires, etc. The engineer of today who is uptodate and even ahead of the times is the one who is sought for the position of big responsibilities.

## Danger of Incompetent Boiler Inspection

A sad illustration of the danger of boiler owners neglecting to employ suitable competent persons to examine their boilers is afforded by the comments of the Board of Trade commissioners in their judgment at a formal inquiry respecting the bursting of a traction-engine boiler that occurred at Canterbury on November 2 last, and killed the son of the owner. The boiler burst in consequence of the defective condition of the firebox, which could have been discovered if the boiler had been inspected by a properly qualified person. Unfortunately, the owner intrusted this duty to his son, who acted as driver, and who, the commissioners state, "was possessed only of the experience which could be gained by watching from time to time boilermakers, whom his father employed, repairing some one or other of the seven engines he kept for the purpose of letting out on hire. His experience, in fact, was that of an ordinary boiler attendant, and did not fit him to form a proper opinion as to the safety of the boiler." There was little doubt, the report states, that the plates of the firebox were bulged, owing to the existence of fractured stays, and that a very casual examination would have revealed its defective condition to a competent person. Discussing the tragic results of the explosion, the question of responsibility, and the costs of the inquiry, the commissioners said the owner, in the ordinary course of events, should have been called upon to pay the whole or part of the costs of the inquiry as a penalty for neglect, but they made no order of this kind, seeing that "no penalty they could order or inflict could bear any relation at all to the grief which he must have suffered, and still must suffer, by feeling that had he acted otherwise his son might still have been spared to him." The case, it is to be hoped, will be taken as a warning by boiler owners who, by reason of carelessness or parsimony, undertake themselves or delegate to their servants the work of boiler inspection, when they are not fitted, either by experience or training, to perform the duty. Numerous instances have been recorded where boiler owners have lost their lives as a result of such short-sighted policy, or what is even more painful, where they have had to regret for life the loss of others near and dear to them.—*The Mechanical Engineer.*

## Measurement of Power Supply

G. L. Addenbrooke, in a paper on "The Public Supply of Electric Power," in a Cantor lecture delivered before the Royal Society of Arts (English), said:

Power is always measured by meter, often by a 2-rate motor, or by an attachment now frequently fixed to the meter by which the number of revolutions of the revolving disk in a given time, say, half an hour, is counted and registered on a separate dial, the pointer remaining fixed at the end of each half hour, when the mechanism resets itself. Thus no fresh movement of the pointer occurs until the number of revolutions in any half hour exceeds the first, when the pointer is moved on to register the higher number, and this number multiplied by a constant gives the maximum horsepower taken during the half hour. The same meter in this way can be made to register the highest rate of using power as well as the total number of units used. A check is thus kept on a customer's demand on the station as well as on the quantity of energy used. Owing to the ability of steam turbines to carry overloads, and to their great flywheel momentum, it is less necessary to be particular about short overloads than it was formerly, and there is a growing disposition to adopt simpler forms of tariff, which can now be done with fairness to both sides on the extended experience of power supply in different industries which is now available. New forms of recording wattmeters are also being brought out which act separately from the meter. There is, however, still room for more work in these directions, as satisfactory means of measuring power, and its rate of use, are of much importance in promoting confidence and good understanding between power users and power suppliers, and the inability to obtain satisfactory instruments of these types until recently has had something to do with progress in power supply not having been more rapid.

Michael Longridge, at the summer meeting of the Institution of Mechanical Engineers, said that he had recently come across a very disquieting fact in relation to forged crank shafts in making tests of a broken shaft. Three pieces had been cut out from the crank web parallel to the arm of the crank and three pieces parallel to the axis of the crank pin. These were subjected to tensile and impact tests in the Izot machine and to fatigue tests in Captain Sankey's machine. The pieces cut parallel to the crank arm broke with a fourth or less of the number of foot-pounds which were required for the pieces cut parallel to the crank pin.

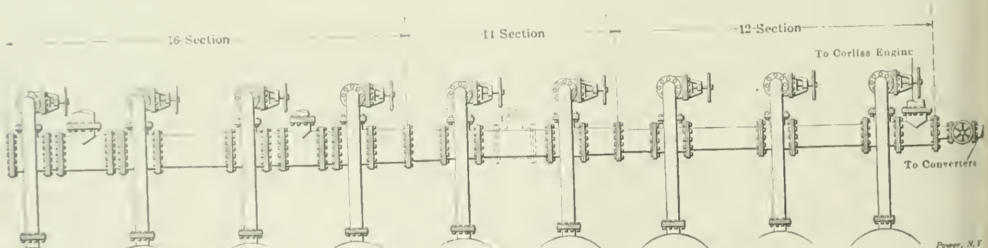
# Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think, Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

## Novel Header Connection

The original boiler installation in a certain establishment devoted to the manufacture of corn products consisted of three return-tubular boilers connected to a 12-inch main. After a lapse of time, the exigencies of increasing business and the adoption of new methods of manufacture compelled an enlargement of the steam-generating capacity of the plant; so the equipment was increased by an additional pair of boilers, which were coupled to a 14-inch extension of the original 12-inch main header. These sufficed for a time, but continued expansion of the business finally created a demand for further increase in the steaming capacity, which was met by putting in four more boilers and extending the main header to correspond. The portion of the steam main to which the last installed boilers were connected, was given a diameter of 16 inches, so that in the ultimate stage of its development, this pipe, which really constituted a common reservoir from which the various apparatus in the works took their supply of steam, consisted of three sections having diameters of 12, 14 and 16 inches, respectively, all of which is shown in the accompanying sketch. The initial steam plant of three boilers supplied steam to a Corliss engine located in a distant part of the establishment, and also to various auxiliary apparatus, through an 8-inch pipe branching from the 12-inch main, while a 5-inch pipe coupled onto the end of the main conveyed steam for the cooking, steaming, drying and similar processes involved in the manufacture of the product.



NOVEL HEADER CONSTRUCTION

It was early observed in the operation of the plant that as the quantity of steam required in the processes of manufacture kept pace with the expansion of the business, the Corliss engine also manifested a growing disposition to slow down while the cooking and converting operations were in progress. The drop in speed, which was at first barely perceptible and of no serious moment, grew so pronounced in the course of time that in order to keep the engine at anything like a reasonable speed, it finally became necessary to run the steam pressure up about 12 pounds above the normal working pressure every time the apparatus supplied by the 5-inch line was operated to its full capacity—the firemen working like Trojans the while to maintain the higher pressure.

While the cause of the trouble in this case was in no wise obscure and, as the sketch shows, was such as immediately to suggest itself to any engineer giving the matter a little thought, it is a fact, nevertheless, that it long remained a profound mystery to everyone connected with the plant until a new head-fireman who was put on the job finally found a solution. This man instituted an investigation on his own account, and rightly surmised that the blast of steam passing through the 5-inch branch from the 12-inch section of the header was robbing the steam going into the neighboring 8-inch branch of considerable of its tension, and suggested as a remedy that the supply of steam for the cooking and converting processes be taken from the 14-inch section of the main. Accordingly, a tee was placed in this section of the main and the 5-inch branch connected thereto, as indicated by the dotted lines in the sketch, after which no further trouble was experienced with slow engine speeds.

A. J. DIXON.

Chicago, Ill.

## Flat Crank Pins

I was very much interested and rather amused at E. G. Tilden's criticism of my article on flat crank pins. In the first place, this particular engine was not designed expressly for my article, but is an ordinary everyday engine. In fact, when I wrote the article, I had in mind, not one particular instance but numerous cases that have come to my notice when crank pins have become flat, and it invariably has been on the side of the pin subjected to the maximum pressure of the steam.

Granting that a certain amount of power is absorbed by the inertia of the moving parts, and is given off later in the stroke, when the propelling force of the steam imprisoned in the cylinder grows less, I should like to know in what manner this force that has been imparted by the whee and other moving parts is restored. Ta the flywheel, for instance. This is not creator of motion, but a regulator and reservoir. Therefore, whatever power force is imparted during the latter pa of the stroke from this source must restored by the power of the steam in t earlier part of the succeeding stroke. T being so, the incoming steam has not o to provide power enough to sustain load, but also to restore the power t has to be expended by the moving pa during the latter part of the stroke. T would seem to me to have a practical be ing in favor of my former assertion t the maximum pressure on the pin is d ing the earlier part of the stroke. course, I bow to the theoretical view Mr. Tilden, but I have had numer crank pins turned up under my su vision and have invariably found the side to be where the steam was at maximum pressure on the pin, and this, [ believe, was the objective in my former ırticle.

**Charles H. Taylor.**

Bridgeport, Conn.

## Work Done by a Vacuum Pump at Different Degrees of Vacuum

The dry vacuum pump, so called, is an r compressor designed to take air at different initial pressures below that of the tmosphere, and deliver it against a constant terminal pressure, namely, that of e atmosphere. Consider the piston mov- ng back and forth in a perfect vacuum. e valves do not open, no air is com- ssed and no work is done, except that overcoming friction of the moving rts. If a small amount of air is ad- tted to the cylinder, a small amount of rk is done. It is easily seen that as a eater amount of air is admitted and mpressed, an *increasing* amount of work ll be done.

New, consider the *maximum* amount air admitted, or which is the same in ect, consider the cylinder heads re- ved The piston then merely displaces against no increase of pressure, and ain no useful work is done. There must, refore, be an initial pressure between ro (30 inches of vacuum) and the pres- e of the atmosphere, at which the ximum amount of work is done on the a. This is made a little clearer when is considered that the work done, or sepower required, depends not only on the pressure ratio but upon the density of the air. When maintaining 29 inches of vacuum, or 1 pound absolute pressure, the pressure difference is great, but the density at that vacuum is very small; and we can understand that it may be possible for the work done to be the same as in compressing much denser air from a vacuum of about 6 inches to the same terminal pressure.

Rarefied air, such as handled by a vacuum pump, has not the heat capacity of denser air which is compressed above the atmosphere, and it is usual to water-jacket only the cylinder heads The cooling during compression, however, would be very slight in any case; and the compression may be considered as adiabatic, or having no heat transfer during compression. The general formula for adiabatic compression is

$$m\,e\,p. = 3.46\,p_1\left[\left(\frac{p_2}{p_1}\right)^{0.29} - 1\right].$$

where

$p_1$ = Absolute initial pressure in pounds per square inch,

$p_2$ = Terminal pressure = 14.7 pounds per square inch,

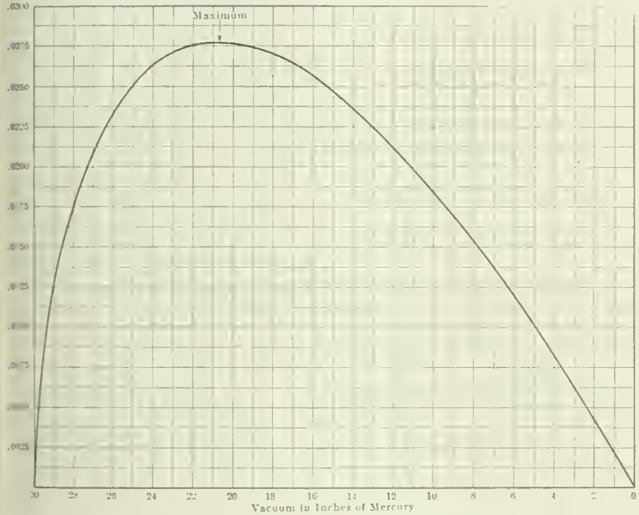
$m.\,e.\,p$ = Mean effective pressure in pounds per square inch.

The formula also expresses the theoretical work done on one cubic foot of air in inch-pounds.

To obtain the theoretical horsepower required, neglecting friction, to compress and expel against atmospheric pressure one cubic foot of air per minute, we have $m.\ e.\ p. \times (144 \div 33{,}000)$.

The mean-effective pressures and horsepowers are given in the accompanying table for each inch of vacuum and the corresponding absolute pressures in inches of mercury. The relation is more easily seen in the curve herewith, which gives the vacuum reading in inches of mercury and corresponding horsepowers per cubic foot of air compressed per minute.

It is seen from the table and curve that the greatest mean effective pressure horsepower and amount of work is done when the absolute pressure is betweeen 9 and 10 inches of mercury, or when the reading of the vacuum is between 20 and 21 inches. The higher the vacuum is carried above this point, the less the power required.



CURVE SHOWING THE RELATION BETWEEN THE INCHES OF VACUUM OR ABSOLUTE PRESSURE AND THE THEORETICAL HORSEPOWER REQUIRED BY A VACUUM PUMP

| Vac. in Inches of Mercury. | Abs. Press., Inches of Mercury | $\frac{p_2}{p_1}$ | Theoretic m.e p. | Theoretic H.P Developed |
|---|---|---|---|---|
| 30 | | | | |
| 29 | 21 | 30.00 | 2.86 | 0.0124 |
| 28 | 2 | 15.00 | 4.05 | 0.0177 |
| 27 | 3 | 10.00 | 4.83 | 0.0211 |
| 26 | 4 | 7.50 | 5.40 | 0.0235 |
| 25 | 5 | 6.00 | 5.78 | 0.0252 |
| 24 | 6 | 5.00 | 6.05 | 0.0264 |
| 23 | 7 | 4.28 | 6.23 | 0.0271 |
| 22 | 8 | 3.75 | 6.33 | 0.0276 |
| 21 | 9 | 3.33 | 6.37 | 0.0278 |
| 20 | 10 | 3.00 | 6.36 | 0.0277 |
| 19 | 11 | 2.73 | 6.31 | 0.0275 |
| 18 | 12 | 2.50 | 6.21 | 0.0271 |
| 17 | 13 | 2.31 | 6.05 | 0.0264 |
| 16 | 14 | 2.14 | 5.89 | 0.0256 |
| 15 | 15 | 2.00 | 5.68 | 0.0248 |
| 14 | 16 | 1.87 | 5.42 | 0.0236 |
| 13 | 17 | 1.76 | 5.17 | 0.0225 |
| 12 | 18 | 1.67 | 4.88 | 0.0212 |
| 11 | 19 | 1.58 | 4.57 | 0.0199 |
| 10 | 20 | 1.50 | 4.23 | 0.0184 |
| 9 | 21 | 1.43 | 3.89 | 0.0169 |
| 8 | 22 | 1.36 | 3.52 | 0.0153 |
| 7 | 23 | 1.30 | 3.13 | 0.0136 |
| 6 | 24 | 1.25 | 2.73 | 0.0119 |
| 5 | 25 | 1.29 | 2.31 | 0.0101 |
| 4 | 26 | 1.15 | 1.88 | 0.0082 |
| 3 | 27 | 1.11 | 1.42 | 0.0062 |
| 2 | 28 | 1.97 | 0.96 | 0.0042 |
| 1 | 29 | 1.03 | 0.49 | 0.0021 |
| 0 | 30 | 1.00 | 0 | 0. |

It is also advantageous to run a vacuum pump at the slowest speed possible to maintain any given vacuum. One reason for this is that the slower speed allows the air compressed in the cylinder more time to become cooled, and less power is required as we come more nearly to realizing isothermal compression.

**Robert R. Pratt**

Brooklyn, N. Y.

## Graphite for Lubrication

In the July 6 issue was an article concerning graphite lubrication. Following is an account of an experiment that I made more than 20 years ago, when I was assistant engineer in a sawmill in Florida:

It was an old-style slide-valve engine, with throttling governor, and the crosshead had "jaws" which engaged three sides of the guides. These jaws were fitted with adjustable brass gibs, and they were both narrow and short, which, together with a short connecting rod and the engine running over, made the gib pressure per square inch upon the guides very heavy. It was in fact so great that oil (lard) applied to the surface of the guides was swept away at once, and the guides were hot all the time.

After I had been there a few days, I asked the chief engineer if I might try to improve the lubrication of that crosshead and I was given permission to do anything I pleased, if I would only cool off those hot guides. So I procured some [illegible] graphite, mixed a lot of it with oil, to about the consistency of thick paint, then made a swab of candlewick on the end of a stick and daubed some of it on while the engine was running, and the very first daub of it got between the gibs and slides (guides) and *stayed right there for three hours.*

Well, that ended the trouble with hot guides and my pot of "slush" with its little mop sat along side of the engine and was used regularly, saving power and a lot of breath which had been previously expended upon unchristian remarks about hot guides.

I am a firm believer in flake graphite—I keep it on hand all the time and find use for it every working day.

M. F. Copley.

Alton, Ill.

I believe that a great deal of the article in Power is based on facts, but some of it seems not altogether to coincide with the consensus of opinion of high-class mechanical men, particularly the part where it is suggested that the amorphous grade of graphite, because of its powdered condition, may be a better lubricant than flake graphite. In this connection I wish to quote from a letter received from an engineering friend concerning a little research into this subject:

"Regarding the merits of amorphous graphite versus flake graphite, I wish to state that my experience has been that the best results are obtained from the use of the flake graphite. This can be secured in a large flake, or in a finely ground flake. My particular reason for arriving at this conclusion is that the flake graphite appears to be and I believe is considerably freer from grit, or any substance that might score or cut the bearings. This is due, I understand, largely to the reason that the flake graphite can be refined more readily to a more perfect state of purity than the amorphous grade, because the residue in the amorphous grade takes on the same shape as the particles of the graphite itself, so that they are harder to extract than with the flake variety, where the graphite is of a particular flake shape and the residue of an entirely different shape.

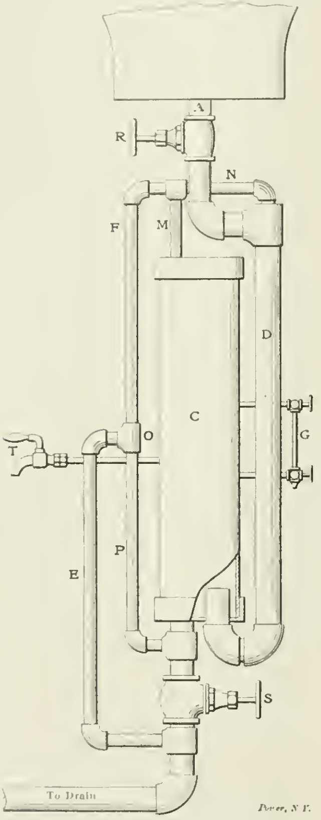
"While the large flake graphite may not be quite as adhesive as the amorphous grade, I am satisfied that the finer-ground flake graphite is just as adhesive as the amorphous grade. This can be easily determined by inserting a piece of metal into a receptacle of each of the varieties. Also, as to the point of adhesiveness, on an open bearing the flake graphite acts in the same manner to the bearing as a piece of paper that falls to the floor, and which is difficult to pick up, because the pressure of the air on the light object really binds it to the surface."

J. M. Willitts.

Philadelphia, Penn.

## An Oil Separator

The oil separator shown herewith was designed for the purpose of separating the oil from the mixture collected by a grease extractor. The separator was located between the grease extractor in the exhaust main of a large factory and the trap through which the mixture formerly passed.



AN OIL SEPARATOR

The device consists of a separating cylinder $C$, about 4 feet long and 6 inches in diameter; an inlet pipe $D$ 2 inches in diameter; the overflow legs $P$ and $E$; the pressure equalizing legs $F$ and $M$, with the connecting pipe $N$; the valves $R$ and $S$; the tap $R$, and the gage glass $G$.

The action is as follows: Steam, oil, water, etc., are collected by the grease extractor and flow into the separator through the 2-inch pipe $A$, the valve $R$ and the pipe $D$, which projects about 2 inches into the chamber $C$. The pipe $N$ is tapped into the top of the T-joint on $D$, so that the exhaust steam present there flows through $N$ into $F$ and $M$, tending to establish similar pressure conditions in the pipe $F$ and the chamber $C$, which is necessary to prevent the constant siphoning of the contents of $C$.

As the contents of the extractor flow into $C$, the oils rise to the top and do not pass over into the overflow pipe $P$. The hight of the liquid in $C$ rises to such a point that the pressure head, due to the combined weight of the oil and water, is equal to the head due to the hight of the water in $P$ at $O$.

At this point, any addition to the contents of $C$ will cause the water to overflow at $O$, into the pipe $E$ and out through the trap into the drain, until equilibrium is again established. This action is repeated continually as long as the separator is in service, thus causing an accumulation of oil in $C$, which can be drawn off at the discretion of the attendant through the tap $T$.

When the separator is in service, the valve $R$ is open and the valve $S$ closed. In case it is desired to cut the separator out of service, it is only necessary to open the valve $S$. The contents of the extractor then flow directly to the trap.

W. W. Parker.

Chicago, Ill.

## Pump Repairs

A discharge-valve seat broke and cam out, in a large service pump, and no having an extra valve seat, a blank wa used.

Two circular iron disks were procure a little larger in diameter than the valv seat. A hole was drilled through th center of each disk. They were the placed, one each side of the pump dec and a bolt put through and tightened place.

As these valve seats were of the wed type, we placed heavy iron disks, as show in Fig. 1, on opposite sides of the dec with the valve seat between. A b was extended through to the sucti chamber with a washer and nut on a wrench was applied to the nut and t seat was forced down tight to its pro place.

A source of much annoyance was breaking of the stuffing-box gland on brine pump.

In Figs. 2 and 3 is shown a split gl that can be put on in a few minutes. T two large screws at $A$ and $B$ hold parts together. In trying to pack the st ing boxes at the end of the coils on of the condensers for the absorption chine, the packing could not be ea removed, as one ring was hydraulic the next ring lead and had not been iewed in a number of years. It was asily accomplished after making a tool, shown at Fig. 4.

The coils being 1¼ inches in diameter, piece of pipe large enough to encircle th was made for the tool as follows: It was 1½ inches in diameter and 8 inches long, and ⅜-inch holes were drilled around the circumference near one end, and a hacksaw used to cut the teeth, as shown. The pipe was split down the center, and a pair of clamps made When the tool was adjusted at the stuffing box, the clamp was put on as shown at *C*. The clamps were made of 3/16-inch iron, 1½ inches wide, with ¼-inch bolts. A pipe was used on the body of the tool to turn it.

James G. Sheridan.

Brooklyn, N. Y.

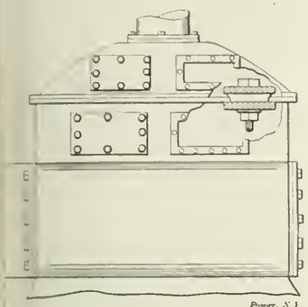

Power, N.Y.

FIG. 1

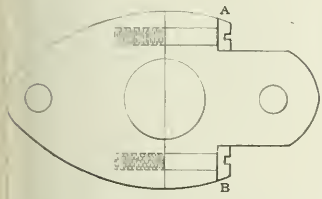
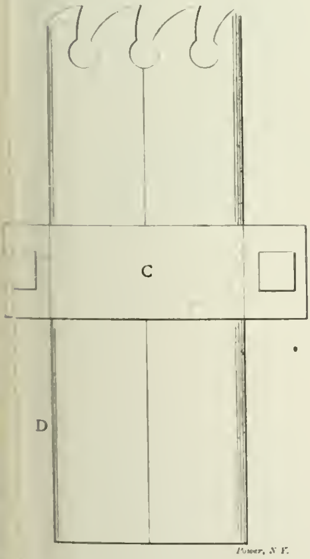


FIG. 2



Power, N.Y.

FIG. 4

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## Engineers and Oil

It was with considerable satisfaction that I read the article on lubricating oils by Messrs. Wells and Scott-Taggart, as it seems to have eased my mind on a subject that I have always felt I was somewhat backward about. In my experience, which is lengthy and varied, whenever the subject of the quality of oils arose, I have been very reticent in expressing an opinion, and, when compelled to say anything, have always made the request to be allowed to put the oil to a practical test wherever it was to be used, and have formed my opinion from the results produced thereby; and I am free to admit that I know of no other way to judge the quality of an oil.

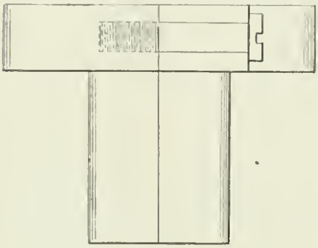

Power, N.Y.

FIG. 3

In my early days as an engineer, I used to look with great respect upon the men who would take half a dozen small bottles of different kinds of oil and set them on the window sill for a certain length of time and then very confidently pick out those that were the best (so they said) and discard the others, although how they arrived at their conclusions they were never able to explain to me in a sufficiently lucid manner to enable me to do it; and also the fact that frequently the discarded oil was later given a trial and produced better results apparently had no effect upon their ability as judges of oils.

Now, from what I have seen, and the results of many arguments, I am under the impression that the average engineer can know very little about oil, unless he puts it to a practical test, and the article of Messrs. Wells and Scott-Taggart seems to bear me out. I think that imagination and, with some, the personality of the oil salesman, have a great deal to do with the supposed quality of the oil. I know of one case in particular where his imagination placed an engineer in a very embarrasing position. He was using a certain brand of engine oil on a 1200-horsepower Corliss engine and nothing else, in his opinion, would run that engine satisfactorily. There came to the office one day an oil salesman of a rival company and he wanted the superintendent to try his engine oil, which he claimed was fully as good, if not a little better than the brand they were using. The engineer was consulted and he flatly refused to entertain the idea. Upon being asked by the "super" to try it on the engine, he refused again, saying that he had used the oil in a former place and was thoroughly satisfied that it was infetior to the oil he was using.

That apparently settled the matter with the "super" and he and the oil man left and went to the office. Right here is where the oil man introduced his very dark-colored scheme; he proposed to the superintendent that he send a barrel of his oil to the plant and upon its arrival they pump it into an empty barrel of their own brand and watch when it was sent into the engine room. This was an easy matter, as the oil was kept in a storeroom and the requisitions had to go through the "super's" hands, so that when they sent for oil the next time the "super" held back the requisition until there came an urgent call from the engineer, saying the tank was empty and all he had was in two-gallon measures on the engine.

The barrel of oil was sent up immediately and of course it was the new oil. Nothing was said about it and about a week later the "super" dropped in to have a talk with the engineer, when by the irony of fate the engineer started to talk about the oil salesman.

"Well," said the "super," "he certainly was a talker and if his oil is as good as he claims, it deserves his confidence."

"Yes," said the engineer, "but it is not in it with ours, and do you know I think this oil is really getting better, as I have cut down a few drops on the bearings and they are running fine? There is no use talking, there is nothing like it."

"Oh! Well, I think it's about half your imagination," said the "super;" "I suppose there is other oil as good as ——," naming the brand they were using.

"That may be," said the engineer, "but I have yet to see it."

"Well, now," said the "super," "let me tell you something, the oil you are using is the ——— company's oil (the new oil) and I was a partner to the scheme to get it in here. I did not do it to humiliate you in any way, but merely to show you (if it was so) that your imagination was obscuring your judgment. You have admitted that the oil seems a little better and I expect you will not care to retract the statement, and as it is a little cheaper I think we had better continue its use."

"By all means," said the engineer, "and I will admit that it is a bad one on me; but I honestly believed the other oil was the best."

Now, this was told to me by the engineer himself and he said to me at the time:

"Can you imagine a more crestfallen engineer in North America than I was that day?"

My reply was:

"It served you right, for not trying the oil and putting yourself in a position to state positively what it would do on that particular engine."

But the fact that one case turned out that way is no indication, of course, that because the oil man says the oil is better it is always so, as most of us know to our sorrow. But it seems to me, judging from the standard of the man in this case (one who has held large positions very successfully) that it emphasizes the fact that the average engineer's knowledge of oil would fill a very small book. This is in no manner to be construed as "knocking" the engineers, because if I understand the article of Messrs. Wells and Scott Taggart, the practical test is the only one of any value to the engineer.

I should like to cite one more instance, which happened to me personally. In the article in question, the authors state "that no one would think of putting a thin spindle oil on a heavy engine bearing;" and yet I have done it, with apparent success. We were using a very good grade of engine oil on a mill engine which had large and heavy main bearings. We kept our oil in a room where there was very poor light, and upon sending for a barrel of oil discovered that although there were five or six barrels, none of them contained engine oil. We had to have oil, so I told the men to send up a barrel of spindle oil and we would try it. We filled the cups one at a time and kept a close watch on the bearings, until everything was running on spindle oil and you can imagine my surprise when I found the bearings running cooler and apparently being better lubricated than before; and we gradually cut down on the feed until we were using less of the spindle oil than we had of first-class engine oil.

Now, if that wasn't enough to jar a man's belief in what he knows about oil, I'd like to know it. The "super" came in later, looked at the oil cups and asked me:

"What kind of oil have you got on that engine?"

"Spindle oil."

"Good lord," says he, "that is no good, it only cost 15 cents a gallon."

"It doesn't matter if it only costs 15 cents a barrel," said I, "it is giving better satisfaction on a smaller amount than anything that has been on this engine;" and I was in a position to know, having started the engine when new and tried out different oils until we decided which was the most satisfactory. But he insisted that I take it off as soon as our oil came and of course I did so, but I have often wondered why it was that contrary to all expectations that spindle oil gave such results. But it only causes me to repeat again that I think we engineers know very little about oil, and I somehow don't feel quite as much ashamed of my lack of knowledge regarding oils as I did before reading the article of Messrs. Wells and Scott Taggart.

W. N. Wing.

Brooklyn, N. Y.

## Trouble with Motor-Driven Exciter Set

Referring to inquiry of C. L. Greer, in regard to trouble with his motor-driven exciting set, the trouble is due to the fact that the induction motor driving the exciter receives its current from the alternating-current busbars which are affected by the action of the short-circuit as follows:

The short-circuit causes an excessive current to flow and the first tendency of this excess current is to act upon the voltage and flux of the generators, as the armatures furnish ampere turns fully as important as the field. The phase of this current caused by the short-circuit is one giving a lagging effect and is very demagnetizing and, consequently, overcomes the normal excitation of the machines. Thus, the rush of current will almost instantly pull down the voltage of the generator to zero; and, of course, when this takes place the indicator motor driving the exciter must stop and, consequently, the steam set must be resorted to in order again to excite the fields so as to build up the alternating-current circuit.

In case the steam set were operating at the time of the short-circuit, the effect upon the generators would be the same, but the instant the short-circuit burned off, or was otherwise removed, the machines would immediately build up to normal voltage.

T. A. Lees.

Quincy, Mass.

If there is any chance at all for the exciter to continue running after a short circuit, it must be by having leads to induction motor come direct from the board at a point between the generator and circuit-breaker. The writer has a motor generator outfit wired up from line wires, and it shuts down every time that a short circuit occurs. If Mr. Greer would stand by the board and watch a load come or sufficiently heavy to make the engine slow down, it would become evident to him why the trouble occurs.

The lowered electromotive force on th line causes his induction motor to slow that, in turn, slows his exciter and th weak field on the generator follows. Occasionally this happens at our plant whe a 50-horsepower synchronous motor started, and if it happens that the onl generator that is running is, for instanc a half-loaded 75-kilowatt-ampere machin the result stated occurs.

Francis J. Thompson

West Raleigh, N. C.

## Bending a Pipe

Piping is generally laid out and cut that it will go up with little, if any, troul

In Fig. 1 is shown a case where a lar bend had to be put in from the ma steam line to a large engine. This be screwed into the throttle, as shown at and the throttle valve was screwed on pipe and placed in position, only to f

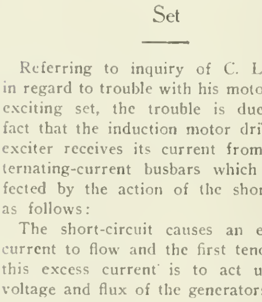


FIG. 1

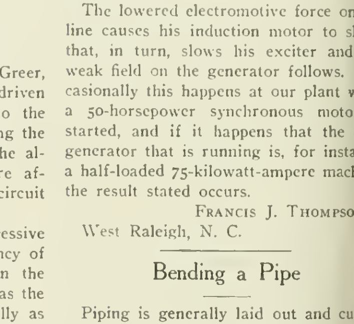


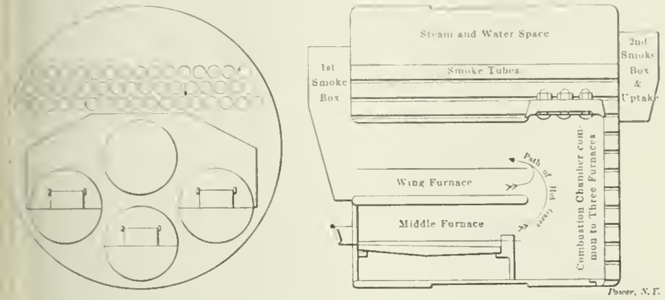
FIG. 2

the pipe cut as shown at *C*. Steps taken to get this pipe in place by ar ing a scaffold as shown in Fig. 2, some earth on a board so that a fire be built around the pipe to heat it. the pipe was thoroughly hot we on the blocks and the bolts at *C* an bend was soon in place. When col gasket was inserted and the joints tight.

C. R. McGa

Richmond, Va.

## A Smokeless Boiler



A SMOKELESS BOILER

Herewith is a short description and encil sketch of a boiler which does not nake any smoke or soot and in which team can be raised from cold water at 0 degrees Fahrenheit to 180 pounds presure per square inch in 30 minutes. It as been tried here on board the S. S. Glencairn," and where formerly ten tons coal per day was consumed with an or- nary Scotch multitubular boiler, only ght tons per day was burned and for one- f knot per hour more speed. This ler was severely tested by the Glasgow nicipality and when three men were ng at once there was just the faintest e of smoke to be seen, but after firing rd for 12 hours no soot could be found.

As will be seen, it is an ordinary three-f nace marine boiler, the prominent feate being the large return flue through ich the gases return before entering smoke tubes.

t is in coming back through this large t with the heat from all three furnaces ring on it that the gases get thoroughly sumed, and combustion is made al- t perfect. After passing through the s l smoke tubes the gases pass up the cmney in the ordinary manner.

George Bell Laidlaw.

asgow, Scotland.

## Valves Require Setting

ith regard to the diagrams submitted b H. Conway on page 196 of the August mber, I give herewith instructions for se g the valves correctly so as to get g diagrams.

he diagrams submitted by Mr. Conway sl clearly that admission is very late o both ends, but later on one end than h other; that there is no compression; th release is late on both ends, but also la on the same end that shows the la t admission. The point of cutoff ap- pe s to be unequal, also.

r. Conway could proceed to set the va es by the marks, but since the diagrams show clearly what the trouble is, I should not advise him to follow this method; because after doing the work in the most careful way possible, the indicator will show defects in the results obtained, and point out places where final adjustments can be made, so I advise him to proceed with the aid of the indicator.

In this type of engine valve, the main valve has positive control of admission, release and compression and, like the plain slide valve, is designed to give these three events correctly according to the idea of the designer for that particular type of engine; hence, there can be only one position for the eccentric that will move the valve correctly to fulfil its duty in the way it was designed to do.

The point of cutoff is the variable point in the steam distribution with this valve, and this point is controlled exclusively by the action of the shaft governor and its connections with the cutoff valve.

Now, the diagrams show that the events controlled by the main valve are all very late, but that they are later on one end than on the other. This shows that the valve does not travel equal distances each way over the ports. To correct this, first see that the rocker arm rocks equal distances each side of its central (or vertical) position; if it does then the trouble is not there, but in the length of the valve stem, which must be changed so as to equalize the travel of the valve over the ports. Now, shift the main eccentric ahead on the shaft in the direction the engine runs, say ½ inch, measured on the shaft, and secure firmly. Now speed up the engine and take a diagram. The diagram now should show the admission earlier, and release earlier, but it may not show any compression yet. If this is the case, shift the eccentric ahead another ½ inch or so and then take another diagram, noting the changes produced, and continue as stated until the diagram shows one or other of the admission lines vertical. If both admission lines are exactly vertical, the eccentric is set correctly, but if only one line is vertical and the other line inclines toward the center of the diagram, adjust the length of the main valve stem until both admission lines have the same amount of inclination, and then shift the main eccentric ahead just a little at a time, until both admission lines come exactly vertical. Your main eccentric and valve are now correctly set, and your diagram should show good release and a good compression curve.

It may be, that on account of the unequal point of cutoff, one end may show a high terminal pressure and the other end show a negative loop; but this, if it occurs, will be the result of too light load or too high a boiler pressure, combined with the unequal point of cutoff, and is nothing to be alarmed about.

To set the cutoff valve, which will correct these defects, if they exist as a result of unequal cutoff, for convenience place the engine on one of its dead centers; loosen the governor wheel on the shaft, and turn the governor wheel on the shaft so as to bring the full side of the cutoff eccentric on the same side of the shaft as the crankpin, and have the center line of the eccentric exactly in line with the center line through the crankpin and shaft. Secure the governor pulley in this position. Speed up the engine and take a diagram and, if necessary, equalize the point of cutoff by changing the length of the cutoff-valve stem at the knuckle joint.

H. W. Benton.

Cleveland, O.

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The indicator diagrams presented by Mr. Conway seem to be about the extreme from this engine, as this particular engine is capable of producing good diagrams when in proper condition. The engine is very much out of adjustment. The Buckeye valve gear is not difficult to set when understood and treated as a simple gear. In this case the eccentric needs moving in the direction to cause an earlier admission of the steam to the cylinder and this will cause an earlier closure of the exhaust valves and more compression, which is needed.

One of the first steps necessary in the readjustment of this valve gear is to get the lost motion out. Then see that the main rocker arm is properly set; that is, when the eccentric is in a central position this rocker should stand in a vertical position, and should move the same distance on each side of a perpendicular line. This it does not do now. This main rocker carries the smaller or cutoff-valve rocker, and the slightest error in the main rocker will be very noticeable in the diagrams, and this should be set correctly, before attempting to set the cutoff rocker.

The supply pipe to this engine had better be investigated, also. The valve gear is in bad repair and adjustment, as well as the valves. In setting the Buckeye engine valves, set the main rocker first and then the main valve; and then follow by setting the cutoff rocker properly, then the cutoff valve, and when this has been done take another diagram and you will find things different

C. R. McGahey.

Lynchburg, Va.

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I have had some experience with an engine of the size and make of Mr. Conway's. I ran mine at 210 revolutions per minute. I think his main eccentric is acting late. It should be advanced until he gets a perpendicular admission line, and then move the main valve toward the end of least compression until the compression on both ends is equal to secure smooth running.

It may be possible that the cutoff valves do not uncover the ports until after passing the dead center. If such is the case the containing wheel should be slipped, in the direction of rotation, enough for the governor to control the engine with no load. The cutoff valves also need adjusting. This is done by moving the cutoff valve toward the end of the latest cutoff.

There may be some other details to work out, but when the above is done there will be an appreciable reduction in the amount of steam consumed.

John R. Rountree.

Welsh, La.

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## Interesting Condenser Operation

We are operating a condenser under somewhat unusual conditions. It is of the double independent-jet type, and is used to condense the steam from two cross-compound Corliss engines, 21 and 42 by 48 and 15 and 30 by 36, the former running at 83 revolutions per minute and the latter at 120 revolutions per minute.

The condenser pumps the water from two 10-inch wells, 85 feet deep, the lift varying from 7 to 20 feet, and discharges against a head of 40 feet. The diameter of the steam pistons is 14 inches and the water piston 28 inches, with a 14-inch stroke common to both.

The average vacuum maintained is 26 inches. The temperature of the well water is about 56 degrees Fahrenheit the year round. About 80 per cent. of the water used for condensing is used on two paper machines and in the beater room of the paper mill, for which the engines furnish power and light. This, of course, brings the cost of condensing down very low, as the water would have to be pumped to tanks on the roof for mill use.

The condenser pit is about 8 feet lower than the engine-room floor, and below the sewer, and as there is always more or less leakage around the stuffing boxes, and some water seeping in from outside, it was found necessary to keep a siphon going all the time, and in wet weather two. To save the steam necessary for those, and also do away with the necessity of watching to keep from wasting steam, when the water was low, the scheme shown in Fig. 1 was resorted to. A 1½-inch hole was tapped into one of the well suction lines, just over one corner of the pit; a 1½-inch pipe, near the top of which there is a regulating valve such as is used to regulate the water in open heaters, answers for a suction to the pit. On the handle of this valve there is a cord which passes over a pulley and down to a float in the water. In this way the condenser has taken care of all the water without any attention.

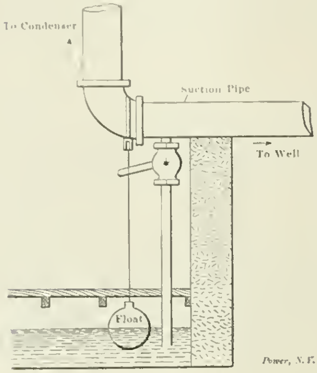

FIG. 1

Before the condenser was installed the water for the mill was pumped by two Cook deep-well pumps. The wells are now arranged as in Fig. 2, so those pumps can be used in case the condenser is down, and either one can also be used to prime the condenser, should there be trouble in getting it to lift the water. So far there has been very little trouble from this, however.

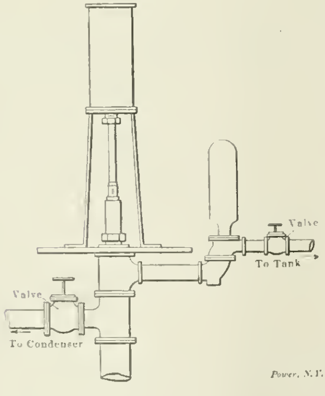

FIG. 2

W. C. Schueler.

East St. Louis, Ill.

## Firing Boilers

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This topic seems to have raised quite a discussion. I did not expect my articl to escape criticism, but would remind W E. Sargent, who writes in the July 2 number, to confine himself to that whic was written and implied.

I did not say that a fire should b "stirred;" I particularly said this shoul be avoided and gave reasons. I also sai to use the slice, *if necessary*. Neither di I say that a man from the farm or "any thing in trousers" could learn the dutie of a fireman in three days; indeed, I sai it took years to become proficient.

What I did say, and repeat, was th the person under discussion could *fire* job where the steam would hold for quarter of an hour with one pitch of co I know it would not be wise to trust hi with the water level, or to cut a boil in on the line on such an apprenticeshi Again, the other duties of a fireman a not under discussion. Also, both M White and myself mentioned the fa which Mr. Sargent states, in his openi paragraph, that we lost sight of.

Will Mr. Sargent tell us how a firem who has to be continually with a tool his hands, forcing the coal to burn quic to keep the pressure up, is wasteful?

There are plenty of such jobs in t world, where the fireman has no time the "other duties;" a water tender s to them. Assuming the operator to b fireman, not a raw laborer, that he d not waste steam through the safety va or shake unburned fuel through the fi bars, where is the waste? I am kee interested on this point and have id about it which I reserve, contending t those who are so fond of using the phr "economical results" should offer expla tions.

The method of firing which I descri was for general guidance, only. shape of the fire I have found best natural draft and compressed-air would not do on a blast job, such Howden's patent. Here the coal mus thrown well into the back and wing the furnace, as I found this was w it burned quickest; often it was consu before I could get back with the ra

The aim of a fireman, when it is cult to get enough steam, is to keep surface of his fires at the greatest sible heat for the greatest length of This he sets himself to do the best w knows of under the circumstances. test of a fireman is to put him on a single-handed job; then the eng knows who to blame for poor result

To fire with a gang is a poor as the result is all connected on the line, and if the steam is not satisfa the engineer often pounces on the w man. I have frequently seen this d

What does Mr. Sargent mean by s

"it took every pound of steam the boilers could make to keep the cars moving?" He probably means it took every pound of steam the firemen could make. What would he have done on the job he describes, had he been supplied with inferior coal?

W. Bowden.

West Toronto, Can.

As W. E. Sargent, in the July 27 number, takes exception to Mr. White, Mr. Bowden and others on firing boilers, I write to explain how a saving was shown in fuel in 30 days by a change in coal, watching the draft and furnace temperatures closely and by proper firing.

I agree with Mr. Sargent that you can tir your fire too much and that a man rom the farm or "anything in trousers" annot learn the duties of a fireman in ree days' apprenticeship, and that conditions are far from being the same in all nts in regard to economical firing.

But I find from experience that an inlligent and willing inexperienced man, he will do just as he is told, will make e best fireman, rather than one who has red some, or who has ideas from some her plant where the conditions are not e same.

An editorial, in the same number, on nace draft speaks volumes, as the sucssful combustion of any fuel depends rgely upon a good draft.

We were burning a run-of-mine coal at contained considerable slate and nkered badly, but upon request nut, a and slack from the same mine were tained and a comparative 30-day test s made on each.

We have adopted the marine style of ng with thin coal, or by throwing a every five minutes, and by firing every her door at this interval an even fure temperature is obtained.

t having shaking grates, the fires are ked, just before firing, every two hours very other door, with a T-hook which run back and forth under the fire or to the grate bars, but never up ugh the fire. This works the ash and rs through, making a bright ashpit a thin, bright fire which keeps the constant.

throwing a fire every five minutes, must throw a light one, and well ead to keep the grate bars evenly red, and it is surprising how soon a man will learn when a light fire is red and that it is to his interest to kp it so, for every fireman and engin r knows that if the steam drops 8 or pounds with a load it requires some ly spading to get it up again.

y a continual thin fire which must be fid at regular intervals, the furnace soon omes a bright red all over, and if the k temperature is not much below 500 d rees and the draft is what it should be, should get good results from the fuel you are using, with very little smoke.

In handling the peak loads we find that instead of four light shovelfuls in every other door at the five-minute interval, it requires five or six, well spread, to hold the steam very near the popping point, and if the load should drop, a quick closing of all ashpit doors will prevent the boilers from popping.

In the comparative test of the coals, several tons less of the nut, pea and slack were burned than of the run-of mine with the same load and number of engine hours for 30 days, and there being a difference of 35 cents per ton in favor of the nut, pea and slack, interest in the new coal was quite noticeable.

If you have ample boiler capacity (and you should have for economy and safety) to be ready for an emergency, the fires may be cleaned one door at a time, by throwing the fresh coal just before cleaning in the center of a two-door furnace for a few times, and when one side is cleaned wing it over to the clean side. By doing this you will not lose much of your furnace temperature, as you have a good fire on one side all the time.

By disposing of ash and cinders every two hours, with possibly a few clinkers from each fire door, plenty of time is given the ash wheeler to dispose of all of it before the regular time of thorough cleaning, which is only twice in twenty-four hours, or once each shift.

With the run-of-mine, or most any coarse coal, we were cleaning fires about half the time, and they were never as satisfactory as with nut, pea and slack fired as explained.

W. D. Ranney.

Columbus, O.

## Repairing Pump Rods

On page 102 of the July 20 issue, Lewis C. Reynolds suggests a method of making worn pump rods as good as new by turning down the worn part and driving on brass tubing, which is then turned to the correct size. This method is undoubtedly economical in some cases, but I would warn an engineer from advocating it before he has examined and measured up the worn rod and compared it with the nearest commercial sizes of brass tubing procurable, for it may happen that the inside diameter of the tube is less than the diameter over the threads on the end of the rod, and if so it would not be possible to adopt this method. Then it may be that it would form only part of the shoulder the piston slips against, perhaps the tapered part; and in these cases the economy would be doubtful, as the amount of machine work and fitting may cost more than a new rod and "the old man" nowadays does not give credit for ingenuity unless it also costs less than the other way.

George P. Pearce.

Exeter, N. H.

## Gage Cocks

Referring to Mr. Kennett's method of connecting gage cocks, as described in the August 3 number, I doubt if many engineers would care to substitute it for a good water column properly installed. To cut three holes in the tube sheet of a boiler, within a few inches of each other, is undesirable and the three separate pipes extending halfway across the head and through the front will be found in the way in repairing tubes, cleaning and inspecting. A water column, with its gage glass and gage cocks, is supposed to receive the attention accorded any other automatic device. The piping to and from the column should be as direct as possible and all turns made with crosses, with the unused openings closed with a substantial brass plug.

The column should be connected to the piping with ground-joint unions close to the column and the blow-down from the sediment chamber, also attached with a union. When installed in this manner it can be taken down in a few minutes and by removing the brass plugs can be kept clear. The frequency with which this is done will depend on conditions; the writer has known columns to run for years with no sign of "lining up."

The pet cock, which is usually found in the bottom glass connection, should be omitted, as it is inconveniently located to use, will not stay tight and will rapidly corrode. In its place install a small pipe extending down to a globe valve and connecting into the column blow-down pipe. The column should be of a type having a flanged top bolted on so that the interior can be easily cleaned. The glass should have quick-closing connections operating by chains from the floor. The usual compression trycock, with wood wheel, and which requires a ladder to reach, should be replaced by a lever cock closing with a spring or weight and operating by a chain from the floor. By being thus conveniently reached, they will be used where the compression type would be allowed to corrode fast.

The firemen should be instructed to blow down the column and glass daily and to make frequent use of the trycocks. It would be good practice for the man in charge when making inspection rounds to blow down the glass and note the promptness with which the water returns. Arranged as described, it can be quickly done. It is difficult to see how such an arrangement for indicating water level can be improved upon.

Lewis C. Reynolds.

Willard, N. Y.

## Expert Advice

Personally, I should like to shake hands with Henry D Jackson for his expressions in the June 22 issue. I wholly agree with him. H. E. Samuels has an opinion that keeps him in a class by himself. There has never yet been a man who knew all about any one trade or profession, and it behooves all engineers to be awake to the fact that stationary engineering is a profession and an endless study. We may know a lot, but there are a host of men who know vastly more; we can never know it all.

Here in Ohio, where we have a license law, I personally know several men operating in small shops, box factories, planing mills, etc., who have licenses, and so far as their "bosses" are concerned their work must be satisfactory, or they would not be kept in their employ; and yet they do not know how to set the valves of their own engines.

As an illustration: In a planing mill there are three boilers, about 60 inches by 14 feet, supplying steam to one 22x42 "Wright" engine, running at 80 revolutions per minute. Two firemen are worked hard and an engineer is employed who has a "first-class license;" three men in all, and I know positively that most of the trouble (and there is a lot of it) is in the engine. One week's time of an expert would remove one boiler from service and at least one fireman; but one man ought to do the job himself and have a good time, too.

This plant is the worst of any I know of at present, but I know of several in almost as bad a condition, and some of the engineers would be quite "huffy" if an expert were employed to straighten matters out.

One engineer I talked with once told me that he considered that he "owned" any plant that he had charge of, and that the proprietor had no right to employ an expert, a machinist or anyone to do any work of any kind on the power plant, without first consulting him. This man's boss allowed him to superintend the installation of a new boiler recently. The boiler was set up and a boiler house was built over it after the boiler was set. The wall of the boiler house and the boiler setting were built solidly together, no allowance being made for expansion of the boiler shell, and no space provided around the shell up to the fire line. The boiler has been in use daily for about five months and now the boiler house is falling down from the cracking of the walls, caused by the expansion of the boiler shell. An expert's advice would have saved this, yet this is one of the engineers who is so well posted that he does not require an expert in his plant, and he is his own worst enemy; the expert would be a friend to him, if he were a broad-minded man, and awake to his own opportunities.

H. W. Benton.

Cleveland, O.

## That Vacuum Bottle Question

On page 284 of the August 17 number, I notice that Melvin E. Weil thinks he has put us all to shame by the manner in which he considers that he has answered the question of why the patent vacuum bottle will do as its advertisers say it will do, that is, remain cool three times as long as it will remain hot.

Mr. Weil's analogy of comparing the flow of heat to the flow of water, and his application of the term "pressure" to the flow of heat, are very pretty indeed, except that he forgets that not only may heat be considered as flowing under "pressure," but also he must consider that heat has "volume" as well. It is all right to say that the hot liquid has a difference of 180 degrees of temperature, constituting the pressure tending to cool it off, and the cold liquid has a pressure corresponding to 60 degrees tending to warm it up and that therefore there is three times as much tendency to cool off the hot liquid as there is to warm the cold one; but Mr. Weil forgets that the quantity of heat transferred in the two cases should also be taken into account.

The quantity of heat to be transferred is of course in each case the weight of the liquid multiplied by the specific heat of the liquid and by the temperature change. Bearing this in mind, it is easy to see that while the hot liquid has three times the so-called pressure to cool it off as the cold liquid has to become warm, there is also three times as much heat in the hot liquid to be transmitted as there is in the cold liquid, presuming of course that the bottle contains the same kind of liquid in each case.

Now, then, why should one process take longer than the other? This problem can be solved by integral calculus, but I'm not going to do it that way for two reasons: first, the publisher doesn't like integral signs in the paper and, second, I've forgotten how to integrate.

Let's get down to hard tacks. Mr. Weil says, and quite correctly, that the rate of flow of heat is proportional to the temperature difference. Well, as the hot liquid gets colder and the cold liquid gets hotter, the temperature difference or "pressure" is growing less and less and consequently the rate of heat transference is also decreasing. There will come a time when the temperature difference is so small, that the rate of heat transference is so exceedingly slow, that the temperature difference is decreasing so slowly, that the rate of heat transference is becoming so— etc. That's where the integral sign would come in. Anyhow, the thing is slowing up all around and as a matter of fact the hot bottle will never, never get cold and the cold bottle will never never get hot.

The question is, which happens first?

S. B. Redfield.

New York City.

## Cylinder Lubrication

In the early days, many engines ra without cylinder oil. Tuft, of Springfielc Mass., made no provision for getting o into the cylinder.

On a trip up from Sandy Hook, o the "Monmouth," the engineer told m that his pair of three-cylinder engines ha had no cylinder oil for four days. O a trip on the "Bridgeport," running fro New York to Bridgeport, Conn., the e gineer said that no cylinder oil had bee used for three years. He also said th he was once on a steamer and saw th engineer starting out with his cylind lubricator disconnected and called his a tention to it, and was informed that oil was used and that he could do t same by simply making up his mind it. He said that when he first start when steam was shut off there was good deal of groaning, but he stuck it and in a few days the groaning stopp and his cylinders and valves had been good condition ever since.

Where surface condensers and verti engines are used, it would be good pol to investigate and see if this could done, as the saving in cost of feed wa or of cleaning badly-scaled or dirty b ers would more than pay for any ex coal cost caused by friction. Vertical gines lend themselves readily to this p cedure, the chief trouble being with valves.

One engineer learned that the 10, horsepower engines of the steam "Etruria" used a smaller amount o pure mineral oil in a six-day trip than used in a twelve-hour run on one of own 64-inch low-pressure cylinders, compounded oil at that. The enginee the "Etruria" could separate the s amount of mineral oil from the feed w but the large quantity of compound could not be separated, and he had to $12,000 per year for feed water.

There is more friction without which means more coal, although t running without oil claim that no coal is used. When valves have t handled by hand, this is readily see

Locomotives used to be oiled fr cup and pipe leading to the steam c ts. When steam was shut off there was fi- cient suction to draw the oil in whe he cock was opened.

The throttle valves were slide ves and would lift from their seats lik or dinary slide valves. Sometimes after ter had gone over with the steam these ves would act as though they were weighted down, and in switching operations it was ard work to handle them. Oiling the cylinder and then throwing the lever over and changing the engines into compressor and forcing air under the throt-le would carry a spray of oil so that he valve would work easily.

It would be difficult to make a person believe that there was no excess of friction on a nonoiled steam surface. It is simply a question of which is the more economical, the cost of oil, feed water and cleaning boilers, or a little extra al.

When opening the cylinder and mineral oil is found in apparently the same form that it was before entering, the probability it has done no good. When a white, milky substance is found, it indicates that he oil has done good work; in other words, not oil but the result of the oil s what should be seen. This applies to linders where there is moisture present, and, because of this, it is important that there should be something in the oil that will emulsify or mix with the moisture, especially in single and low-pressure cylinder engines.

The best grease for soapmaking is tallow, and it emulsifies the best of any grease, and as a lubricant is the best of any grease known. For obvious reasons it will not do to use it alone, even if acidless tallow is advertised.

Tallow has a low viscosity and fairly high flash test, so that it does not vaporize, nor meet the requirements of those who think of high viscosity; but it is an elegant mixer with water.

One trouble with cylinder oil is due to the design of the valves. Of late years it has been the practice in many Corliss engines to make the ends of the valves extend beyond the ports from 3 to 4 inches, and as they are made round, there is no chance for a moderate amount of oil to get to those places and lubricate them, and recourse is had to an abnormal amount of cylinder oil to keep this wholly needless thing quiet.

I took charge of four 14 and 22 by 42 condensing engines running at 120 revolutions per minute that had this fault. These engines had been run about a year by the building contractor, and when I took charge I found that the men were using a barrel of cylinder oil in four [illegible]n two of the engines running twenty hours per day. The steam pressure was [illegible] pounds; superheat at the engines from [illegible] 70 degrees, depending on how the men carried the water. The receiver pressure was 35 pounds. I tried to cut down on the cylinder oil but was met with the story of the groaning. I told them to let the engines groan, it was simply due to those long ends and would do no hurt. As soon as possible I took out the valves and turned down the ends, leaving about an inch bearing, and grooving that so it would be lubricated. I locked up the oil and gave each man a certain amount for his watch and instead of using a barrel in four days, it would last for five months, one engine running twenty-one hours and the second about seven or eight hours. The oil cost 65 cents, and was compounded with neatsfoot. Later a 40-cent oil of the same stock was used, but not filtered.

At one place I had a 22 and 38 by 48 engine, running at 90 revolutions, and a 16 and 30 by 42 engine driving a variable-speed air compressor. The steam pressure was 165 pounds; no superheat. The main-engine receiver pressure was 35 pounds, with a surface condenser.

In the high-pressure cylinder we used a light oil (35 cents), that worked nicely and in the low-pressure a 35-cent oil compounded with an oil that separated easily from the water, and with a tank separator we had feed water free from oil.

The manager was young and was hypnotized by an oil agent and bought a 65-cent oil, nearly all mineral and of high viscosity. The engine was fitted with piston valves and oil worked fairly well but did not oil the Corliss valves on the compressor engine as well as the other.

About this time the old engine was abandoned and replaced by a 25 and 50 by 24 Corliss vertical running at 150 revolutions. The viscosity was too high for the high-pressure cylinder and the flash point and viscosity too high for the low-pressure and the ends of the valves.

Even after working down to a short bearing, it would groan when a reasonable amount of oil was used. To get the oil to feed all around, I put in about 25 per cent. of machine oil, which reduced the viscosity and flash point.

The high-pressure cylinder does not require high viscosity and the low-pressure needs a low flash test, if manufactured oils are used.

I think it doubtful if low-pressure, horizontal cylinders can be run without oil and compounded oil at that. With the two engines and four smaller ones it required about a barrel of oil a month.

W. E. CRANE.

Broadalbin, N. Y.

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The editorial on "Cylinder Lubrication" brings to mind an experience with a cut cylinder. It was the low-pressure cylinder of a compound condensing Corliss engine, 16 and 30 by 42 inches, running 60 revolutions per minute, with 100 pounds boiler pressure and 15 pounds receiver pressure. Upon taking charge, one of the first things looked into was the internal condition of the cylinders and valve chambers. The bottom and part way up the sides were considerably scored and the surface roughened, seemingly for want of oil. The walls of the high pressure cylinder were in excellent condition.

The low-pressure piston was dismantled and thoroughly overhauled. The sharp edges of the bull rings and steam ring were rounded, and an S type of spring was used for setting out the steam ring instead of the stiff, old-fashioned style of spring.

After the piston was reassembled, the cylinder was well oiled, and the head put on. Cylinder oil was fed to the internal parts by sight-feed lubricators. Oil was fed into the low-pressure cylinder at the rate of about four drops per minute, making the amount used per watch of eight hours, 1½ pints, or 0.18 + pint per hour. The engine was run for a week, and as far as could be judged, no cutting occurred. But in order to make sure, at the end of the week the low-pressure head was again taken off and the cylinder examined from end to end. There was a marked improvement, and it was certain that in the course of time the roughened surface at the bottom and sides would again become smooth and take on that glass-like polish which is desired. All the rings were turned round to a new position, with the idea of preventing any opportunity for scoring to occur. The cylinder was coated with oil, closed up and run for another week as before. This treatment was continued for a month, turning the rings to a new bottom bearing each time; a noticeable improvement showed up right along. Every time an examination was made the entire surface of the cylinder was found to be covered with a film of oil, and no matter on what part the hand was placed it could be felt that the surfaces were certainly getting and retaining oil. After a few such overhaulings, and by carefully watching at all times during operation that the cylinder got the four drops per minute, a glazed surface gradually came on, and never again was there any trouble from cutting and scoring. The engine is running today, and has been in service about eighteen years.

It may be thought by some that a pint and a half of cylinder oil for an eight-hour run of such a cylinder is too much, but judgment suggested that quantity, and experiment showed that it was about right. It might perhaps have been cut down a small amount without scoring the cylinder, but at any rate the error, if any, was on the right side.

The oil that was used was suitable for the purpose and cost 33 cents per gallon. As 1½ pints per eight hours were used, the oil cost 6.18 cents for the run, or 0.772, say 4/5 cent per hour. The average horsepower of that one cylinder all day was 50, so that 50 horsepower for one hour cost 4/5 of one cent for lubrication, and one horsepower-hour cost

1/50 × 4/5 = 2/125 *cent*,

or 0.016 cent per horsepower-hour.

CHARLES J MASON.

Scranton, Penn.

# Methods of Measuring the Flow of Water

## Tank Measurement, the Tank Orifice Method and Direct Measurement by Orifice in Thin Plate. Calibration of Flow through a Valve

BY FRANKLIN VAN WINKLE

Water is so generally employed for domestic and industrial purposes that methods for measuring its flow are of interest to all branches of engineering. Selection of a method of measurement will naturally depend upon the economy, convenience and accuracy required. Measurements of commercial importance should be made in a manner that is both convincing and reviewable, not only to allay doubts that may subsequently arise in the mind of the engineer who conducts the measurement, but also that he may be better prepared to meet reflections likely to be cast on his work by uninformed and interested critics. While accuracy is always of leading importance, the rule which obtains in surveys and other engineering measurements respecting precision of method and refinement of detail also holds true with respect to practical hydraulic measurements, viz., that refinement carried further than the degree of precision demanded of the results only tends to befog the results, and is of no possible advantage beyond scientific interest.

### TANK MEASUREMENT

When sufficient head is available for delivery and discharge from a suitable measuring box or other form of tank, undoubtedly the simplest and best method of gaging flow is by tank measurement. This consists in catching a known quantity of water and observing the time required. The greater the depth of tank employed the less the per cent. of error in observation of quantity, and the greater the volume caught per charge, the less the error in observation of time required per charge. When the flow to be measured is of considerable magnitude it is difficult to shut it off instantaneously from the measuring tank, or to estimate when to divert the supply so as to fill the measuring tank precisely to a mark. On this account the level of water received for each charge should be marked and noted, and the capacity of the tank carefully calibrated for each point of filling.

Cubical capacity of the simpler forms of tank is readily calculated. If the form of tank is irregular, requiring intricate calculations of capacity, then the capacity employed can be calibrated by drawing down known measures of water, or by weighing the quantities required for filling or drawn down from the points of fillings.

It may seem superfluous to call attention to the fact that errors are introduced from losses of water by spilling or leakage from the measuring tank. Inexactness in these respects leaves uncertainties in the mind of the experimenter and casts a reflection on the results as unworthy of confidence in any degree of precision. However confident one may be of the absence of leakage, the amount should be determined by test, and any material amount should be accredited to the flow. Careful observations should be made to ascertain if there is any reduction in volume when the measuring tank is left standing filled to the different points of level of test charges. If the rate of leakage is inappreciable when the tank is filled to the charging points, then error due to leakage may be neglected from calculations, but the rate should be noted along with other data. Strictly speaking, the rate of leakage should be determined at a large number of levels and duly accredited in the result according to their rate and the time required by the flow under measurement to fill the tank from one such level to another.

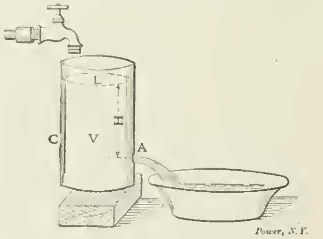

FIG. 1. TANK-ORIFICE METHOD

An absolutely tight tank is seldom obtainable, especially for measurement of large quantities at a filling, and all causes for errors incident to leakage should be reduced to a minimum. Estimates of the filling of an ordinary reservoir, pond or other irregular cavity in earthwork are not to be construed in the sense of accurate hydraulic-tank measurements because of the uncertainties in computation of their capacity, and the undiscoverable losses from seepage and evaporation.

### TANK-ORIFICE METHOD

Measurement of water by orifices or apertures consists in directing the flow through an opening whose discharging capacity is known or assumed for the conditions under which the opening is employed. This method of gaging water may be considered as coming next to tank measurement in point of accuracy. Measurements made by employment of sharp-edged orifices and apertures may be regarded as standard, because standard conditions of flow and form of aperture are more readily obtained and identified than with other forms, and with ordinary care they yield results which are nearer the truth than the percentage of absolute accuracy required of practical hydraulic measurements.

As rate of flow through an opening o given form depends on its size and th head of water acting, the measurement o an unknown rate of flow by orifice o aperture requires either that it shall b adapted to the flow with a constant hea on the aperture, or that the head ma adapt itself to maintenance of the flo through a constant size and shape of open ing. Generally speaking, it will be foun most convenient to make selection of a approximate size of opening and then a certain the head required for dischargin through it the flow to be measured.

A simple and efficient method of mea uring flow, which has the merit of suff cient accuracy for most practical pu poses, consists of what might be term a combination of orifice and tank measur ment and will be found both convenient a useful for metering small quantities water. It is founded on the hydr dynamic principle that when a vertic sided vessel like *V*, in Fig. 1, is fill with a liquid to any level, *L*, above t center of an aperture *A* in the side the vessel, then the liquid down to t center of the aperture will discharge self through the aperture with droppi head in twice the time the same qu tity would be discharged if the head w kept replenished to the original level *L*

This being true, the rate of discha may readily be determined for any h *H*, within the dimensions of the ta the process consisting simply in first ing the tank to the desired level, determ ing the quantity from the center of opening up to the level in question noting the time required for that sa quantity of water to discharge itself do to the center of the aperture. The vol so discharged can be estimated from dimensions of the tank, or, better, it be caught and weighed in a recei vessel. The rate of discharge from a c stant head *H* is readily determined by ing the time required for the tank thus discharge itself. The principle is an esting one and may be demonstrated very simple apparatus. A round or tin can, measuring 3x6 inches, or r, may be used as a measuring tank. discharging aperture may be a round r square hole cut in the side of the can, avoid errors which would be due to suppression of the natural contraction f the discharge, the hole should be placed to three times its own hight above the m of the can. It will be found most nient to perform the demonstration t the head of water carried at the top f measuring tank, for the tank may ld full to overflowing with greater than at any other level by drawing r from a tap or pouring from another . Having determined the time re- l for emptying the vessel by natural rge down to the center of the open- the measuring vessel may then be ed and kept full to overflowing, the s water being allowed to waste. these conditions established, catch scharge in the receiving basin for lf the length of time which it re- to empty itself down to the center orifice. The quantity should be ne in both cases.

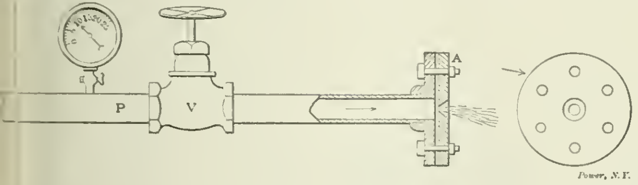

FIG. 2. ORIFICE IN THIN PLATE

T principle affords means for de- g the rate of discharge of almost the simpler forms of orifice, when rging under any head, and a ready r gaging flow by an orifice, pro- nly, that the necessary head is for the supply and discharge of rom the measuring tank.

eorem holds true only on the that the ratio of the actual theoretical discharge is constant ds. This assumption is not true for any form of aperture. uite nearly enough true for most purposes, especially employing r forms of "aperture in thin charging without suppression of n.* If greater refinement is de- a series of tests may be made of discharge of the aperture at heads, and this will admit of for the determination of actual ith as much precision as though harge of the aperture had been y separate tank measurement.

tion has been made to the inex- f employing a dropping head for ting the discharge of an aperture for the reasons (1) that for large orifices the time of descent is usually so small that it cannot be observed with precision; (2) that friction of the liquid on the sides of the vessel may introduce an uncertainty; (3) that with small heads a vortex forms about the orifice with unknown effect on the discharge; and (4) that the ratio of the actual to the theoretical discharge varies with the head acting on the orifice. All of these criticisms are more in line of refinement than is usually required of practical hydraulic measurements. As for the first one, ordinary engineering acumen will decide whether conditions are suitable for proper observation of time, that being simply a question of having a tank large enough in proportion to the size of aperture to obviate serious percentage of error in observation of time. As for frictional retardation of flow through the orifice, due to contact of the liquid with the sides of the containing vessel, it is hardly to be expected that for practical purposes one would use a tank so small in cross-sectional area that there would be any appreciable capillary effect or that there would be enough velocity downward through the tank to create a friction like pipe friction.

The third criticism, viz., that respecting the formation of vortices, is worthy of more than passing attention. It is true that some error may be introduced from formation of vortices which form as the head approaches very nearly down to the aperture, retarding the egress of the liquid. Any disturbance of this kind is likely to be regarded by the novice as seriously interfering with velocity of discharge, for it is to be observed only toward the end of the experiment when the observer is intent on catching the expiration of the time, and as the discharge is very much slower than in the beginning, he is liable to be impressed that it is unnaturally slow, rather than that it has been properly reduced as a result of reduction in head. The formation of vortex may be very materially reduced by the momentary introduction of a thin paddle let down vertically into the liquid If vortices occur to an annoying extent, then two or more smaller apertures may be employed, in which case they should, of course, have their centers on the same level, though they need not necessarily be of the same size or shape. For elimination of errors it is better that no aperture should be nearer another or to the bottom or side of the tank than three or four times its largest diameter.

As the combined tank and aperture method of measurement is founded on the hypothesis that for a given orifice the ratio of the actual to the theoretical discharge, called the coefficient of discharge, is constant for all heads employed, the fourth criticism is probably the first which would suggest itself to the mathematician. Upon looking over a table of discharges of circular vertical "orifices in thin plate," [illegible] inch to 12 inches diameter, giving discharges under heads varying from 9 inches to 10 feet, the coefficients are found to vary from about 62 per cent. to about 60 per cent. of the corresponding theoretical discharges; and for the same orifice under different heads, the variation will be observed to be less than 2 parts in 62, i.e., between 3 and 3½ per cent. The same general fact holds true for square apertures. This margin is close enough for almost any practical purpose, and closer in fact than independent experimenters would be likely to obtain results of the same flow by any method of measurement. When it is considered that the tank-aperture method consists of calibration of the aperture actually employed and under actual conditions of its employment, then under reasonable conditions it would seem that this method of testing and using an aperture should be quite as reliable for measuring flow as by employment of an orifice which has been constructed, applied and rated on the authority of an independent experimenter.

### DIRECT MEASUREMENT BY ORIFICE

Making direct measurement of flow through orifices in thin plate is a favorite method among engineers of metering the rate of flow of liquids and gases because of the simplicity of conditions required, the convenience of construction of such orifices and the small variation in value of coefficients of discharge which we have referred to. If a flow of water can be delivered to an orifice of this kind, under constant known head and without undue suppression of contraction, or other hindrances to natural formation of a jet of the form which it would assume if discharging freely into the atmosphere or emerging from a submerged orifice, then the effective head and the size of orifice being known, the discharge taking place may be relied upon to agree with the tabulated values close enough for all practical purposes.

Grave errors are frequently made, however, in assuming that passages through a valve, fitting, pipe, discharge outlet of a pump, etc., can be construed as orifices in thin plate. It may chance that an opening of this kind will deliver the quantity so estimated on the basis of some one or more of its dimensions, but estimates of this kind should be set down as of little greater value than guesswork.

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*S POWER AND THE ENGINEER, Aug. 25, age 314, and Oct. 13, 1908, page 606.

In gaging a rate of flow, some difficulty may be experienced in arriving at the size of orifice which will meet the required conditions. The required size may be determined either by gradual enlargement of the orifice up to a size found adequate, or a somewhat larger orifice may be employed, with suitable provision for creating a counter head on the discharge side of the orifice, thus effecting measurement of the flow in question, with its discharge taking place under normal condition of its head. Gaging flow by orifice may be better understood from the following illustrations.

Suppose it is required to test a water meter or the quantity of water delivered by a pump in either case by a 1½-inch pipe *P*, Fig. 2, the normal condition of delivery being through the valve *V* opened to such degree as to cause pressure in the pipe *P* to be reduced to 10 pounds per square inch. The size of aperture required for discharging the flow may be approximately determined by inserting reducing bushings in the discharge side of the valve *V*, and noting what size of bushing, if any, is required when the valve is full wide open, to check the flow to the normal (10 pounds per square inch) pressure on the inlet side of the valve. The internal diameter of bushing so required will generally be smaller than the diameter of orifice required for gaging the flow, but if the normal condition of flow requires the valve to be opened to its fullest extent without bushing down its outlet, then the measuring orifice may have to be smaller in diameter than the size of the pipe *P*.

The measuring orifice is most conveniently made by drilling a beveled-edged hole in the center of a blank flange, or diaphragm, made from a piece of plate iron, as shown at *A* in Fig. 2, the smaller diameter being the determining size of the orifice, and in measurement of the flow is to be presented "up stream," that is, so that flow takes place only by coming in contact with the sharp edge of the smaller diameter.

The orifice plate may be attached to the regular discharge valve *V* by means of a nipple and flange, and the orifice gradually enlarged until it comes up to proper size for discharging the flow with normal pressure showing on the inlet side of the valve *V*, but with the valve *V* opened to its utmost. If the size of orifice thus required is found to be larger in diameter than about one-fourth the diameter of the pipe *P*, then the valve must be removed and some other form of receiving chamber is to be employed which is four to five times the diameter of the orifice and of at least the same length, in order to obtain conditions of presentation of flow to the orifice which will be compatible with ratings that have been established for the flow through orifices in thin plate discharging without suppression of natural contraction.

Under some circumstances the process of thus arriving at the size of orifice may be very tedious and a method of measuring by orifice discharging against a counter head, which is under control, may be found more convenient. For this purpose a suitable aperture chamber must be provided for receiving the flow which is to be discharged through the orifice, and means must be provided for throttling its escape to any degree of back pressure found necessary to check and hold the discharge to the rate required for satisfying normal conditions of the flow which is to be measured.

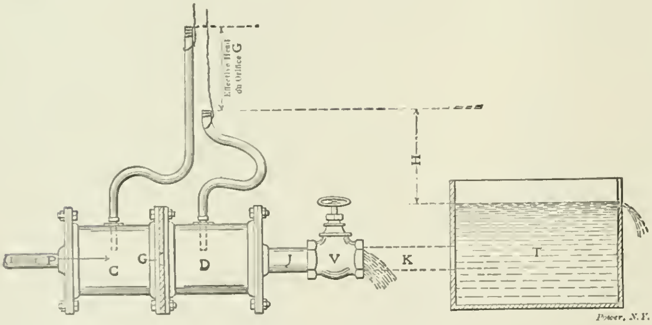

FIG. 3. METHOD OF CALIBRATING A VALVE

Assuming as before that the normal conditions of flow consist of discharge from a 1½-inch pipe *P*, Fig. 3, with a stated pressure of 10 pounds per square inch at the point of delivery to the discharging valve *V*, an aperture chamber *C D* may be improvised for employment of a diaphragm having an orifice *G* made as before by drilling a beveled-edged hole in a blank flange or diaphragm made of plate iron. The compartments *C* and *D* may either or both be composed of full lengths of pipe, but neither should be shorter than five to six times the diameter of the orifice employed and neither of the aperture chambers should be of diameter less than four to five times the diameter of the orifice. The size of the orifi
can be approximately determined by fin
ing the least size of bushing required
effect the discharge, as previously
scribed, but the size of orifice should
made larger rather than smaller. If th
is no objection to dimensions required
the orifice chamber, there is an advant
in making the orifice the size of
internal diameter of the pipe *P* for
purpose of rating the discharge unde
broader range of pressures or degrees
opening of a stop valve. The nippl
and valve *V* are the outlet connect
and escape valve from the compartment
This connection and valve should
be of greater capacity than the su
pipe, though two or more openings
be employed, and of any form for regu
ing the rate of discharge of the ch
ber *D*.

Some means must be employed for
termining with a fair degree of accur
the difference in pressure between the
let and outlet chambers *C* and *D* w
are on each side of the orifice. Ordi
metallic-pressure gages are unsuitable
this purpose; for portable purposes,
cury-column gages will be found
satisfactory; but for measuring mod
pressures, no better form of piezon
can be employed than ¾-inch ru
garden hose connected by long ni
down into the body of each compart
of the orifice chamber, as indicate
Fig. 3. The open end of each end of
can be drawn up against the wall
building by cords and pulleys or othe
elevated side by side for convenient
termination of difference in elevati
the hose ends when each is at the
of overflowing. This difference, p
ably measured in feet, is the diffe
of heads acting on opposite sides o
orifice *G*, and, for all practical pur
the discharge through the orifice f
pressures may be assumed as bein
same as though the orifice were
acted upon by a pressure equal to th
ference, and the discharge throug
orifice took place direct into the a
phere in place of discharging in
chamber *D*. As discharge from the
ber *D* is capable of being throttle
desired degree of counter head les
the head in the compartment *C* is
obtained.

### Flow Through Valve

For calibrating the flow through
ting, or for determining flow for di
points of registration of valve o
under different heads, the same f
apparatus may be employed by
the valve or fitting to be tested
discharge end of the chamber *D* i
of the valve *V*. If such a calibrati
be made with reference to the flow
takes place through the valve or
when discharging direct into the
phere, then it is only necessary t
a valve at the inlet of chamber

regulating the flow to the chamber *C* and then adjust the pressure in the chamber *D* to the desired intensity. When the valve or fitting under test is opened any stated amount and is discharging to the atmosphere, the rate of flow may be determined therefore from the size of the orifice *G* and difference of heads in the chamber *C* and *D*. If, however, the valve or fitting is to be tested to ascertain the discharge which takes place for a given drop in pressure for which it is responsible when inserted in a pipe line, then the valve or fitting under test should have a submerged discharge as into a wasting tank *T*. This tank should be of liberal proportions. The connections *J* and *K* should be of the same diameter and roughness as the pipe line and each should be three or more diameters in length so as to conform to the same advantages or disadvantages of advantages as those afforded by the pipe line. The supply to the admission chamber *C* is then to be so adjusted that *H*, the difference in elevation of the heads in the chamber *D* and wasting tank *T*, is equal to the stated drop of head in the pipe line.

Calibrations can thus be made of rates of flow through valves to determine the drop in pressure accompanying various degrees of opening, and if their construction is such as to be depended upon for a positive registration of their degree of opening, they may be employed with great advantage for metering the flow of pipe lines.

It may be understood from the above that mechanical apparatus required for the measurement of flow by orifices in thin plate need not be very elaborate. In estimating the discharge, the important factors for observation are measurement of the effective head (reduced to feet), the smallest diameter of orifice (if circular in form) for determination of its area in square feet. The theoretical velocity of flow, in feet per second, which would be due to any particular head may be readily determined from the formula:

$$v = \sqrt{2gh} = 8.02\sqrt{h},$$

or it may be obtained from tables of velocities of falling bodies.* A table giving areas of circles will give the area of orifice employed. This, reduced to square feet is to be multiplied by the theoretical velocity in feet per second, and the theoretical discharge of the orifice is obtained in cubic feet per second, and for practical purposes the actual discharge may be assumed to be 62 per cent. of the theoretical discharge so obtained.

Practical metering by employment of orifices should not be attempted unless the water to be measured can be delivered to the orifice with an effective head of at least ten times the depth of the orifice and generally with not less than 2 feet of head. These conditions are usually attainable wherever there is a supply of water of sufficient importance to be measured, but if they cannot be obtained, recourse must be had to other methods of measuring flow.

---

*See POWER AND THE ENGINEER, Aug. 25, 1908, page 314.

## Coal Imports and the Duty on Coal

Some of our contemporaries appear to be very much exercised about the probable result of the reduction of twenty-two cents per ton in the duty on bituminous coal made by the new tariff. One or two of them have gone so far as to predict heavy imports with a corresponding reduction in the trade of our own mines. It seems to us that this alarm is altogether needless, and that the lower duty is not likely to have any considerable effect upon the general coal trade. It is possible, of course, that in the East there may be a slight increase in the imports of Nova Scotia coal into New England territory, where it can be delivered by sea at a very low freight rate. The quantity of coal so imported, however, is not at all likely to be a serious menace to our own mines. The total present capacity of the Nova Scotia mines is very small in comparison with those of a single region in Pennsylvania—such as the Clearfield, for instance—which is now engaged in supplying eastern territory. Moreover, the quality of most of the Nova Scotia coal is not such as to make it a formidable competitor of such coal as Cumberland, New River, Pocahontas or Clearfield. The probability is that the great majority of manufacturers will prefer one of these coals to that of Nova Scotia, even if offered at a lower price. Moreover, if the reduction in duty is to be considered as a limitation in price, its effect would be very much less in that direction than is the present competition between West Virginia and Pennsylvania coals. We do not expect to see any marked increase in coal imports on the Atlantic seaboard.

On the Pacific coast, especially in California, the greater part of the demand for coal is already supplied from British Columbia and Australia. The reduction in duty is not sufficient to stimulate these imports to any great degree beyond the amount which they have already reached, and which is established by the existing demand and the absence of any strong competition from domestic coal. In recent years, in fact, the limiting agent in the consumption of foreign coal in California has not been the competition of domestic coal, but the use of fuel oil.

The only part of the country where the reduction in duty is liable to make any important difference is in the northwestern States of Montana and Idaho; where the lower duty will probably help the consumption of the excellent coal from the Crow's Nest pass district, a very considerable quantity of which already finds its way to this side of the line. This trade is of growing importance, but, after all, it owes its increase rather to the comparatively short haul and lower freight rates than to any tariff considerations.

The duty still charged of forty-five cents per ton will give domestic coal a certain advantage; but quality and freight rates will still remain the principal consideration, as heretofore, both in the East and the West.—*Engineering and Mining Journal.*

## Coal Production in Pennsylvania

The total production of coal in Pennsylvania in 1908, as reported by the United States Geological Survey, was 200,448,281 short tons, having a spot value of $276,995,152. This included 74,347,102 long tons (equivalent to 83,268,754 short tons) of anthracite, with a spot value of $158,178,849, and 117,179,527 short tons of bituminous, with a spot value of $118,816,303.

The production of both anthracite and bituminous coal in Pennsylvania in 1908 was less than in 1907, but owing to the fact that anthracite no longer enters to any great extent into manufacturing industries, it was less seriously affected by the financial depression than bituminous coal. The aggregate production of both kinds in 1908 showed a decrease of 35,299,208 short tons, or 14.97 per cent., in quantity and of $42,252,930, or 13.24 per cent., in value from that of 1907.

It is estimated that in Pennsylvania 16,970,000,000 tons of anthracite remain yet to be mined, and 109,000,000,000 tons of bituminous coal.

## Limiting Water Rights

Following the lead of the National Irrigation Congress which recently met at Spokane, Wash., the National Conservation Congress in session at Seattle on August 28 adopted a resolution to the effect that the Federal Government ought to limit grants and water rights to a reasonable and definite time and fix an annual tax upon them.

In a speech on "Conservation" at Chautauqua, N. Y., August 26, G. Grosvenor Dawe, managing director of the Southern Commercial Congress, said: "The harnessing of water power is urgently important. The prompt use of water power will indefinitely extend the life of our coal beds. This calls for a new body of previsionary legislation, giving aid to the development of water powers, but making their permanent alienation impossible."

POWER AND THE ENGINEER

DEVOTED TO THE GENERATION AND
TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

John A. Hill, Pres. and Treas. Robert McKean, Sec'y.

505 Pearl Street, New York.
355 Dearborn Street, Chicago.
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of Power solicited and paid for. Name and address of correspondents must be given—not necessarily for publication

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 10 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "Powpub," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During 1908 we printed and circulated 1,836,000 copies of* POWER.
*Our circulation for August, 1909, was (weekly and monthly)* 174,000.

*September* 7............ 42,000

*This paper reaches 42,000 separate readers each month and 33,000 each week.*
*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*

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## Misleading Exactness

In using formulas and making calculations it would seem that over exactness could do no harm, but if some of the factors in an equation are so indefinite as to nullify the apparent precision of others, then any exactness in excess of that demanded by the probable error in the most indefinite factor is a waste of time. Besides, the result obtained is often misleading, for if one factor is accurate to a small fraction of one per cent., it is only natural to suppose that the result will be equally close, when as a matter of fact there are other factors in the equation which can be determined only to within one or two per cent., and the supposition as to the exactness of the answer is, of course, in error.

In wiring calculations, for example, it is not often that electrical men strike a happy medium between crude approximation and an exactness obtained only in laboratory work. Take the formula used frequently in direct current work, where the volts lost equals the mil-foot resistance times twice the product of feet and amperes divided by circular mils. In the tables commonly used the circular mils are given to an average exactness of one-tenth of one per cent., and in making the substitution in the formula the circular mils are almost invariably used to the last place. This is surely over-exactness when the resistance per mil foot of pure copper at sixty-eight degrees Fahrenheit, as given by various authorities, varies from 10.35 to 11 ohms. In estimating the length of wire in a street circuit an error of two feet in a thousand, due to sag and the tilting of corner poles, is negligible, and in computing the length of wire from building plans it is almost impossible to come closer than two or three inches in one hundred feet.

With a relatively large variation in the conductivity of copper, owing to difference in hardness and purity, and since estimated lengths of wire may easily differ one-fifth to one-half of one per cent., there is no good reason for greater accuracy in the other factors, that is, one-fifth of one per cent. error in circular mils would be allowable, and for 000 wire the calculator would be perfectly justified in using 168,000 in place of 167,800, the value given in the table, and 1.97 for feet per pound in place of 1.969.

In the formula where weight per mile equals circular mils divided by 62.567, the denominator might well be changed to 62.6 and make an error of but little more than one-twentieth of one per cent. There are other formulas which might well be treated in the same way, but to be able to approximate intelligently and to distinguish between too great accuracy and careless figuring requires a thorough knowledge of the work, and perhaps it would be better to be on the safe side and be over-exact until familiar enough wi
the subject to know when and just ho
much to approximate.

## Care of Clippings and Catalog

The usefulness of manufacturers' ca
logs as sources of the latest and i
quently the only printed informatio
tainable on many technical subjects, l
recently been recognized by the trust
of the Free Public Library of Newa
N. J., in making special provision fo
collection of literature of this kind, an
is to be expected that the good exan
will be followed by public libraries
other industrial centers.

Printed matter is so freely distrib
nowadays that we are liable to exten
general neglect of gratuitous publicat
to those containing information worth
our special attention. Every progres
engineer is alive to the fact, howe
that a rich fund of information is t
gleaned from clippings of advertisem
and from trade catalogs, and knows
frequent reference to literature of
kind is almost unavoidable.

For want of simple and inexpe
methods of preserving private collec
of printed trade matter, it is often
case in consulting literature of this
that fruitless search for a much-de
clipping or catalog leads one to the
clusion that it must have found its
to the waste basket. Under those
cumstances a person who is inten
seeking information on a particular
ject, especially if not successful in fi
what he wants, is strongly impelled w
desire then and there to make a tho
house-cleaning of all advertising m
not immediately required. In this m
many catalogs in which more than
sible value is recognized become dest
for the very good reason that their
ence, in littering up a desk or offic
become intolerable. A confused co
of advertising matter is very liable t
tain a large proportion of pamphlet
culars and clippings that never
have been given more than ten
houseroom, but without means for
an orderly arrangement of such
as may have present or prospective
the whole lot sooner or later come
regarded as an untidy mass of rub

No one can appreciate the rea
of his collection of trade literatur
he has adopted a simple system o
matter of this kind and has accor
it the same care and dignity wh
does to preservation of other boo
papers Once a beginning is ma
time and mental effort required f
ing and filing advertising matter
found much less than that taken
obscure places for it, and with th
advantage that when a catalog or p

s needed there is no waste of time in etermining where to look for it.

Anyone who has never undertaken to le pamphlets and catalogs under a few ivisions of subjects will be surprised to d how large an amount of valuable ma- rial of this kind can be compressed into small space, and once some simple sys- m is inaugurated, its great advantage ver no system at all will be so highly preciated that the system selected is ite sure to develop itself into a very d one for its purpose.

No particular system of filing can be ated as best for all cases, but for a moderate-sized collection of cata- , when one does not wish to incur expense of a regular card-indexed wer file, it would be hard to find a ler more compact or less expensive d than by employing common box r files for receiving the matter under w leading heads. These box files are t two and three-quarters by ten by lve inches, they cost very little, are inable at most any stationer's, and en provided with bold labels signifying r special contents they present a good, ness-like appearance.

employment of five or six box files, we have suggested, an engineer or fore- can maintain a very satisfactory cat- le which will not only be a source great convenience to him but will be ressive of his ability and intelligence. ning with a promiscuous pile of cat- , pamphlets and circulars, it is well t rt them out under only a few heads, (1) Engines and Appurtenances; (2) ers, Pumps, Heaters and Appurte- s; (3) Electrical Machinery and plies; (4) Shafting, Pulleys, Belting, (5) Pipe, Valves, Fittings, Plumbing a Steam Goods; (6) Hardware Sup- . General Merchandise.

fore filing away in the boxes it is to make a thorough weeding out of esirable catalogs, and if any classi- n is then found too large for a box, part of the collection under head can be carried over into the box, and if by thus distributing the ts there does not appear to be room for the collection, the y is evident, viz., either to cut down by a closer pruning or add a box or two. A few catalogs will lly be found too large to be placed filing boxes; these can be stood up between the boxes next to those ining their proper classification.

making use of box files, as we have ed out, it is not necessary to take a box every time a catalog is ready e added to the files, as the circular amphlet can be slipped between the s to the right- or left-hand side of one containing its classification until time as it becomes convenient to e it in its proper box. The unfiled phlet is thus brought to notice in g down its proper box just as effectually as though it had actually been filed. One great advantage of box filing with a small number of headings lies in the fact that double filing and dead matter are quickly detected, and if more space is required, the system is easily expanded by addition of a new box right along side of a filled one, without disturbing the accustomed order of arrangement of subjects; but the principal advantage of this system of filing is its compactness.

The owner of a catalog file is not continually confronted by a nightmare of printed matter of doubtful value but pretty nearly knows what he has on file, and when he wants a catalog or clipping, quickly lays his hand on it.

# The Detroit Boiler Inspection Ordinance

For a market for the sale of boilers, either new or second-hand, Detroit is likely to be second to none of the cities which have boiler-inspection ordinances in operation. According to the recently adopted ordinance, boilers in which the shells or drums are directly exposed to the fire and are of the lap-seam type, the factor of safety used is 4 for pressures of 100 pounds or less, $4\frac{1}{2}$ for boilers carrying pressures not exceeding 125 pounds per square inch, and 5 for pressures not exceeding 150 pounds. While these factors are low for new boilers of the lap-seam type, they apply equally to boilers of any age, and the inspector, if inclined to use discretion in the matter, cannot legally do so. In the matter of age, Detroit makes no distinction, allowing the same pressure on a boiler which has been in service any number of years as on one fresh from the shop. A boiler of lap-seam construction twelve years old which would be allowed 100 pounds pressure in Detroit would, by the Massachusetts rules, be allowed only 72.9 pounds pressure per square inch, and there would be no stretch in the inspector's ruling that would say 73 pounds is near enough. It seems that water-tube boilers are discriminated against by the requirements of higher factors of safety than are used for boilers of admittedly unsafe construction; unsafe because uncertain. The glaring inconsistency in the ordinance is the selection of 5 and 6 as the factor of safety for water-tube boilers for pressures of 150 and 200 pounds pressure, respectively, notwithstanding the fact that seldom, if ever, are the drums of water-tube boilers exposed to the direct action of the products of combustion.

A lap seam may be safe until the bending action which takes place along the joints at every change of pressure has made a crack which extends nearly through the sheet, but there is no way of determining when this crack, which is certain to come, will pass from the safe to the unsafe side of the line. It is to be regretted that the authors of the ordinance did not have this in view, together with the higher factors of safety that obtain in Massachusetts, Philadelphia and Chicago, when this ordinance was passed. It may be necessary in some sections to get out digests of inspection laws in order to have boilers pass inspection in the various localities where they are sold, or get together and secure uniformity in inspection laws.

# Massachusetts Inspection and License Laws

In the editorial on the above subject, on page 164 of the July 27 issue, the following statement occurs: "New boilers of the lap-seam type above *forty-two inches* in diameter are forbidden use or installation in the State. Massachusetts legislated wisely in the matter of lap-seam boilers," etc.

In the edition of the Massachusetts Board of Boiler Rules, dated January 9, 1908, paragraph 8 section 17 reads as follows: "The longitudinal joints of a boiler the shell or drum of which exceeds 36 inches in diameter shall be of butt and double-strap construction." Attention is further called to paragraph 7, page 29, of the present rules formulated by the Board of Boiler Rules, where it will be seen that the original rule has not been changed.

It will also be noted, on page 45, that when it is desired to install a boiler which does not conform in every detail with the rules formulated by the Board of Boiler Rules, the longitudinal joints of such boiler must be in accord with the provisions of paragraphs 7, 8 or 9; that is to say, if the diameter of the shell or drum exceeds 36 inches, the longitudinal joints must be of butt and double strap construction, or some form of longitudinal joint other than lap-riveted, which would require to be approved as provided for by paragraph 9, page 29, of the rules.

---

A report on the resistance of rivets is presented by Charles Fremont to the *Bulletin de la Société d'Encouragement* for April. It is pointed out that the resistance of riveted plates to statical forces or shocks should be borne as much as possible by the adhesion of the plates and as little as possible by shearing of the rivets themselves, and the author emphasizes the necessity of standardizing the heads of rivets and of regulating the maximum temperature during the process of heating, so as not to destroy the elastic qualities of the rivet. The increased efficiency obtained by the application of continued pressure during the riveting is also mentioned.

# Monster Dry Vacuum Pump in Salt Works

Evaporating the brine from salt wells, with the consequent recovery of the salt held in solution, has developed a demand for high-vacuum apparatus to be used in this service, the early crude processes having given way to more refined methods, as it is obvious that when evaporated in a vacuum, the precipitation will be more rapid and economical. Furthermore, it is customary whenever possible, to use exhaust steam from some other industry in this connection, so that the salt obtained may be considered more or less a byproduct. This plan is being followed at the plant of the R. G. Peters Salt and Lumber Company, East Lake, Mich., where the exhaust steam from a large sawmill furnishes the necessary heat energy for vaporization. Water which has been forced to the salt bed 2100 feet below the surface of the earth comes to the plant as an almost saturated solution of sodium chloride, running ordinarily from 96 to 100 per cent. saturation. The salt is precipitated in minute crystals, clean and white, and when dry is ready for the table.

Three enormous vacuum pans, each 30 feet in diameter, arranged to run with double or triple effect, are installed here with a combined capacity of 4000 barrels as double, or over 6000 barrels as triple effect, in twenty-four hours, and connected to a barometric condenser. The pans are each fitted with over eight thousand $2\frac{1}{4}$-inch copper tubes and are generally operated for triple effect, the hot vapor from the first going to the second, etc. The first pan operates under about 12 inches of vacuum, the second 20 inches and the third about 28 inches. This arrangement produces about six tons of salt for 16,000 pounds of steam at atmospheric pressure, which is equivalent to one ton of coal on the basis of eight pounds of water evaporated per pound. It is to augment the vacuum obtained by the condensing apparatus that the dry-vacuum pump shown herewith has recently been put in side by side with another pump of the same type, though somewhat smaller, being 42 inches by 36 inches stroke, that has seen ten years' service. With this equipment a vacuum within one inch of the barometer is guaranteed, with water at 60 degrees Fahrenheit, and at times it is within $\frac{5}{8}$ of an inch of the barometer when condensing 45,000 pounds of steam per hour.

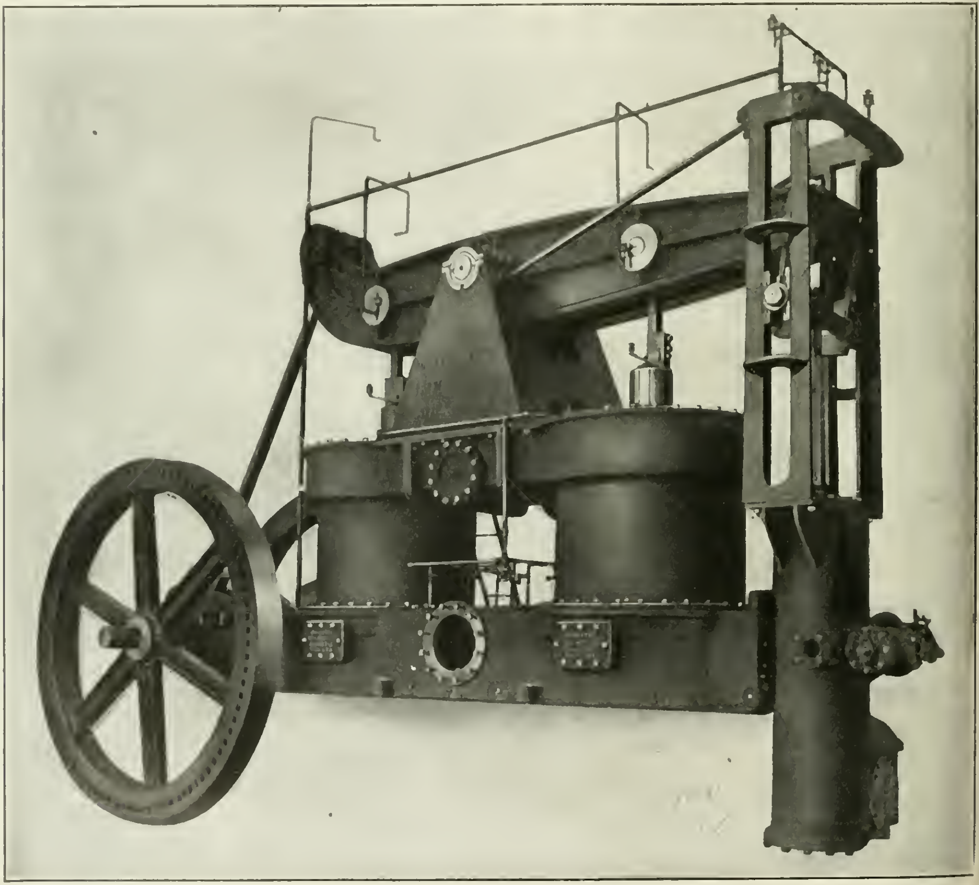


FIG. 1. MANISTEE DRY-VACUUM PUMP

The pump, as can be seen in Fig. 1 steam-driven, of the beam type, with cra and flywheels, and is said to be the larg dry-vacuum pump in the world, hav 48-inch diameter by 36-inch stroke cylinders and a steam cylinder 18 inc in diameter by 72-inch stroke, and wei with steel foundation and cast-iron umns, about 125,000 pounds. The p is supported by heavy concrete four tions at an elevation of some 25 feet f the surface of the ground on cast- pillars and steel beams and is closely nected with the condenser head for effective working. The base consists of one large casting which forms a support for the steam cylinder, air cylinders and main bearings. The suction valves, 26 in number for each cylinder, are located 22 under each piston and 4 on the two higher decks to pass the lighter air at each stroke. Bronze linings are fitted to the air cylinders, each of which is single-acting, as indicated in the sectional drawing.

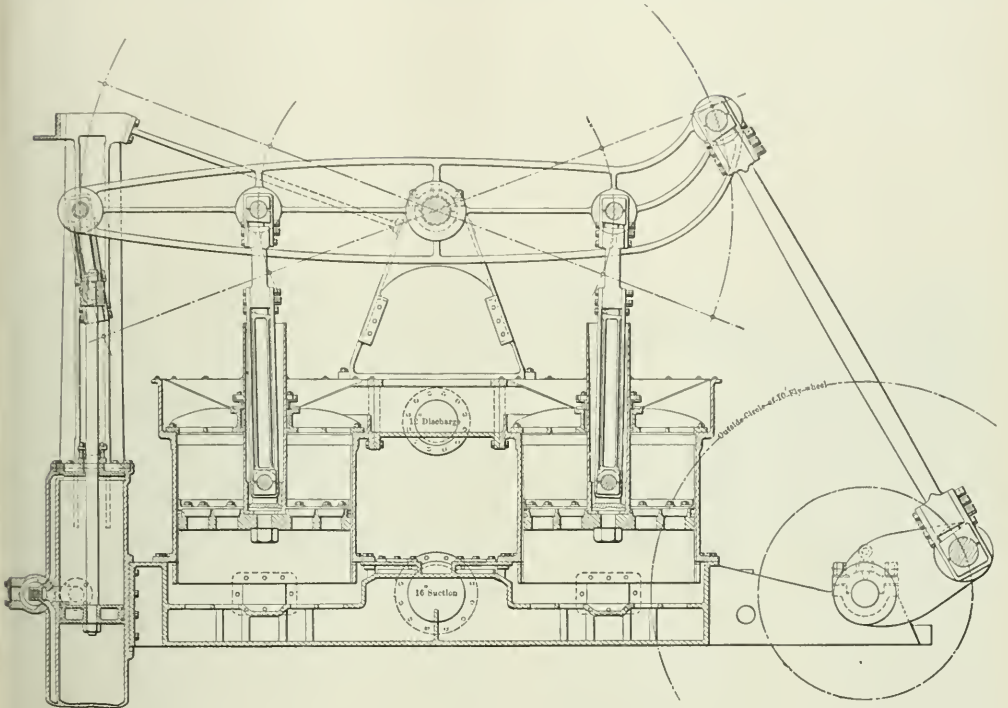


FIG. 2. SHOWING MANISTEE PUMP IN SECTION

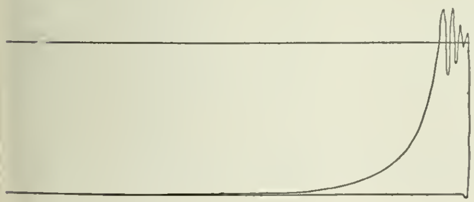


FIG. 3. DIAGRAM TAKEN ABOVE PLUNGER

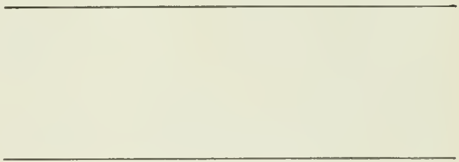


FIG. 4. DIAGRAM TAKEN BELOW PLUNGER

All valves are 7 inches in diameter, of flat rubber disks and have no springs. Discharge and piston valves, 44 for each cylinder, are sealed with about three inches of water, while the four individual higher-suction valves are located in cast-iron cup rings which provide about one inch of water on the valves, or just sufficient to seal them effectively and allow them to lift under the very slight difference in pressure between the upper and lower sides of the suction valves. On the large gland surrounding the trunk piston rod provision is also made for a water seal, not only on the gland itself but on the stuffing box as well, as indicated in Fig. 2.

Clearance is made as small as possible by making the piston of one solid casting with bronze followers arranged to carry 3 inches of water seal on the piston valves, thereby occupying all space not taken up by the valve openings. Fig. 3 shows a diagram taken above the piston and marks its position at the time of discharge. Large as the cylinder is, it can be seen that the discharge did not open until the piston had nearly completed its stroke, in this case about three inches from the end of the stroke. As an item of interest, Fig. 4 is presented, being a diagram taken in the suction chamber under the piston.

The steam cylinder is fitted with an ordinary rocking or semirotary valve, operated from the main shaft with an eccentric. The guides are well braced to the main frame and the crosshead attaches to the beam through a link connection. Sight-feed oil cups and wipe oilers are provided for all lighter bearings, and grease is used on the main journals and crank pin. An interesting constructional feature is the crook in the walking beam, as shown, where the connecting-rod wrist pin is located on a center 26 inches above the center of the main beam. This has been found necessary in order to decrease the crank radius, shorten the main base plate and at the same time provide an adequate length of connecting rod, which is 11 feet 8⅝ inches, center to center. The flywheels are each ten feet in diameter, and as installed there is an outboard bearing at each end of the shaft. As each piston is working in an almost absolute vacuum during the greater part of the stroke, the steam required to operate the pump is little more than that necessary to overcome friction, the excess energy being stored in the flywheels to be given up during the short discharge. No governor is required. Thirty revolutions per minute is the normal speed.

This pump is perfectly adapted to service as a dry-vacuum pump in a central station where its large capacity would enable it to take care of a number of condensers at once. The pump was built by the Manistee Iron Works, Manistee, Mich.

## The N. A. S. E. Convention

The twenty-seventh annual convention of the National Association of Stationary Engineers will take place at Columbus, O., during the week beginning September 13.

### Monday, September 13

The opening of the annual convention of the Ohio State Association of the N. A. S. E. will occur on the roof garden of the Southern hotel, at 9 a.m. The Ohio State convention was held over to this late date for the purpose of receiving the delegates to the national convention.

The bureau of registration will be open all day and evening.

The official opening of the mechanical exposition of the National Exhibitors' Association will take place in Memorial hall at 1 p.m.

The regular session of the Ohio State convention will begin at 2 p.m.

There will be a general reception to delegates and visitors at the Southern hotel at 8 p.m.

The annual meeting of the National Exhibitors' Association will be held at 8:30 p.m. in Memorial hall.

### Tuesday, September 14

The official opening of the N. A. S. E. convention in the auditorium of the Board of Trade building will be at 10 a.m. The opening address will be by Charles M. Gilbert, chairman of the local committee; invocation, Rev. Washington Gladden, D.D., "Welcome to Ohio," by Governor Judson Harmon; response, by National President Fred J. Fischer; "Welcome to Columbus," by Mayor Charles A. Bond; response, by W. J. Reynolds, national vice-president; address by Past National President Joseph F. Corney.

The official photograph will be taken on the steps of the State capitol immediately after the close of the opening exercises.

The first business session of the national convention will take place at 1:30 p.m. All sessions of the convention will be held in the Board of Trade auditorium.

The opening of the annual national convention of the Ladies' Auxiliary will take place at the Southern hotel at 2:30 p.m.

The annual meeting of the Life and Accident Department of the N. A. S. E. will be held at 7:30 p.m., at the Southern hotel.

There will be an entertainment by the Ladies' Auxiliary of Columbus at 8:30 p.m., at the Southern theater.

A continuous concert will be given by the Newsboys' band at Memorial hall, from 7 to 10 p.m.

### Wednesday, September 15

There will be a trolley trip to the new water-softening and filtration plant at 9:30 a.m.

Cars will leave Southern hotel at 1:30 p.m. for Olentangy park, where the theater and various other attractions will be open to the delegates and guests.

### Thursday, September 16

There will be morning and afternoon sessions of the delegates, and a morning meeting of the Ladies' Auxiliary. All sessions will be at the Southern hotel.

An automobile trip through the parks has been planned for the ladies at 2 p.m.

At a meeting of the National Exhibitors' Association in Memorial hall, at 7:30 p.m., the election of officers will take place.

An entertainment will be given at 8:30 p.m., in Memorial hall, by the New York "Bunch."

### Friday, September 17

There will be morning and afternoon sessions of the N. A. S. E., and of the Ladies' Auxiliary. At the afternoon sessions officers will be installed.

A visit by the ladies to the relic room in the State capitol will take place at 3:30 p.m.

The installation of newly elected national officers of the N. A. S. E. will occur at 8 p.m. in U. C. T. hall.

There will be a grand ball in U. C. T. hall at 9 o'clock.

### Saturday, September 18

Delegates and guests will be welcome at the various power plants nearby.

The mechanical exposition in Memorial hall will be open every day from 10 a.m. to 2 p.m., beginning Tuesday, September 14.

## Turbine Club Outing

The annual outing and games of the Turbine Club, of New York City, took place at Wetzels' Point View park, Long Island, on Saturday, August 28. This association is composed of the janitor engineers connected with the public schools in Greater New York. The steamer "Isabelle" conveyed the party to the grove, on Long Island sound, where breakfast was awaiting them. After satisfying the inner man, the company adjourned to the grounds, where outdoor sports of all kinds were indulged in. The serving of an appetizing clambake concluded an enjoyable occasion.

## Water Power Trust in Michigan ?

"The recent incorporation of 18 power companies in Lansing, Mich., 14 Loud companies and four others, with a total paid-in capitalization of $3,200,000, is but a forerunner of the formation of a great holding company that will take over not only these 18 companies, but a number of still larger and more important ones in Michigan," was the statement made to a representative of Power. Immediately back of the formation of the new companies, it is claimed, is the Hodenpyl-Walbridge syndicate, of New York.

They have coupled with the Louds of Au Sable, it is alleged, in the development of the Au Sable river, and it has been reported for some time that the Eastern Michigan Power Company, which secured franchise rights to all the power sites on the Au Sable river, was merely an exploration company, and that before the work of developing the dam sites was taken up, new corporation steps would be taken.

But back of the whole scheme is discerned the hand of the General Electric Company, according to Michigan men who believe they are well posted. The General Electric Company is said to be identified with the Hodenpyl-Walbridge people, but more particularly with the Commonwealth Power Company, of Jackson, Mich. The connection of his firm with the formation of the new concerns is easily traced through W. H. Claire, of Detroit, who appears as one of the incorporators of the largest group of new corporations.

Any attempt to secure a monopoly in Michigan's water rights has been emphatically denied by Mr. Walbridge, of Hodenpyl, Walbridge & Co. The firm has absolutely no connection with the Loud interests and no dealings with the General Electric Company, except as a purchaser of power-plant supplies. The Louds disclaim any connection between the water power companies they have formed an the three companies of the syndicate, an furthermore, a representative of the General Electric Company speaks of th rumors as being utterly absurd. Howeve this may be, Michigan would do well t guard her rivers so carefully as to mak such a monopoly of her water powers im possible, and, while encouraging in ever legitimate way their early developme and to this end granting the requir rights upon such terms as will offer a attractive return upon the venture, to saf guard the interests of her people in th waters by providing for their recovery those rights under conditions fair to concerned whenever their exercise private interests becomes unreasonab and extortionate.

# Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

## The Improved Milne Water Tube Boiler

In the Milne water-tube boiler which has been previously described in these columns, May, 1904, notable improvements have been added that will prove of interest. This boiler consists of an upper and a lower horizontal drum, connected with outer banks of tubes, and an inner bank of tubes between them, so arranged that spaces of suitable width between the banks of tubes provide access for inspection, cleaning and repairs through doors set in masonry adjacent to these spaces. The tubes are all uniformly shaped, and are interchangeable. The large radius of curvature permits the use of any of the standard cleaning tools, and the removal of one manhole plate gives access to an entire set of tubes. The tubes stand in vertical staggered effect and are spaced in such a manner that any of them can be removed and replaced without interference from adjoining tubes or the setting. This arrangement is shown in the accompanying illustrations.

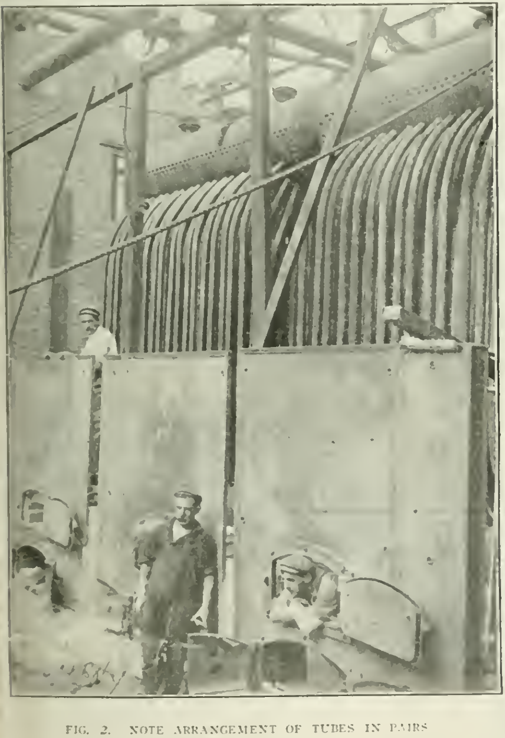


FIG. 2. NOTE ARRANGEMENT OF TUBES IN PAIRS

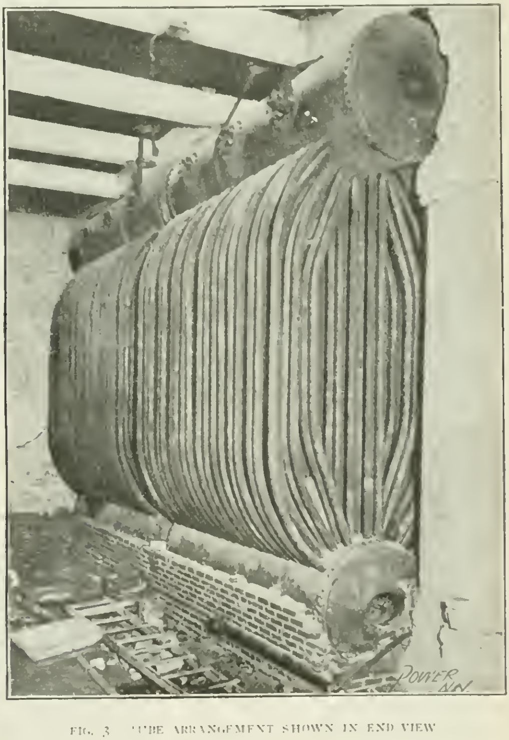


FIG. 3 TUBE ARRANGEMENT SHOWN IN END VIEW

It has been found in daily practice, as might naturally be expected, that the tendency for ashes and the dust of combustion to adhere to the exterior surfaces is lessened, and that such accumulations find their way to the rear chamber, being easily removed through the door shown at the right of Fig. 1. Likewise on the interior of the tubes, scale-forming matter does not readily adhere, but is precipitated and settles in the large lower drum, where it can be blown out at will.

An interesting feature is the feed chamber, shown in the lower drum. This chamber is usually connected with the two rear rows of tubes, and is closed or sealed against the water in the lower drum, so that the incoming feed water is not mixed with the hot water in the drum, but is forced up by the pressure of the pump through the two rear rows of tubes, and as its passage requires an interval in time of over ten minutes before it finally enters the upper drum, its temperature is gradually raised to a high point, and the great bulk of the scale-forming matter is precipitated to the chamber below. Another good point about this arrangement is that the cool water (in the two rear rows of tubes connecting with the feed chamber) coming in contact with the gases on their way to the flue absorbs a great deal of heat which would otherwise be wasted; a proportionate economy of fuel is, therefore, effected.

The water-holding capacity per horsepower is unusually large, which will be apparent when the volume stored in the

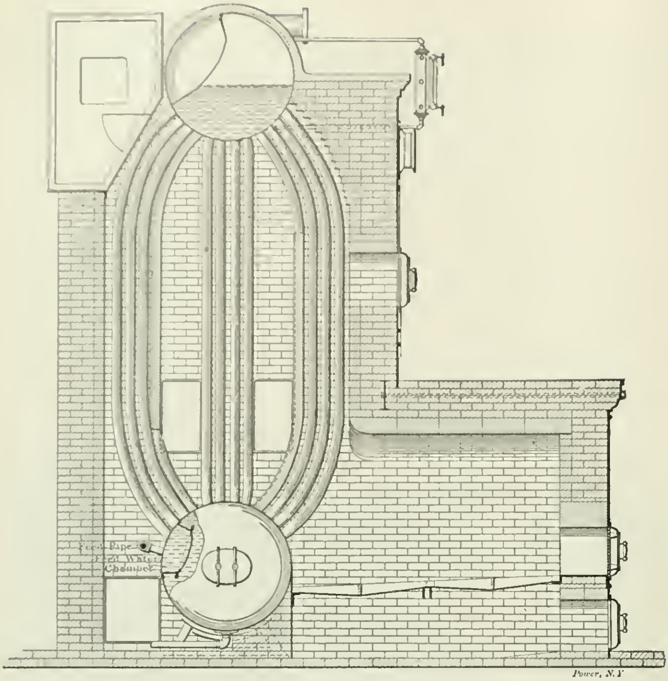


FIG. 1. SECTIONAL END ELEVATION OF MILNE BOILER

lower drum is taken into account. The steam-liberating surface is ample, and on account of the evenness of circulation, and the fact that the feed water enters the upper drum at the steaming point, priming is unknown and dry steam is produced under all varying conditions. With the construction shown, the upper drum is clear of all obstructions, and all tube joints are accessible, but in instances where head room is limited, a dry-pipe arrangement is applied, and the steam outlet placed at the side instead of on top.

The furnace, Fig. 4, is of the dutch-oven or dog-house type, but with a notable improvement in arch construction, and has proven highly efficient and of great durability. The boiler setting is bound together with heavy channel beams set flush with the brickwork, and of such substantial form as to avoid cracking of masonry.

When the boiler is in operation, the gases of combustion, leaving the furnace, rise upward, flooding the front bank of tubes. A portion of the gases take a horizontal as well as vertical direction, but the baffle tile forces the bulk of the gases upward the full length of the tubes. At the upper drum the gases turn and take a downward direction, thence turning again under the baffle tile in the rear bank of tubes and rising to the outlet.

Circulation is upward in the front bank of tubes, the velocity being very rapid on account of the high temperature, the large exposed fire surface and the absence of all restrictions. In the second bank of tubes the circulation is also upward, but with lessened velocity proportionate to the difference of temperature; and in the rear bank of tubes the circulation is downward through the two rows of tubes not connected with the feed chamber, and upward through the tubes that are connected with it.

The construction throughout is simple. No handhole plates, headers or flat stayed surfaces exist, and the floor space occupied is comparatively small. The boilers are made in all sizes from 150 to 1000 horsepower for all pressures by the Milne Water Tube Boiler Company, 154 Nassau street, New York City.

## Producer Gas from Crude Petroleum

A process for the production of producer or power gas from crude petroleum is now being brought to the attention of power users. This is carried out in an apparatus known as the "Nix-Frost" oil-gas suction producer, which depends for its efficiency upon three essentials: First, a zone of high temperature maintained practically uniform; second, a supply of carbon, preferably in an atomized form, which passes into this high-temperature zone; third, the removal of the products from the generator itself by suction.

No water or steam is used. The gas is made with air and oil only, free air being admitted during the process of gas generation. The resulting gas is peculiar in that it contains a very small percentage of hydrogen, which, of course, allows high compression in the engine.

The owner of the United States patents, the Western Gas Engine Company, of Los Angeles, Cal., has operated this sys-

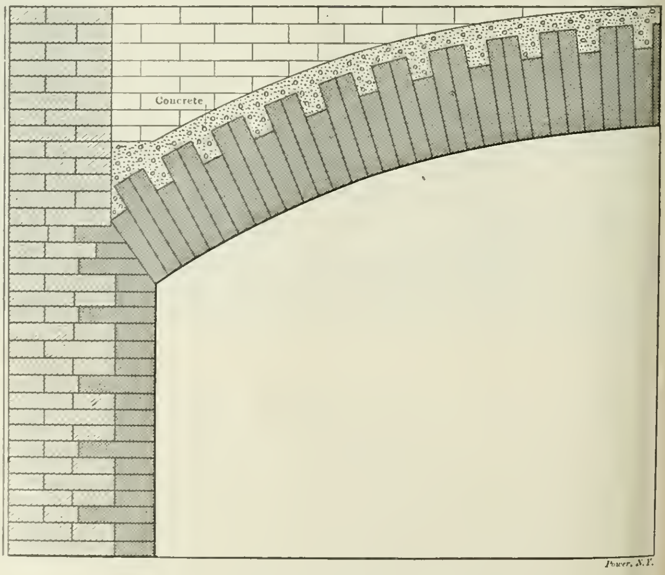
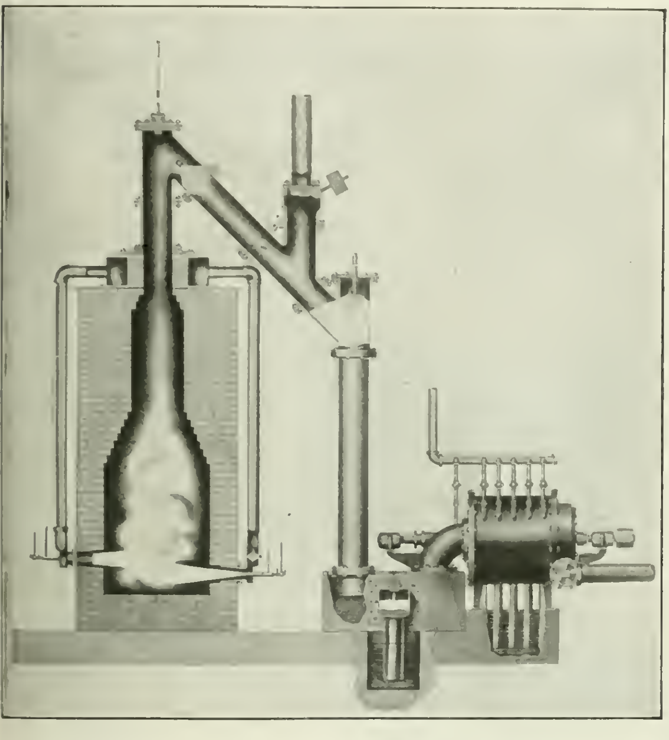


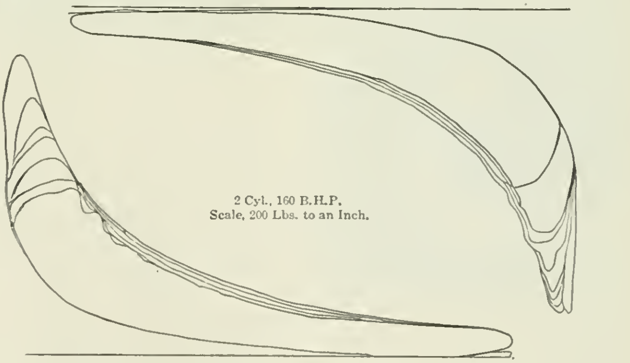
FIG. 4. FURNACE CONSTRUCTION FOR MILNE BOILER

tem experimentally more than three years, during which time the apparatus has been reduced to its simplest form, so that it is now presented to power users not merely as a gas producer, but as a complete power system, covering the generation of the gas and also the removal from it of the lampblack, tar or other deleterious particles which are not wanted in the engine. It also embodies means for keeping the supply constant and the quality uniform, and for changing the values at such times as the load on the engine is changed.


"NIX-FROST" SUCTION OIL-GAS PRODUCER

While it is practicable to operate with a gas holder, yet it has been found that it is unnecessary, and that the best running results are obtained by taking the gas directly from the scrubber to the engine, without intermediate storage. After leaving the gas generator, the gas is drenched with a water spray which removes a large portion of the lampblack or tar, and it then goes through a specially designed centrifugal scrubber, to which is attached a suction fan. In this, it is claimed, the last particles of foreign matter are removed and the gas goes to the engine clean.

The manufacturers state that a 150-horsepower engine on the testing stand, after being operated for about six weeks practically every day, under full load, showed not a particle of foreign matter of any description when the cylinder heads were removed, the cylinders, rings and other internal parts being perfectly clean.



DIAGRAMS FROM ENGINE RUNNING ON GAS FROM "NIX-FROST" OIL-GAS PRODUCER

For three weeks the valves were left untouched. At the end of that time the deposit on the inlet valves was found to be insignificant in quantity and not sufficient to impair the proper operation of the valves.

As to economy, it is claimed that one pound of crude oil per hour will yield one brake horsepower in the engine, in units as small as 1 horsepower. In a test run by Prof. William F. Durand, professor of mechanical engineering at the Leland Stanford University, on an engine rated at from 125 to 140 horsepower, and delivering at the time 108.9 brake horsepower, 102.45 brake horsepower was obtained with the consumption of 107.81 pounds of crude oil per hour, making the fuel consumption for one brake horsepower 1.05 pounds of crude oil per hour. The manufacturers state that since then they have produced much better results. In one case an electric-generating plant just started on a first load showed 319 kilowatt hours with 59½ gallons of crude oil per hour, the auxiliary load being about 25 kilowatt-hours. This gives nearly five kilowatt-hours per one gallon of oil, or 207.9 kilowatt-hours per barrel of 42 gallons net output of the plant.

The producer generator is very simple, consisting of a steel shell lined with firebrick, into which is sprayed the oil through compressed-air atomizers. The gas passes over to the wet scrubber, receiving a shower of water on the way which condenses the gas and drives out a large portion of the lampblack or tar. From there it goes directly into the centrifugal washer and thence to the engine. The compressed air is supplied by a small air compressor, and the oil is fed by any suitable pressure means.

The water used in the cleaning of the gas may be used over and over for a long period of time. As it flows away from the scrubber, the lampblack or tar floats upon the surface and is skimmed off by a wing dam into tanks. The water then passes into the sump, is partially cooled and returned by a pump to the scrubber.

The attendance required appears to be very slight, as the whole system is designed to be self-cleaning and requires very little internal attention. It is stated that one man is quite enough for the operation of a 300-horsepower producer and engine. On larger plants more help is required, not for the producer but about the plant generally. Very little space is used, a floor area of 12x12 feet being large enough to contain a generator, air compressor and cleaning machinery for a 500-horsepower plant.

As to the character of the fuel employed, the builders state that they have used every form of petroleum which they could obtain. The crude petroleum of the Pacific coast is especially heavy, being composed largely of asphalt, the most difficult of all petroleums to reduce to a gas, but this process is said to handle the heaviest oils without difficulty, also refinery residuum, as well as the light hydrocarbon oils. The builders state that they are ready to garantee the apparatus to gasify anything in the form of fluid carbon that can be put through a pipe and atomized.

## The Turbo-Blower

The apparatus known as the "Turbo-Blower," manufactured by the Turbo-Blower Company, 30 Church street, New York City, is herewith illustrated. Its purpose is twofold—first to produce a mechanical draft so that various grades of cheap fuel may be burned in a boiler furnace, and, second, to increase the capacity of any boiler from 25 to 35 per cent. It is of simple design and is self-contained.

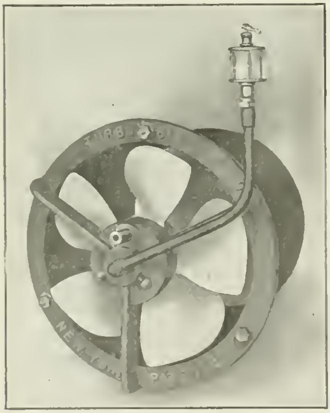


FIG. 1. FRONT VIEW OF TURBO-BLOWER

It consists of an aluminum propeller, a turbine motor and a casing which is set in the front, side or rear walls of the boiler setting, as conditions dictate, there being no projecting part beyond the brick setting to become broken or in the way. All parts are protected from dust and ashes and the only attention required, it is said, is to fill the oil cup occasionally.

Fig. 1 is a front view of the Turbo-Blower assembled and ready to be set in the brick boiler setting. Fig. 2 shows the propeller casing removed. It will be noticed that the propeller hub is practically in the form of a sphere, the idea being to eliminate losses of air volume due to eddy currents. The sphere design also provides a suitable receptacle for the turbine rotor and stationary blading. This is shown in Fig. 3, which illustrates the propeller detached from the spider and the buckets and nozzle arrangement.

In operation, steam from the live-steam pipe enters the connection shown in Fig. 1, at the top of the hub, and passes into the steam chamber, shown in the center of the spider, Fig. 3, leading from the steam-chamber nozzles, the number depending on the size and the requirements of the blower.

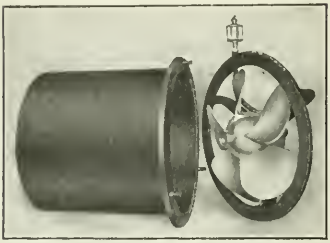


FIG. 2. PROPELLER CASING REMOVED

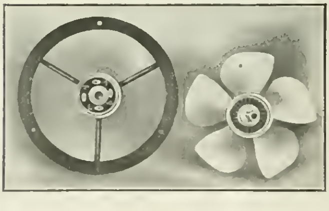


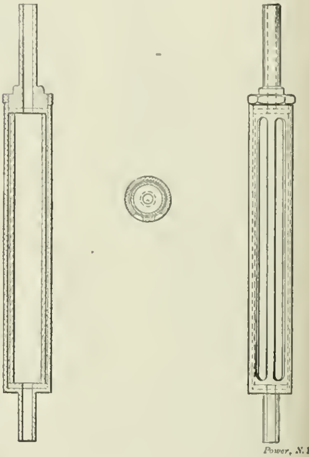
FIG. 3. PROPELLER DETACHED FROM SPIDER

The steam leaving the nozzles impinges upon the buckets shown in the rotor, Fig. 3, which causes the propeller to revolve. After striking the buckets, the steam is taken up by the exhaust vanes behind the turbine ring and is ejected through the orifice in the hub, shown in Fig. 2. The steam is then mixed with the air supplied by the blower, and carried under the grates.

When a boiler is being served by a Turbo-Blower, the damper regulator can be arranged to operate a balanced valve in the pipe line leading to the blower. In this way the blower will be controlled automatically, the damper working in conjunction with the blower and a balanced draft effected. The blower can also be regulated by hand, or by a regulator valve.

## "Malcolm" Water Gage

A water gage that has been designed for use wherever there is excessive vibration is illustrated herewith. As shown, an outer casing is represented, which is provided with vertical slots and a reduced lower end, on which is formed a shoulder upon which rests a rubber washer of suitable yielding substance, such as lead. A glass tube is arranged within the casing, and its lower end rests upon this washer; a corresponding washer rests upon the upper end of the glass tube. The upper end of the casing is provided with an interior thread which engages a corresponding outer thread on the head. This head is provided with a stem which has an opening communicating with the interior of the glass tube. The outer thread of the head also engages the interior thread of the nut, which extends over and is adapted to bear against the upper edge of the casing.



"MALCOLM" WATER GAGE

The glass tube is of sufficient thickness to withstand considerable strain and pressure applied longitudinally. When it is placed within the casing, the head is screwed down firmly onto the tube, thereby forcing the ends of the tube into the upper and lower washers, making a water-tight joint at the upper and lower ends of the tube. The nut shown is then screwed down firmly onto the upper edge of the casing and made tight. The head is by this means held firmly in place and so prevented from becoming loose and breaking the water-tight joint formed by the washer with the end of the tube, but the strain which holds the head in place is exerted by the nut on the upper edge of the casing and not on the tube itself. This water gage is patented by Walter R. Malcolm, Albany, N. Y.

## Inquiries

*Questions are not answered unless they are of general interest and are accompanied by the name and address of the inquirer.*

*Temperature Effect of Dropping a Heated Iron Ball into Water.*

An iron ball weighing ten pounds and having a temperature of 850 degrees Fahrenheit, is dropped into a tank containing 100 pounds of water at a temperature of 32 degrees. To what temperature will the water be raised?

G. A. C.

To solve this problem it must be remembered that all of the heat which omes out of the ball goes into the water, nd that they will eventually come to a mmon temperature. Let this common emperature, which we would determine, e *T*. Then the heat coming out of the ron ball as the temperature drops from 50 degrees Fahrenheit down to the common temperature of *T* will be the weight f the ball times its specific heat times e drop of temperature. Or,

$$10 \times 0.13 \times (850 - T).$$

this expression, 0.13 is the approximate ecific heat of cast iron.

The amount of heat going into the ter would be the weight of the water s its specific heat times the rise in mperature from 32 degrees to the com- temperature. This quantity will then

$$100 \times 1 \times (T - 32).$$

this expression 1 is the specific heat of water. As all heat coming out of the l goes into the water, these two ex- ns must be equal to each other. refore, an equation may be formed king the two expressions equal to h ther.

he only unknown quantity is *T*, for h we wish to solve, and by the solu- of this equation we find that the r is 42.5 degrees Fahrenheit, the temperature of the water and the b This of course assumes no radiati

his problem is easily proved as fol- The heat coming out of the ball a going into the water, as aforesaid, is weight of the ball times its specific times the range in temperature. The l temperature of the ball was 850 hrenheit. The final temperature 42.5, making a range of 807.5 de- ahrenheit. This multiplied by the 10 pounds, and the specific heat iron (0.13) gives 1050 B.t.u. given e ball. The range of temperature h the water has risen is 42.5 de- minus 32 degrees or 10.5 degrees. multiplied by the weight of the water, nds, and by 1, the specific heat of ter, gives 1050 B.t.u. absorbed by ater, and it will be seen that this ge is the same as the amount of heat given up by the ball; consequently, the problem proves itself.

*What Will Improve the Diagrams?*

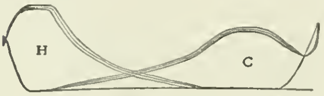
The accompanying diagrams are from a Brown automatic-cutoff engine. Can you tell what would improve them?

F. E. D.

The diagrams show that the steam valves are late in opening, that the exhaust valves close too early in the stroke, giving more compression than is necessary, and that the clearance is not the same in both ends of the cylinder.

The small eccentrics on the side shaft should be turned ahead until a proper amount of lead is obtained. The exhaust cams should be turned backward slightly, or some of the lap taken off and the clearance should be equalized and shims placed in the end of the connecting rod.

Changes in the position or travel of valves in engines with gridiron valves should be made with caution, for in some cases, shoulders on valves and seats have resulted from long wear and when changes of travel have been made, leakage resulted from the openings made by the riding of the valve over the shoulder on the seat.



*Power, N.Y.*

WHAT WILL IMPROVE THE DIAGRAMS?

## Book Review

HEAVY ELECTRICAL ENGINEERING. By H. M. Hobart. Published by D. Van Nostrand Company, New York. Cloth; 338 + xxiv pages, 6x9 inches; 290 illustrations and tables. Price, $4.50.

This is the latest book from the pen of Mr. Hobart, and it deals with questions concerning design of electric power stations rather than the apparatus to be used in them. It contains a large mass of data relative to plants in actual operation, which have been compiled by the author mainly from English and Continental practice; however, there is so much similarity between these and American installations as to make it almost as useful to American engineers as to those for whom it was written. The book is seriously marred for English-speaking engineers, students and steam users by the use of unaccustomed units throughout. For example, the author uses the word "ton" to signify the weight in kilograms of one cubic meter of water at 4 degrees Centigrade. This is very confusing because one ordinarily associates the idea of 2000 pounds with the word ton. Again, steam pressures are expressed in kilograms per square centimeter; to one used to pounds per square inch, this conveys very little concrete meaning until converted into ordinary everyday units. In one place he gives a table of the heating power of various coals, one of which (South Yorkshire steam) is stated to have a calorific power of 9500 kilowatt-hours per ton! This blemish exists all through the book and makes it exceedingly difficult to grasp the import of the author's statements wherever units are used. A most attractive feature of the work is that wherever possible plots of tables and data are given, the usefulness of which is too obvious to need comment.

Chapter I is introductory in character, and is devoted mainly to definitions of the various units which are used throughout the book and to tables and curves of the properties of steam, with illustrative examples of how to use them. Chapter II is devoted to a consideration of the overall efficiency of generating stations, with data and examples taken from practice, the purpose being to lay down a systematic plan of procedure in the choice of plants of various types to suit different conditions of service. Chapter III takes up the details of the steam equipment with due regard to the proper use of various styles of engines and steam turbines. Chapter IV treates in detail the relative merits of piston engines and steam turbines for large central stations and Chapter V is devoted to condensing apparatus. The next chapter takes up in detail the electric-generating part of the station, setting forth the suitability of different types of generator for various conditions of service. Chapter VII treats of the design of the generating station as a concrete whole, making use of the data and examples given in previous chapters for the purpose; this chapter contains a great quantity of data taken from first-class stations, and is one of the best and most interesting in the book. Chapter VIII contains an excellent and exhaustive treatment of the various classes of high-tension power-transmission lines for heavy service. The relative merits, together with the costs, of copper and aluminum lines are discussed and also the advantages and disadvantages of overhead and underground systems. Chapter IX gives an excellent treatment of the high-tension direct-current series system, and in it a comparison is made with the high-tension alternating-current system under similar conditions of service and operation. The remaining two chapters are devoted to electric-traction calculations, and to traction motors and the electrification of railways. Taken altogether, Mr. Hobart's book is a very meritorious production; the reviewer is of opinion, however, that there is an attempt to cover too much ground in the limited scope of one volume. It contains an excellent index, and the illustrations are good.

## Business Items

[illegible], boiler-setting specialist, having found its old quarters at 184 Summer street, inadequate to his increased business, has secured larger quarters at Room 504, Post Office Square Building, 79 Milk street, Boston, Mass.

F. C. Armstead, supervising engineer of the stoker department of the Westinghouse Machine Company, who, for a number of years, has been located at East Pittsburg, Penn., has moved his headquarters to the Westinghouse Works, Attica, N. Y., where the stokers are manufactured.

The Hoppes Manufacturing Company, Springfield, Ohio, has just shipped to the Metropolitan Street Railway Company, New York City, one of its 25,000-horsepower Class R type open exhaust steam feed-water heaters. This machine is to take the place of the closed type secondary heaters now in use at the Ninety-sixth-street power plant.

The Northern Water Softener Company, Madison, Wis., reports the recent closing of the following contracts: Cedar Rapids & Iowa City Railway and Light Company, Cedar Rapids, Iowa, for a 20,000-gallon-per-hour machine; Power Construction Company, Galena, [illegible], for a 15,000-gallon-per-hour machine; Sandusky Portland Cement Company, Sandusky, O., for a 10,000-gallon-per hour machine; Webster City Electric Light and Water Works, Webster City, Iowa, for a 2000-gallon-per-hour machine; Los Angeles Paper Manufacturing Company, Los Angeles, Cal., for a 2000 gallon per-hour machine.

Alfred J. Thompson, 71 Broadway, New York, who prior to 1893 was in the laboratory of Thomas A. Edison for four years, and since then has devoted his entire time to the sale, installation and operation of American machinery in Latin-American countries, has formed a selling organization to hustle for business in that rapidly developing section. During the past sixteen years Mr. Thompson has lived in and traveled extensively through Cuba and every republic of South America, and has established most pleasant personal relations with consumers. In order efficiently to handle a line of mechanical goods Mr. Thompson has associated with him in each of the capital cities a graduate engineer who makes his home there, and who knows the conditions of service and technical requirements of this vast market.

A dozen commercial systems of exhaust-steam heating are described and illustrated in a 48-page, 6x9-inch book issued by the Harrison Safety Boiler Works, Seventeenth and Clearfield streets, Philadelphia, Penn. The drawings show several varieties of both the gravity return and the so-called vacuum systems, in which a vacuum pump or ejector is used for withdrawing water and air from radiators. There are also several variations from these two main types, such as those using "combined" regulation, that is, one radiator for steam and another for the hot returns, the "positive differential" system in which a constant difference of temperature is maintained between the radiator system and the return piping, in order that a simple type of valve may be used at the outlets of the radiators, etc. One section of the book is taken up by a comparison of different systems of piping open feed-water heaters when installed in connection with such exhaust-steam heating systems and, by means of comparisons in different colored inks, the reduction in complexity and cost and the improvement in convenience attained through the use of the new Cochrane steam-stack and cut-out valve heater and receiver are shown. This innovation in open feed-water heaters is designed to render unnecessary the use of an independent separator to protect the heating system from oil, as the separator on the heater performs this service for both the steam condensed in heating the boiler-feed water and the steam which passes directly to the heating system. In the latter part of the book several methods are described by which space in crowded boiler rooms, as in basements of office buildings, hotels, etc., can be still further economized by specially constructed heaters. There is, finally, a brief description of a special heater designed to purify the make-up water, as well as to act as heater and receiver for the condensed returns from the heating system. A feature which will undoubtedly be of interest to architects, owners, etc., is a model specification covering a heater and receiver for use with exhaust-steam-heating systems.

## New Catalogs

National India Rubber Company Bristol, R. I. Folder. Pump valves. Illustrated.

Kingsbury Packing Company, 526 Spruce street, Scranton, Penn. Circulars. Oxford packings.

Edge Moor Iron Company, Wilmington, Del. Catalog. Boilers. Illustrated, 94 pages, 6x9 inches.

Du Bois Iron Works, Du Bois, Penn. Catalog. Steam and power pumps. Illustrated, 32 pages, 6x9 inches.

Becker Valve Company, Minneapolis, Minn. Pamphlet. Balanced piston valve. Illustrated, 12 pages, 4x9 inches.

The Hill Clutch Company, Cleveland, Ohio. A B C Engineering No. 1. Line shaft bearings. Illustrated, 5x8 inches.

The Jarvis Engine and Machine Works, Lansing, Mich. Bulletins Nos. 101-106. Pumping apparatus. Illustrated.

H. W. Johns-Manville Company, 100 William street, New York. Folder. Leak-No metallic compounds. Illustrated.

C. H. Wheeler Manufacturing Company, Philadelphia, Pa. Bulletin No. 10. Pumps. Illustrated, 32 pages, 3½x6 inches.

Power Specialty Company, 111 Broadway, New York. Catalog. Duval metallic packing. Illustrated, 16 pages, 6x9 inches.

Mesta Machine Company, Pittsburg, Penn. Catalog. Holander barometric condenser. Illustrated, 16 pages, 6x9 inches.

Greene, Tweed & Co., 109 Duane street, New York. Booklet. History of the Marathon Races. Illustrated, 5x7 inches.

Sight Feed Oil Pump Company, Milwaukee, Wis. Bulletin No. 210. Union-Cinch fittings. Illustrated, 8 pages, 6x9 inches.

Du Bois Iron Works, Du Bois, Penn. Bulletin K-21. Single cylinder throttling gas engines. Illustrated, 16 pages, 6x9 inches.

## Help Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

WANTED—Chief draftsman or engineer for engine works. Address "Corliss," Box 3, POWER.

WANTED—Good mechanical designers and detail draftsmen for machinery manufacturer located in Wisconsin. Box 98, POWER.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

AGENTS WANTED to sell Burgmann celebrated engine packings in territories not yet covered. See our advertisement on page 67.

ESTABLISHED New York concern handling steam specialties, desires partner. Small capital and unquestionable honor required. Box 11, POWER.

WANTED—Feed water heater designer and draftsman. One who has had experience in designing successful open-type cast iron heaters. Advise age, experience, education and compensation desired. Box 97, POWER.

ENGINEERS—A leading manufacturer wants to make arrangements with an engineer in every city who can use his spare time looking after their interests and by so doing add greatly to his income. Address "Manufacturers," Box 21, South Stillwater, Minn.

WANTED—An engineer experienced in design and application of electric controlling devices for industrial installations. Must thoroughly understand latest commercial systems and apparatus. No application will be given consideration except from engineers of established reputation and experience. In reply, give references, experience and salary expected. Box 8, POWER.

WANTED—Intelligent, ambitious and industrious young man, 22 to 27 years old, desiring to become an engineering salesman, for position in sales department by established and prominent manufacturer of valves and specialties. Prefer one having had mechanical engineering education and one or two years' practical experience. If without technical education, practical experience necessary. State age, education, experience and where obtained and salary desired. Box 10, POWER.

## Situations Wanted

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DRAFTSMAN, power house designer, wid experience, member A.S.M.E., desires pos tion. A-1 references. Box 9, POWER.

WANTED—Position as oiler or wiper; thre years' experience in mechanical and electric work. I. C. S. education. E Ransburg, 51 Keasey St., South Bend, Ind.

WANTED—Position as assistant to supe intendent. Present position chief draftsm gas and steam engines, pumps, condense and general machinery. Best references. B 5, POWER.

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WANTED—Position as chief engineer. Ha had 10 years' experience in charge of pow plants. Can furnish best of reference fr former employers. Position preferred in East. Box 7, POWER.

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## Miscellaneous

*Advertisements under this head are inse for 25 cents per line. About six words a line.*

IF YOU DESIRE to learn the latest provements in steam boilers, correspond the Detroit Water Tube Boiler Co., Detroit.

ENGINES AND BOILERS, ½ to 2 engine castings in sets. Models and get machine work. Sipp Electric and Mac Co., Paterson, N. J. Catalog 4c.

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# English Practice in Condensing Equipment

## A General Survey of British Practice and Methods of Specification and Design with Particular Reference to Surface Condensers

### BY JAMES A. SEAGER

In Great Britain the practice in connection with steam-raising plants has generally been in the direction of great ability of construction and a certain nount of caution in design. The working results obtained in power houses of agnitude should therefore be worthy of nsideration as embodying to a great xtent the careful thought and design of gineers who are not disposed to risk ything in rash and nonproven experi-ents. The large increase of electric-wer supply, in some cases in very con-sted districts and in other cases over ry wide areas, has led to the develop-nt of very large power houses whose m units are of a correspondingly ge size, and it is chiefly in connection th the types of condenser associated w these large houses that it is proposed t deal in the present article.

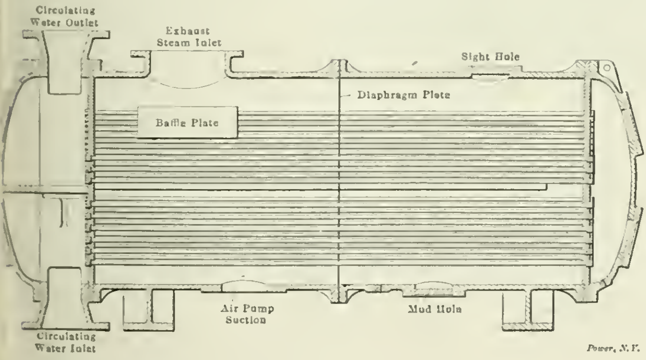


FIG. 1. STOREY TWO-FLOW SURFACE CONDENSER

### GENERAL SURVEY

Great Britain the surface condenser is t generally seen in power-house p tice because it is used where there is a ntiful supply of cooling water, this w r being unsuitable for boiler feed, a where there is no cheap and suitable s ly of feed water to be had, rendering n ssary the repeated use of the same w r with a certain amount of make-up te in the boilers.

ig. 1 illustrates a typical cast-iron sh surface condenser, installed in an English power house of medium capacity, w h is of the two-flow type, the arrangements for giving both the steam and the water a double passage through the condenser being clearly indicated. This condenser was made by Isaac Storey & Sons, of Manchester. Fig. 2 shows a surface condenser of 400 square feet cooling surface, made by the same firm, of the multiple-flow type, adapted to larger capacity steam units, the dimensions of the condenser being 4 feet 9 inches diameter and 12 feet between tube plates, and the flow lines of which indicate the passage of steam and water. It will be seen that the steam at the outlet meets the hottest water, and the steel baffle plates intercept the condensed steam from each section of the condenser, causing it to flow down the sides of the casing to the air-pump suction branch.

Water is generally admitted at the bottom and discharged at the top of the condenser, while the steam enters at the top and the condensed water is taken out at the bottom. In order to insure as good a vacuum as possible in the engine, the steam-inlet pipe of the condenser should be as short and straight as possible. If the steam from reciprocating engines, after being condensed, is used as boiler feed, an oil separator is usually fixed between the engine and the condenser steam inlet. There is no possibility of the circulating water running back into the engine due to failure of the air pump, as may be the case with some jet condensers. An extension of the surface-condenser principle which is to be found in some of the power houses at the present time is the evaporator condenser, which consists of an arrangement of tubes carrying the exhaust steam, over the surface of which water is allowed to flow in a thin film. The whole arrangement is often contained in a chimney, so that natural or induced draft may increase the cooling action.

In jet condensers the cooling water is sprayed into the exhaust steam in an inclosed vessel, the moisture being continually removed by the air pump, upon whose continued operation the vacuum and the clearing of the condensing space continually depend. Steam is admitted at the top of the vessel, the outlet being at the bottom, so that the condensed water drains into the air pumps. Other forms of condensing plant, such as barometric condensers, siphon condensers, etc., which are to be found in power-house practice, are on the same general principle as the jet condenser, and the relative advantages and disadvantages of the various main types may be briefly summarized as follows:

### CONDENSER TYPES COMPARED

The surface condenser has the advantages of a high vacuum, a low working cost, low depreciation, the production of condensed water which is good for boiler feed, thorough reliability in operation, steady vacuum under fluctuating loads and the availability of any quality of cooling water for use if this has been well strained. The disadvantages of the type are its high capital cost, the high freight and transport charges incurred in bringing the plant to a power house, the large floor space which it occupies, the cost of cleaning (which is quite expensive), the fact that it is somewhat heavy, and the large amount of cooling water which is required.

The jet condenser occupies less floor space for a given amount of steam condensed than the surface condenser, the freight charges and erection charges are less, the cooling water required is also less and the capital cost is lower. It is also suitable for corrosive or dirty water which might hurt or choke the tubes of surface condensers. The disadvantages of this type are that the condensed water is not always good for boiler feed, larger pumps are required as compared with those for surface condensing, and, therefore larger depreciation is incurred, it is necessary to exercise great care in preventing foreign matter from entering the air pumps with the cooling water, and there is also the liability under certain circumstances for the cooling water to overflow into the engine

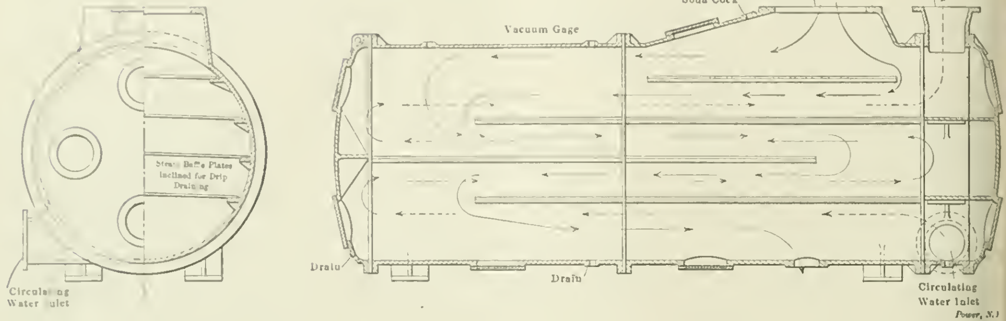


FIG. 2 STOREY MULTIPLE-FLOW CONDENSER

Taking the ejector condenser, the capital cost of this type is very low indeed, depreciation is also small, freight charges are low and an exceedingly small floor space is required as compared with the first two types mentioned. The disadvantages of the type are that the vacuum obtained is usually about 2 inches less than either the surface or jet type and is liable to be unsteady at low loads; unless a nonreturn valve is fitted the cooling water may enter the engine; and there is the disadvantage, shared with the jet condenser, that the condensed water may be unsuitable for boiler feed.

As the result of this examination as to the relative merits, it is easily possible to see why in large power houses of modern design surface condensers are found to a large extent, especially when one remembers that with steam turbines it is necessary, in order to get full economy in running costs, to maintain a very high vacuum. This point is of exceedingly great importance in view of the tremendous increase which has recently taken place in the use of the steam turbine as compared with the older reciprocating engine for power-house practice. It is hardly necessary to add that in modern work, with large steam units, a high diversity factor and clauses with regard to penalties for discontinuity of supply and reliability in condenser design are imperative

## British Practice in Specifying Condensers

It may be interesting to give some account of the specified conditions under which condensing plants are supplied to power houses at the present date. This cannot be entered into in detail inasmuch as local conditions cause a variation of requirements, but the following points may be noted: The condenser is generally specified to pass a certain amount of water per hour, and to maintain a steady vacuum of about 95 to 97 per cent. of barometric pressure, with circulating water at about 50 degrees Fahrenheit when coupled to an engine working at its economical load and exhausting a given amount of steam per hour. It is usual to stipulate that the air-pump discharge shall not be less than 70 degrees Fahrenheit in temperature. As the result of experience it has been found that all bolts, studs and similar fastenings in contact with steam or water should be constructed of delta metal, or some similar alloy, and the tubes either of brass or pure copper. This is in order to prevent corrosion, and as a further safeguard zinc or aluminum blocks are usually fixed on the tube plates in the water chambers. The tubes are required to be secured so as to present metallic contact with the tube plates, and they are not allowed to move endways. Mudhole and manhole doors are provided and baffles are employed in order to distribute the steam equally over the cooling surface. In order to guard against expansion troubles due to variation in temperature, an expansion joint is usually fitted on the water inlet and outlet branch pipes. It is convenient to have tl following fittings on the condensers fo the sake of facilitating periodical tes ing and safety in operation: a vacuu gage, a relief valve to protect the co denser against excessive pressure shou the air pumps fail, a relief valve on tl water box, a vacuum-breaking cock, a chambers on the inlet and outlet chambe

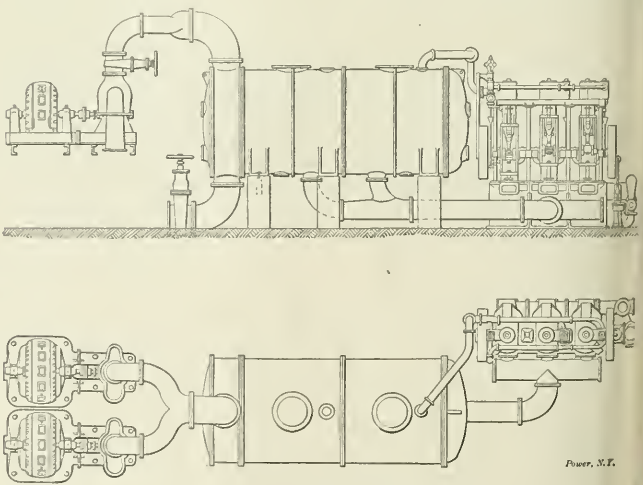


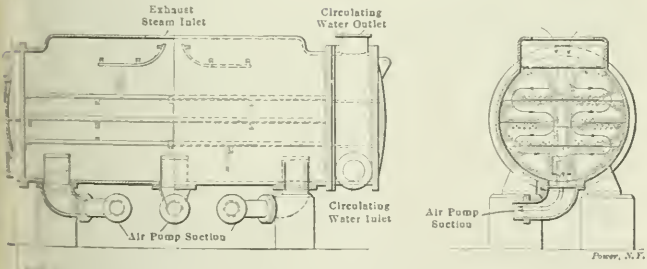
FIG. 3. W. H. ALLEN CONDENSING OUTFIT

in order to collect any air which ma carried in by the circulating water, mercury cups on the inlet and disch branches and also in the steam for holding thermometers.

## Considerations on Design

It is evident that the most effi

ndenser is that which in a given time id under given conditions will transfer the highest number of heat units per are foot of surface from the steam the circulating water. Such a conser will not only maintain the highest icuum but maintain it at the least cost condensing water with the smallest ling surface, and with the least airmp capacity per pound of steam consed. For the highest thermal efficiency the temperature of the feed water uld correspond to the vacuum in the denser, and in order to maintain the ximum condensation per square foot cooling surface for a given velocity cooling water at a given temperature, weight of air in the condenser should reduced to a minimum, and the flooding of the tubes prevented so as to keep cooling surface in its most efficient dition. For a given inflow of air, the ght of air in a condenser of a given acity depends on the design of the denser and the type, volumetric capacity and efficiency of the air pumps. design of the condenser should be such as will promote an even flow of the steam over the entire length of each tube from the steam inlet to the air-pump suction. There should be no eddies or stagnant zones. The vapor flowing over any given tube should contain an equal percentage of air throughout the entire length and the flow over the whole of the length should be uniform, and preferably at right angles to the axis of the tube. Any change in the direction of flow should be in a free space outside the nest of tubes in order that uniformity of flow over the entire tube surface may be maintained, and the creation of back pressure avoided.



4. ARRANGEMENT FOR WATER AND STEAM FLOW IN W. H. ALLEN CONDENSER

For the transfer of heat, the condenser t[illegible] is most efficient when its surface [illegible]t and least so when it is flooded b[illegible]ing streams of water. The two most important results arising from high surface efficiency are the reduction of cooling surface and economy in circulating water necessary. The latter is important because in some English power houses water has to be purchased. Moreover the water has to be pumped through the condenser and piping, and any reduction in this amount means a saving in pumping power or station losses, other things being equal. There is also the consideration that where the water is cooled for repeated use there is not only less water to be pumped, but owing to its higher temperature, there is a greater mean difference between the temperature of the water to be cooled and the air which cools it, hence the cooling towers may be of a smaller size for a given power house capacity. Reduced cooling surface involves lower first cost, less weight and less space, all of which are most important considerations in power-house design.

In order to obtain maximum thermal efficiency in a surface condenser, it is necessary that the condenser steam should be withdrawn at the temperature corresponding to the absolute pressure, that is to say, the vacuum. When maximum thermal efficiency is required it is essential that separate air and hot-water pumps should be fitted, because, although it is desirable to obtain condensed steam as hot as possible, it is also necessary, in order to keep up the efficiency of the air pump, that its temperature should be low.

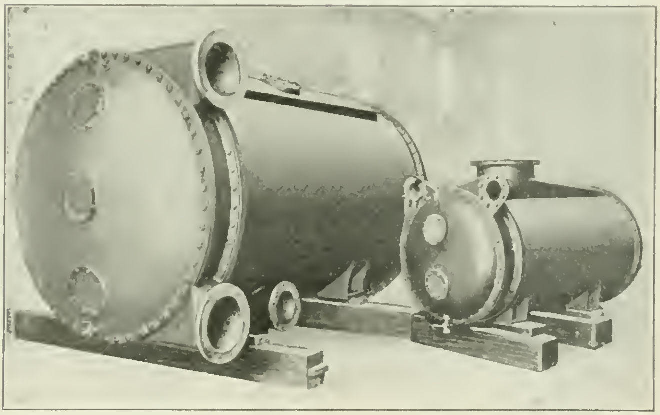


FIG. 5. WILLANS & ROBINSON CONDENSERS AT GLASGOW CORPORATION POWER HOUSE

### THE HORIZONTAL SURFACE CONDENSER

It may now be interesting briefly to examine some of the condenser installations of outstanding interest either installed in British electric-power houses, or else constructed by British engineering firms for use on the Continent and based largely as to the points of design upon English experience. In so doing an adequate idea will be gained of the types of condensing plant to which the most important work in British electrical engineering is entrusted.

Commencing the survey with the horizontal pattern of surface condenser, one of the most interesting installations is a set of thirteen condensers built by Belliss & Morcom, Ltd., each of which deals with Belliss vertical engines, eight of which are about 3000 indicated horsepower and three being 1000 indicated horsepower. Each condenser has a cooling surface of 4200 square feet, and maintains a vacuum of within 3 inches of the barometer pressure at full load, with cooling water at 80 degrees Fahrenheit at their inlets. Each condenser has 1767 brass tubes of 3/4-inch internal diameter, making about 4 miles of tube in each condenser. The exhaust valves of the engines are 26 inches in diameter, and in order to purify the condensed water, an extensive grease-extracting plant is installed. The air pumps for the condensers are driven alternately by steam sets and motors, the former driving direct and the latter through spur gearing and rawhide pinions. The normal speed of the pumps is 80 revolutions per minute, but in emergency this can be raised to 120 revolutions per minute. From each set of air pumps two hot-well pumps are driven, and there is an interconnecting air-pump suction main for all the sets. The condenser castings are of cast iron, cylindrical in shape. The tube plates are of rolled brass, in which the tubes are fixed by screwed glands and tape packings. The plants have operated so well that at the build-

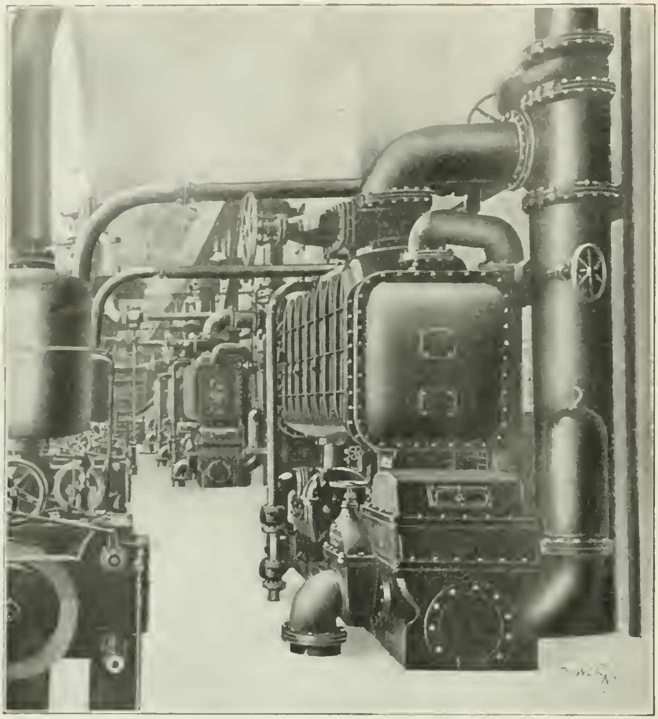


FIG. 6. WHEELER RECTANGULAR SURFACE CONDENSERS

ing of the Park Royal power station of the Great Western Railway Company four sets of the same type and cooling surface were installed, while two sets of 3500 square-feet cooling surface were despatched to South America for the Buenos Aires and Pacific Railway.

Fig. 3 illustrates the general arrangement of two sets of surface condensing plants installed at the Willesden generating station of the Metropolitan Electric Supply Company, Ltd., each plant being capable of dealing with 60,000 pounds of steam per hour, and maintaining a vacuum within 4 inches of barometric pressure, with circulating water at a temperature of 80 degrees Fahrenheit. The sets were built by W. H. Allen, Son & Co., Ltd., Bedford, and each condenser has a tube surface of 11,000 square feet. The air pump is a three throw Allen-Edwards pump running at 100 to 110 revolutions per minute, each pump barrel having a diameter of 24 inches and 11-inch stroke. This is driven by a steam engine having three high-pressure cylinders of 9-inch diameter by 11-inch stroke. In order to deliver the condensed water to a feed tank, a double-acting water force pump of 6-inch diameter is driven from the air-pump crank shaft. An interesting feature of the installation is the provision of two circulating pumps for each set, each having a diameter of 15 inches and each capable of delivering 3750 gallons per minute when running at 500 revolutions per minute and working against a maximum head of 50 feet. Th provision insures against total break down in a very effective manner. Th circulating pumps are driven by two two phase motors running on a 500-volt circui

The arrangement of the direction o flow of the steam in this condenser i rather interesting, and is shown in Fi 4. The circulating water enters at th bottom of the condenser, circulates sev eral times the length of the tubes, an leaves at the highest point, thus obtainin the maximum effect from the coolin water. The steam to be condensed e ters the distributing chamber at the top the condenser, where it circulates tran versely through the various nests of tub the vapor and condensed water bei withdrawn from the bottom of the co denser by the air pumps. The counte current principle is thus observed. T dispersed arrangement of air-pump su tion is also worthy of notice. The tu are of solid-drawn brass having an e ternal diameter of ¾ inch and being No. imperial-wire-gage thick. They are fixed the tube plates at both ends by screwed f rules provided with lips and tape packi

Willans & Robinson, Ltd., of Rug are among the largest suppliers of co densing plants to British power hous and their plant is distinguished for large amount of steam dealt with single sets. For example, of two s

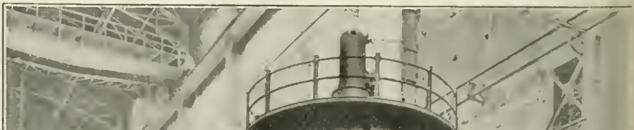
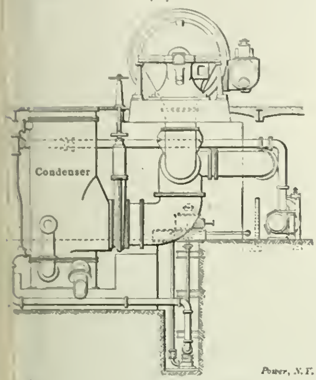


FIG. 7. VERTICAL CONDENSERS UNDER CURTIS TURBINES

uilt for the London County Council each deals with 75,000 pounds of steam per hour, a vacuum of 28½ inches being obtained with cooling water at 65 degrees Fahrenheit. Two sets at the Glasgow Corporation power house, one of which is illustrated in Fig. 5, both deal with 3,000 pounds of steam per hour, a vacuum of 27½ inches being maintained with cooling water at 85 degrees Fahrenheit. Other sets at the same power house deal with 52,500 pounds of steam per hour. At the Formby power house of the Lancashire & Yorkshire Railway a fine set for dealing with 53,100 pounds of steam per hour is installed, a vacuum of [illegible] inches being obtained with cooling water at 60 degrees Fahrenheit, and the use of large units could be extended to a considerable extent. Some further data concerning the London County Council set may be of interest. In addition to the vacuum at full load of 28½ inches, they maintain 28 inches at a 50 per cent. load. The square feet of tube surface in each condenser is 8000 and the average load dealt with by each set is [illegible] kilowatts. The air pumps are of the three-throw Edwards type running at [illegible]2 revolutions per minute, and each pump is driven by a 36-brake-horsepower motor running at 360 revolutions per minute through single-reduction gearing.



Power, N.Y.

F[illegible]. 8. VERTICAL COUNTERCURRENT SURFACE CONDENSER

The types of surface condenser hitherto reviewed have been of the circular-shell form; the rectangular type originated by the Wheeler Condenser and Engineering Company, Ltd., of London, is more expensive to construct, but offers a very large steam-storage space which acts as a receiver in absorbing the pulsations from a reciprocating engine. Moreover, it is difficult in a cylindrical shell to fill the space evenly with tubes, which leaves gaps through which steam can flow directly to the air pump, unduly increasing the work on it; the rectangular type gives a deep bank of tubes for the steam to traverse, with an economy in overall dimensions, so that this shape is used to a considerable extent in power houses erected on costly ground. Fig. 6 shows four sets of condensing plant which the Wheeler company erected at the Corporation tramway station at Kelham island, Sheffield, dealing with 10,000 horsepower of cross-compound engines, and the economy of space, combined with perfect accessibility, is apparent. Similar types of plant have been erected at the power house of the London United Tramways, Ltd., and at the Broadstairs power house of the Isle of Thanet Electric Light and Tramways Company, Ltd.

### Vertical Type of Surface Condenser

A variant to the horizontal type of surface condenser is found in a similar construction arranged vertically. This may be done for a variety of reasons, chief among which are that the ground space at disposal may be cramped or from constructional reasons it may be advisable to combine the condenser with the steam set. A notable instance of this occurs in the novel arrangement of the four Worthington condensers at the power house of the Paris Underground Railway. Each of these is of 20,000 square feet cooling surface, and is fitted with an electrically driven rotative dry-vacuum pump and centrifugal pump of the Worthington pattern. These condensers were arranged as the sub-base for the turbines, which are of the General Electric Curtis vertical type. Fig. 7 illustrates this very interesting arrangement, the merits of which are that it gives the absolute minimum length of steam connection between turbine and condenser with consequent improvement of vacuum. At the Lots Road power house of the London Underground Railways, the Worthington Pump Company, Ltd., installed eight vertical condensers of the same type each of 15,000 square feet cooling surface.

The Brighton Corporation, in installing four 1750-kilowatt turbo-generators, selected the vertical surface condenser, countercurrent type, as being the most suitable, and Fig. 8 shows an end elevation of the plant installed by Cole, Marchant & Morley, Ltd., of Bradford. The top of the condenser is level with the floor to facilitate examination of the tubes, and easy tube cleaning is one of the advantages of the arrangement. The cooling water is taken from the sea and pumped by an electrically driven centrifugal pump. A compound dry-air pump is driven by a Westinghouse motor through reduction gearing, and the hot-water pump is of the two stage centrifugal type, placed below the condenser in order to allow the water to run freely into it. The combination of vertical condenser and dry-air pump is most effective in producing a high vacuum, within about 1 inch of barometric pressure being obtained under favorable conditions.

Fig. 9 shows another example of Cole, Marchant & Morley's vertical condensing plant erected for the Central London Railway. The space available was small and the condensers, of the open-top type, were therefore placed outside the building in a space between the cooling tower and the building. They had to be placed at such a level that the water would flow from them into the cooling tower. Each condenser, which has 9000 square feet cooling surface and weighs approximately 24 tons, is erected on structural steel work. They are of the countercurrent type with suitable baffles. The incoming steam passes through one of the two Baker oil separators, and the condensed steam and air is taken to three-throw Edwards air pumps each 22 inches in diameter by 16 inch stroke running at about 130 revolutions per minute and driven by a Westinghouse direct-connected 32-horsepower motor.

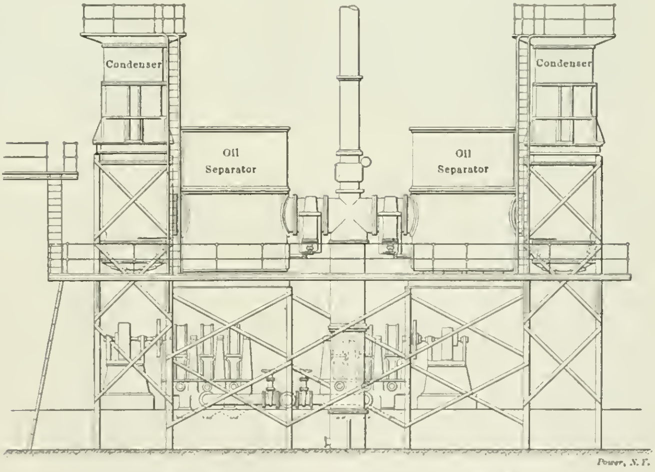


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FIG. 9. VERTICAL CONDENSING PLANT OF CENTRAL LONDON RAILWAY

# The Dilution of Flue Gases

By [illegible]

Since the heat carried away by the products of combustion is more than that wasted through radiation, etc., forms the chief loss in a boiler, a study of the effect of diluting the flue gases with excessive admission of air, both on the percentage of CO₂ and on the percentage of heat carried up the chimney, should prove interesting.

Suppose we consider the combustion of one pound of coal with just the theoretical amount of air necessary completely to burn that weight of coal in such manner that each single atom of carbon and hydrogen combines with all the oxygen in the air to form $CO_2$ and steam, respectively. Then the latter, with the nitrogen remaining from the air, will constitute the products of combustion, and will pass away at the temperature of the flue, carrying a certain amount of heat, which will be the theoretical loss sustained due to the flue gases. Further, the percentage of $CO_2$ will be the maximum amount theoretically possible.

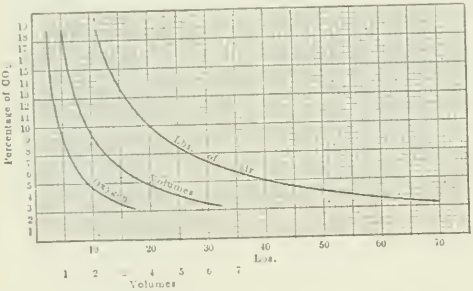

FIG. 1

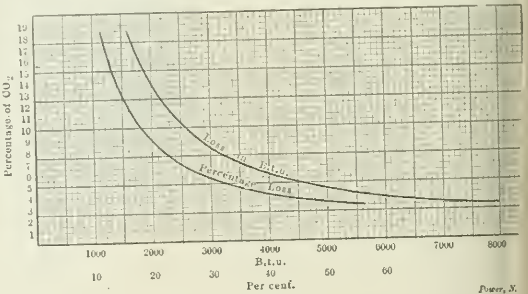

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FIG. 2

In practice, however, it is impossible to burn coal in a boiler furnace with only the correct amount of air, since a large percentage of the carbon would be imperfectly burnt, forming carbonic oxide (CO), and, therefore, a surplus of air is always admitted to the grate to insure against this. This surplus of air naturally increases the weight of flue gases per pound of coal, and in a corresponding degree augments the amount of heat carried away thereby to the flue, but the loss due to this increased heat capacity more than compensates that which would be sustained were not the surplus of air admitted and the coal only partly consumed. But the excessive admission of air is exceedingly wasteful and results in a great loss of heat.

Consider a concrete example, say 1 pound of Lancashire coal having the following composition by weight:

| | |
|---|---|
| Carbon | 0.807 |
| Hydrogen | 0.055 |
| Oxygen | 0.085 |
| Other constituents | 0.053 |
| | 1.000 |

Assume that the oxygen in the coal is in combination with part of the hydrogen, then the free hydrogen to be considered as a combustible will be

$$0.055 - \frac{0.085}{8} = 0.04$$

pound. Now, the carbon and hydrogen will combine with the oxygen of the air admitted in the following proportions:

*Carbon + oxygen = carbon dioxide*
$C + 2\,O = CO_2$.
$12 + 32 = 44$ *atomic weights.*
$1 + 2.66 = 3.66$ *pounds.*

Similarly,

*Hydrogen + oxygen = steam.*
$2\,H + O = H_2O$.
$2 + 16 = 18$ *atomic weights.*
$1 + 8 = 9$ *pounds.*

The products of combustion obtained from 1 pound of the coal mentioned will weigh as follows:

0.807 pound of carbon gives 0.807 × 3.66 = 2.95 pounds of $CO_2$; 0.04 pound of hydrogen gives 0.04 × 9 = 0.36 pound of steam; total, 3.31 pounds. Further, the total weight of oxygen used will be: Oxygen used by carbon = 0.807 × 2.66 = 2.15; oxygen used by hydrogen = 0.04 × 8 = 0.32; total, 2.47 pounds of O.

Now, the amount of nitrogen that will be associated with the foregoing weight of oxygen as air is

$$2.47 \times 3.35 = 8.3$$

pounds of nitrogen. Then the weight of nitrogen plus 2.47 = weight of air theoretically required, assuming that all the fuel is perfectly consumed. This gives 10.77 pounds, say 11 pounds of air.

Furthermore, the weight of the nitrogen + 3.31 = the weight of flue gases from 1 pound of coal = 11.61 pounds.

If the products of combustion are now considered volumetrically the percentage of $CO_2$ can be readily ascertained:

| | | |
|---|---|---|
| 2.95 *pounds of* $CO_2$ | = | 24.2 *cubic feet.* |
| 0.36 *pounds of steam* | = | 9.5 *cubic feet.* |
| 8.3 *pounds of nitrogen* | = | 106.4 *cubic feet.* |

This makes a total of 140.1 cubic feet, say 140 cubic feet. Then

$$CO_2 = \frac{24.2 \times 100}{140} = 17.3 \textit{ per cent.}$$

It will be noticed that the steam was treated as 9.5 cubic feet of superheated steam. Although this quantity has a part in the heat losses (which are discussed later), it has no effect on the percentage composition of the products of combustion when the latter are measured volumetrically, as in everyday practice, by the Orsat or similar apparatus; therefore, if this component is neglected the amount of $CO_2$ will figure out at 18.5 per cent.

Therefore, if 1 pound of Lancashire coal is burnt with the theoretical amount of air (11 pounds) the products of combustion will weigh 11.61 pounds and will contain 18.5 per cent. of $CO_2$.

As already stated, such a result is unobtainable in practice, consequently a surplus of air over and above the theoretical quantity is admitted to effect perfect combustion. Assume that such a sufficing surplus has been admitted, and the percentage of carbon dioxide in the flue gases is lowered thereby to 10 per cent. Now we have seen that 24.2 cubic feet of $CO_2$ is formed from 1 pound of coal and this quantity now equals 10 per cent. of the flue gases. Therefore, the flue gases, under the revised conditions, equal 242 cubic feet, and the products of combustion = 131 cubic feet. Then the surplus air = 111 cubic feet. This is equal to 9 pounds. Therefore, the total air admitted = 20 pounds, 1.82 times the theoretical quantity.

Fig. 1 shows a curve plotted on t basis, giving for various percentages CO₂ the weight of air and also oxyg together with the number of "volum (assuming that 1 pound of the coal un consideration requires one volume, 11 pounds of air to effect complete co bustion). It is now but a step to fig out the loss of heat due to the flue ga Assume that the temperature of the g is 518 degrees Fahrenheit and that the air is 85 degrees Fahrenheit. have seen that the combustion of 1 po of coal with the theoretical weight of produces 11.61 pounds of flue gases; the heat carried away by each constit will be

*Weight of constituent* × *specific heat* × *rise in te- peratu*
$CO_2$ 2.95 *lbs.* × 0.216 × 433 = 2
*Steam* 0.36 *lbs.* × [1146.6 − 53 + (0.481 × 306)] = 4
*Nitrogen* 8.3 *lbs.* × 0.244 × 433 = 8
15

---

**Total heat of evaporation at atmos pressure + superheat up to 518 d Fahrenheit.

Say the calorific value of the coal under onsideration is 14,000 B.t.u. per pound. hen

$$\frac{1599 \times 100}{14,000} = 11.4$$

er cent. loss.

This is the loss sustained when 1 pound i coal is considered theoretically to be urnt with 11 pounds of air, the products of combustion containing 18.5 per ent.

Let us now turn to the practical case which a surplus of air was admitted insure the proper combustion of the coal ereby reducing the $CO_2$ in the flue gases 10 per cent The loss of heat in this se will be that shown above absorbed the products of combustion plus the t carried away by the surplus of air it passes away at the temperature of flue The excess of air was found to 9 pounds and the heat the latter will ke away is

$$9.0 \times 0.238 \times 433 = 927$$

t.u. Then the total heat carried away flue gases will be

$$1599 + 927 = 2526$$

u., which means 18 per cent. loss.

ig 2 is evolved in this manner from curves in Fig. 1, and is self-explanry. Although these curves are based theoretical calculations, to a certain ent they will be found to approach ryday conditions and serve to show evil wrought to economy by the inion of unnecessary air due to leaky rous boiler settings, bad fires, etc, a indicate the saving to be effected by th maintenance of a medium percentage arbon dioxide in the product of combion.

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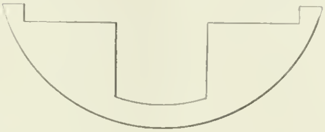
# Erecting an Engine

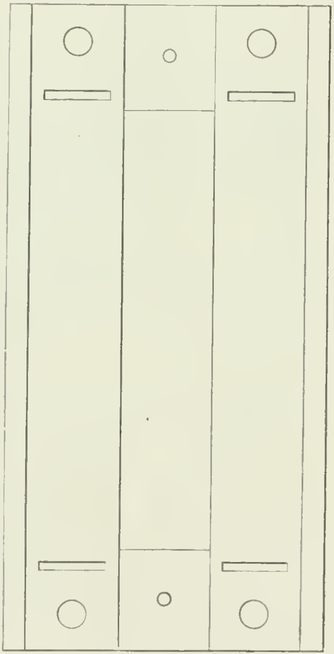
By F. Wiegand

n ounce of prevention is worth a f cure," goes the old saying, and gine building and erecting, it might e increased to one ton of cure. rtheless, in late years and especially e era of prosperity this old truth n very often disregarded. To get it has been the chief considera most engine shops. The ambitious intendent, the hustling foreman and ssfully ignorant assembler had full sway, while the careful and hardking mechanic was considered a back r. The erecting man had to stand firm and finish the deception.

ere have been instances where ens of 200 horsepower and over were mbled, tested and delivered to the a three days after the order had been ved, the machined bed, shaft and ls being in stock or nearly finished. That it is not possible to build and test an engine in 30 working hours is evident to every experienced man, and will probably be conceded by the reader of this article after following through the different operations of building, where alinement and proper fitting are duly considered.

### Leveling Engine Bed





Power, N.Y.

FIG. 1

After being placed on trestles in the shop or on the foundation in the engine room, the engine bed should first be carefully leveled by placing a sensitive level in the housing or bore of the main bearing and lengthwise into the guide. A flat guide should be level with the main bearing crossways, and has to be scraped to suit, if necessary. If an adjustable guide, Fig. 1, is used, this should be fitted and spotted with red lead to the bore of the bed so it cannot be sprung out of true when clamped in place by the guide bolts. The guide should now be carefully leveled and clamped securely in that position. A jig engaging the main bearing and the guide is used in the shop for that purpose. The right distance from the main bearing has to be measured off and holes for the dowel pins continued into the bed, reamed out and pins driven in. Bored or flat-frame guides should be measured for parallelism. It is not of importance if they are a little smaller at the head or cylinder end, as the bed will heat up and expand a little at that end, but the difference should not amount to more than 0.0005 inch to the inch of the bore. If the guide is smaller at the crank end, it has to be filed and scraped until parallel. Before starting to do this, take the bottom shoe of the crosshead and fit it to the guide to a good bearing (pin bearing), so that it can be used as a spotting plate. Next make a pin gage, using a piece of 1/4-inch round steel filed nearly pointed at the ends, or a stick of wood about pencil size with a pin or braid driven in each end. Then fit the gage exactly to the bore or the distance between the guides at the head end. With the pin gage to caliper the distance and the close-fitting shoe to locate the high spots an accurate job can be done.

### Laying the Shaft

Before laying the shaft all parts of the main bearing should be carefully looked over. The head- and crank-end faces of the housing should be calipered for parallelism, and if found to be out, a square should be used to see which side needs correcting, as they have to be at right angles to the bottom. A straight-edge must be run across both housings of the center crank beds. It is well to file and scrape the bore of the main bearing, when loose babbitt liners are used, in order to trim down roughness and high spots. Quarter blocks and gibs should fit the housing with a good general bearing, so that no change in their position can take place after the shaft has been fitted. It is very important that loose babbitt liners be spotted down to the bore of the bed, quarter blocks or caps, as any high places on them will cause the bearing to heat. A good way to test the fit of these liners is to put them in place and tap with a hammer handle to locate the hollow spot.

Next see that the liners or quarter blocks have a little side play between the crank disk and the collar on the crank shaft; 1/100 inch or three thicknesses of paper being enough in most cases. In center-crank engines the clearance between the main bearings must be about 1/64 inch. Center-crank shafts, which are forged in one piece, are not turned to a sharp corner where the crank rises from the shaft, as that would be liable to start a crack, but a fillet of a proportionate radius is left. These fillets are often allowed to bear on the babbitt lining and so cause a rapid heating of the shaft. The babbitt should be amply filed away at this place, enough to prevent its bear-

bearings after the lining has been reduced by wear. Many cases of mysterious heating have been caused by fillets beginning to bear and press the crank disks sideways. Whether a bearing consists of two, three or four parts, none of them should bear on the shaft over their entire width, but they should be relieved and not more than two-thirds of their crown touch the shaft. If they are fitted to bear over the whole circumference of the shaft or begin to bear through wear and taking up, they will run hot. The sides of each part of the babbitt lining should be beveled down in proportion to width to about one-half of its thickness, leaving 3/4 inch on each end full to keep the oil. The recesses so formed act as oilstores and settling places for grit and scum contained in the oil. The four-part bearing should look like Fig. 2.

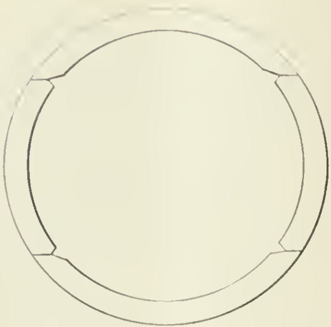

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FIG. 2

Oil grooves have the function of distributing the oil over the whole length of the bearing and conveying it to the points of greatest working pressure, which are the head- and crank-end quarters of a horizontal and the bottom quarter of a vertical engine. Oil grooves cut in the end of the clearance space connected to the source of supply and running parallel to the shaft, as in Fig. 3, would serve well for the purpose of distribution. Such grooves were introduced by some manufacturers, but did not make good in practice, as they soon filled up with sediment which had no chance to get out; the bearing did not get oil enough and the babbitt began to bridge over and make them useless.

This is one extreme; the other consists in running the oil grooves almost in the direction of rotation, Fig. 4. They will carry the oil off too fast and leave some places dry. Another mistake is to cut the oil grooves all the way through the cap or side quarters. This will drain those parts of the bearing, and if there is not a very liberal supply of oil they will heat. Oil grooves should run at an angle of not less than 30 degrees and not more than 45 degrees from direction of the shaft, and should not be continued into the clearance spaces or bevels of the cap nor into the bottom clearance space of the side quarters. Figs. 5 and 6 show the best arrangement of oil grooves for the side pieces and Fig. 7 the oil grooves in the cap piece.

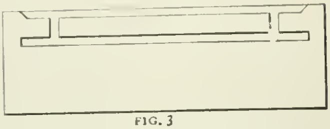

FIG. 3

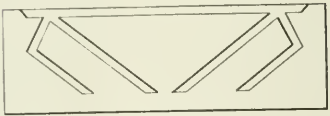

FIG. 4

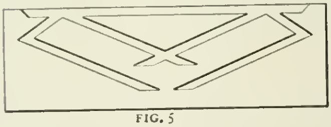

FIG. 5

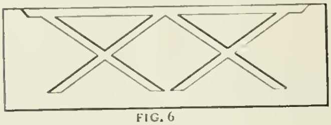

FIG. 6

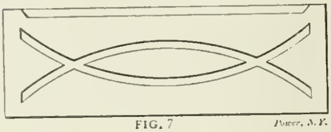

FIG. 7

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The bottom quarter can be grooved from bevel to bevel, and the bottom quarter blocks can now be placed into the bed and tried with a level through their center. A parallel straight-edge should be used for center-crank bearings. After they are leveled the shaft can be lowered into the bed, painted with red lead or lamp black and fitted to a good bearing through the whole length of the lining and two-thirds of its width.

It sometimes happens that center-crank shafts are sprung in the lathe during the operation of turning the bearings and shaft ends. A screw jack is placed in the center of the main shaft between the cranks, to take up the pressure of the lathe centers. If this jack is a little loose the cranks will be squeezed together and the shaft turned in that position. After being released it will return to its original shape and be out of line. When placed into the bearings and turned over, marks will appear at *A* and *B*, Fig. 8, about half way around and not bear at all in the middle. If the jack has been too tight, the shaft will bear on the opposite points.

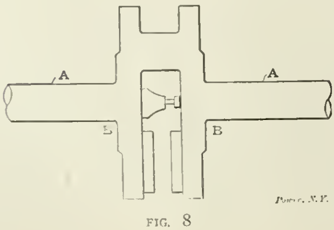

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FIG. 8

A shaft of a direct-connected unit might have left the lathe in a true condition and made a good run on the testing block, but can be so easily sprung by rough handling in traffic that it is wel for the erecting man to watch this point Such a shaft can in most cases be forced back to its normal position. A shaf sprung in the lathe must be taken bac to the lathe and skinned over. In ver slight cases the ends of the main bearing can be scraped a little larger to mak room and avoid heating on these point but this should only be done in an eme gency.

### Adjusting the Crosshead

It is the duty of the crosshead to ho the piston rod central and parallel to t guide, the wristpin at a right angle to t piston rod and in flat crossheads level the shaft and crank pin. It is therefo necessary that an arbor locked into t crosshead should be parallel to the wo ing faces, but an arbor is not alw at hand, and for the first inspection erector has to rely on the face of crosshead hub, which has been machi in the same setting with the bore and thread on the piston rod. Stand crosshead with its hub on a straight face and use a good square against working faces. If the square does show a deviation of more than 1/32 i this might be taken care of by file scraper while fitting the crosshead to guide. If it is more, it is advisabl lock the crosshead to the piston rod have the working faces turned or pla

The crosshead being now nearly can be placed into the guides, the bo rubbed and fitted to it, and a square on the bottom and against the hub to it true. The top shoe can be brough against the top guide and fitted to a ing. Guide bars or guide caps mu left off until a line has been run thr the engine. The inside faces of the c head which confine the wristpin are sometimes not square to the pin. is often not noticed in a round head, as it can turn to suit a dev from the vertical line, but certainly cause the boxes to bind when the are keyed up. The outside faces must necessarily come true to the pin, a the crosshead is set to one of them, ar the other one faced when the pinhole i machined.

# Single Belted Electric Elevators

## The Operating Details of Two Standard Machines, with Especial Reference to Controlling Apparatus and Their Adjustment and Use

### BY WILLIAM BAXTER, JR.

The appearance of a single-belt electric evator machine is shown by Fig. 19. This particular machine is built by Nock & Garside, of Denver, Colo. The sheave *A*, located under the winding drum, is rovided so that the ropes from the drum may be carried up the elevator well and hence to a counterbalance weight. The peration of the machine is controlled by a hand-rope sheave *B*, which in addition operating the motor controller frees brake shoe by means of a cam that ts the lever *C*. The controller is shown *D*, mounted on the side of the machine, such position that the reversing switch, hich is on top of the controller box, can me in line with the shaft on which the. p motion *E* is mounted; thus, when the nd-rope sheave *B* is rotated, by the pull the hand rope *F*, the reversing switch thrown to the side or the other, depending on the direction in which the hand rope is pulled. If the elevator is set in motion and not stopped by the operator, when it reaches the end of the elevator well, the arm shown projecting from the upper end of the platform will strike a stop ball secured to the hand rope at the proper point, and thereby rotate the hand-rope sheave *B* which will carry with it the stop motion *E*. By this means the reversing switch will be moved to the "stop" position and at the same time the cam on the sheave *B* will move out of the way and permit the brake strap to grasp the brake wheel and stop the machine. If the stop balls on the hand rope should get loose and be forced out of position, the stop motion will act to stop the machine by throwing on the brake and turning the reversing switch to the open position. The stop motion *E* is actuated by the drum shaft independently of the hand rope.

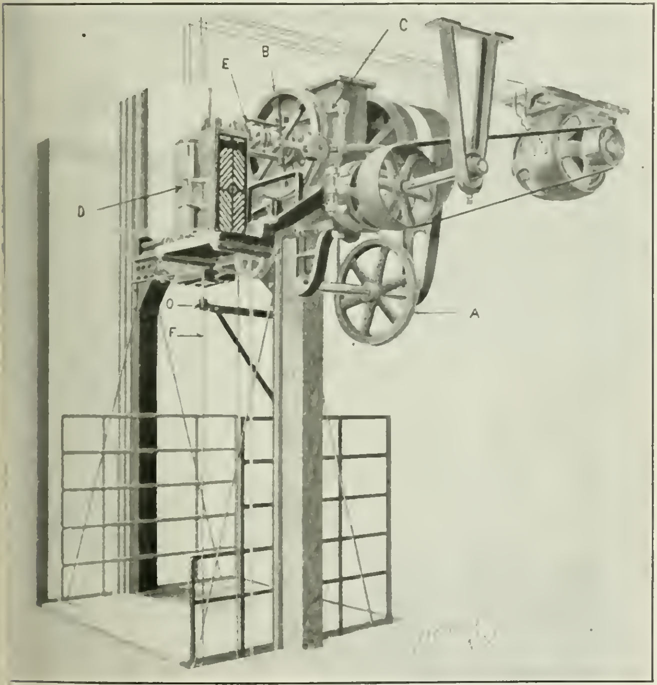
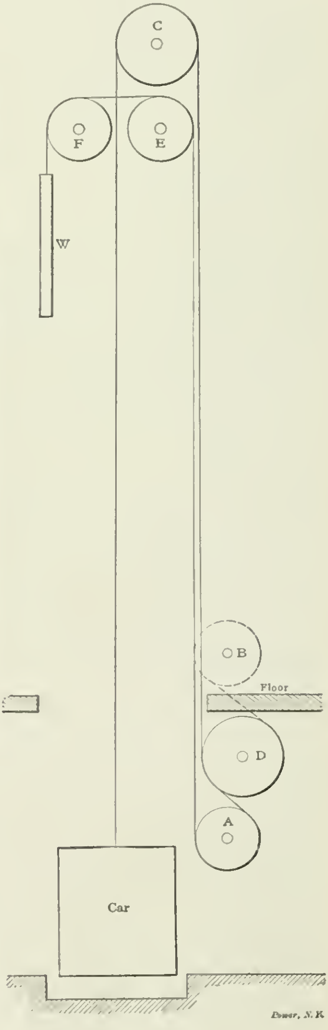


FIG. 19

The way in which the sheave *A* enables the ropes from the hoisting drum to run up the elevator well to the counterbalance can be clearly understood from the diagram, Fig. 20, in which *D* repre-



Power, N.Y.

FIG. 20

[illegible] A the sheave under it, which is commonly called a traveling sheave. It travels endwise on the shaft upon which it is mounted, as the rope unwinds from the drum. In some cases the traveling sheave is placed above the drum, as indicated in broken lines at B. This arrangement obviates the necessity of carrying the ropes so far beyond the drum, but at the same time has the objection that the sheave at B encroaches upon the floor space above the machine, and in some buildings this may be undesirable.

Fig. 21 shows a single-belt machine made by the Otis company arranged with the traveling sheave in the position B of Fig. 20. This illustration is a picture of an entire elevator well, and serves to show clearly the way in which the overhead work, the counterbalance, the hand rope and all other parts are arranged. The traveling sheave is seen at A; the stop motion on the machine, from the end of which the reversing switch is operated, is at B, and the long rope E is the hand rope, which in this case acts to rotate a short shaft from which a sprocket-wheel chain or rope F runs to the hand-rope sheave on the machine. The counterbalance is shown at W, and the way in which the ropes run from it to the drum of the machine is easily traced out.

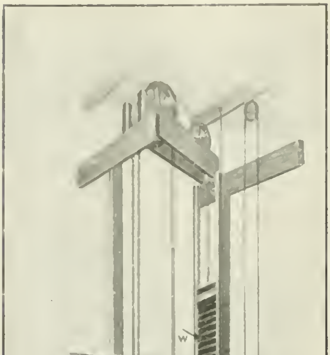


FIG. 21

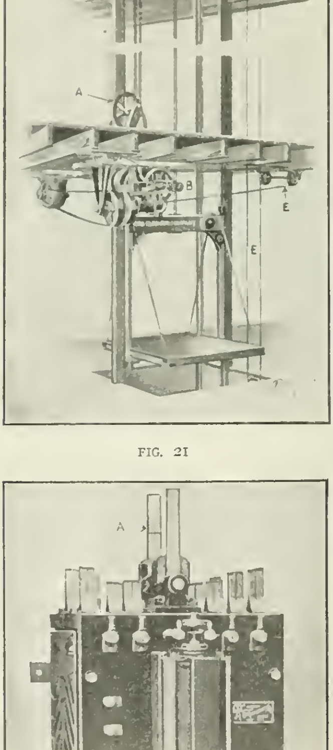


FIG. 22

The controller shown on the Nock & Garside machine, Fig. 19, is more clearly illustrated in the enlarged photographic view, Fig. 22, and the way in which the controller is connected with the motor is shown by the wiring diagram, Fig. 23. In Fig. 22 the reversing switch, on top of the controller, is shown in the open or stop position. In the diagram, Fig. 23, the reversing switch is shown thrown to the left side, and when it is in this position the current flows through the wiring in the directions indicated by the arrowheads. The automatic rheostat is of the solenoid type, the magnet *S* acting to draw up the plunger *P*, which carries at its lower end a crosshead carrying brushes at its ends which make contact with two rows of stationary contacts connected with the starting resistance. Two of these contacts, at the upper left hand side, are connected with the terminals of the series field winding of the motor. The dashpot *D* at the bottom of the controller regulates the velocity with which the plunger is drawn upward, and, consequently, the rapidity with which the starting resistance is cut out of the armature circuit. The current can easily be traced from the left side of the two-pole main-line switch to the upper right-hand contact of the rheostat, thence through the resistance and the motor series field winding and to contact *1* of the reversing switch. From here the current passes through the lower switch blade to contact *2* and thence to the armature-connecting post $A_1$; through the armature to the post $A_2$ and to contacts *3* and *4* of the reversing switch, the latter being in connection with the upper switch blade so that the current passes to contact *5* and thence back to the line.

The current for the shunt field of the motor, and for the solenoid magnet passes from the left hand binding post to contact *6'* of the reversing switch, through the connection *a* to the contact *6*, and thence to the shunt-field connecting post $F_1$. The connection between contacts *6* and *6'* is made by a bridge plate carried by lever *L'* but insulated from it. In Fig. 22 the bridge plate on the lever *L'* is shown at *A*. The current that passes from post *1* to the contacts *6* and *6'* and to the field-binding post $F_1$, from this point flows through the shunt-field winding and returns to the post $F_2$; from there it passes to contact *7* of the reversing switch, and as this is not insulated from the lever *L''*, the current flows to the contact *5* and thus returns to the main line. The current passing from the contact *6* to the post $F_1$ on reaching the junction *8* divides and portion of it flows through the solenoi magnet *S*, and through the disk-shape switch directly above the magnet; thenc into the wire that leads to contact *9* of th reversing switch, and thence through th lever *L''* to the contact *5* and the mai line. When the solenoid magnet *S* ha drawn its plunger all the way up, th disk-shaped switch is raised so as t break the circuit at this point, and the the current has to pass through the re sistance *R*, and as a result its strength greatly reduced.

When the brush-holder crosshead *S* reaches the uppermost position, the mot series field winding is cut out of the ci cuit, providing the connections are shown in the diagram; in some cases t connections are so made that the fie winding is not cut out. To do this that is necessary is to break the conn tion between the upper series field p and the upper contact of the solen switch, and connect this contact with t one below it. This arrangement, in whi the series field is left in service duri all the time the elevator is running is jectionable, for reasons that will be plained hereafter, and when used, the c troller is generally so arranged that operator in the car can cut the ser winding out.

It will be noticed that the shunt-fi winding and the solenoid magnet *S* connected in parallel, the circuits start from the junction *8* and coming toget at the contacts *7* and *9* of the revers switch. Owing to this arrangement, w the motor is stopped and the circuit broken between *7* and *9* by the raising the lever *L''*, the current induced in shunt-field winding can discharge thro the coil of the magnet *S*; the coil *S* also tend to discharge through the sh field winding, but the latter being la will overpower it. With this connec while the field winding will not have a discharge path, the strain on the ins tion will be very much less than if no path were provided.

Belted electric elevators are used principally for freight service, although they are frequently used to operate passenger cars in low buildings where it is not necessary to run at high speeds, say, not above 75 feet per minute. Such machines are not well adapted to higher velocities, one reason being that they are not as safe for high speeds as direct connected machines. When the speed is low, the acceleration in starting is also low, and as a result the belt is not subjected to a strain much in excess of that imposed

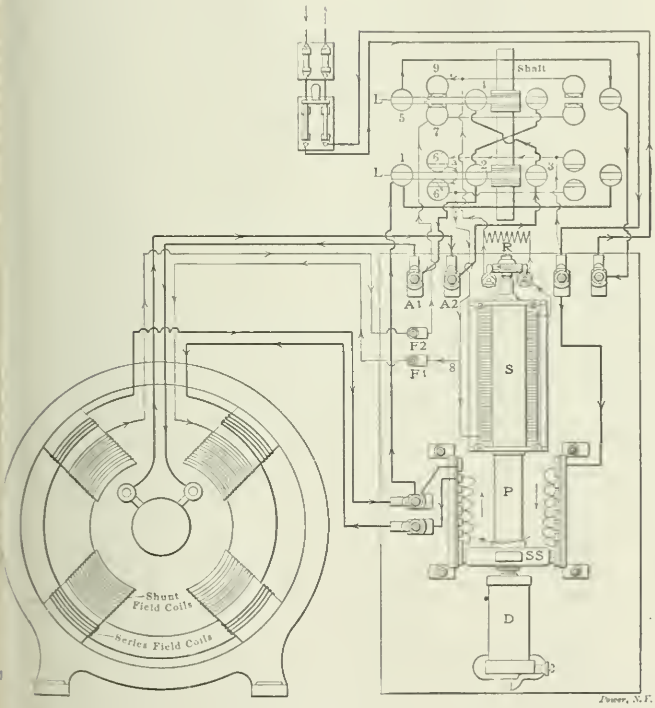


FIG. 23

n it when the car is running at full city. If the running speed is high, wever, the acceleration must be rapid, this will put a greater strain on the in starting, and will increase the nger of running it off the pulley or eaking it. With a direct-connected maine there is no danger of this kind. elted machines are used for freight and mall passenger elevators because they st less to install, but in buildings where is desired to have the best, regardless cost, direct-connected machines are ed even for freight service and the west-speed passenger cars.

# Influence of the Constituents of Coal on the Efficiency and Capacity of Boilers*

By D. T. Randall**

It is difficult to burn all coals with equal efficiency. This may be due either to the character of the coal, the size of the coal, or to both. Having a large number of tests on different coals, one may by systematic study draw some general conclusions regarding the influence of moisture, volatile matter and, in extreme cases, possibly on the effect of the presence of ash in the coal. Unfortunately for the purpose of comparison, the coals high in moisture are usually high in volatile matter and ash as well. That there is a difference in the composition of coals will be readily seen from a comparison of coals mined in the same state, as shown in Table 1. It will be seen from this table that the volatile matter is very much greater in coal mined in some localities than in others, and it may be expected that these coals will behave differently when burned under a boiler.

### The Influence of Moisture

It is of course understood that any moisture in a coal reduces the heating value accordingly. In addition to this influence, there is a further loss due to the absorption of heat in the furnace, which lowers the temperature of the gases, causing a larger percentage of loss in the gases escaping from the boiler. This influence is not readily seen when burning coals which have only a slight variation in the moisture content, but in cases where there is an excessive amount of moisture this influence may be readily traced, as in Western lignites in which the moisture sometimes reaches 40 or 45 per cent. of the weight of the fuel. On the other hand, there are many people who believe that a certain percentage of moisture is favorable to good combustion and, as has been indicated, the influence of moisture is so small that its effect cannot be separated from the many other influences which affect the results of a boiler test. It may be seen from Table 2 that even considerable percentages of moisture may not result in greater loss than may be due to some other influence, such as the size of the coal. It will be noted that even though one of the coals shown in this table exceeds by about 10 per cent.

TABLE 1. COMPARATIVE ANALYSES OF COALS MINED IN THE SAME STATE.

Results Reported in Bulletins of the United States Geological Survey.

| | Pocahontas, Tazewell Co., W. Va. | Clarksburg, Harrison Co., W. Va. | Ehrenfeld, Cambria Co., Pa. | Bruce, Allegheny Co., Pa. |
|---|---|---|---|---|
| Moisture | 1.63 | 2.01 | 3.51 | 2.61 |
| Volatile matter | 17.17 | 37.31 | 16.82 | 34.92 |
| Fixed carbon | 75.34 | 52.13 | 73.01 | 56.30 |
| Ash | 5.86 | 8.55 | 6.63 | 6.17 |
| Sulphur | 0.75 | 2.54 | 0.91 | 1.26 |
| B.t.u. as received | 14,672 | 13,811 | 14,279 | 13,997 |

TABLE 2. RESULTS OF EVAPORATIVE TESTS OF ILLINOIS WASHED COAL ON A CHAIN GRATE STOKER.

Illinois Engineering Experiment Station, L. P. Breckenridge, Director.

| | Test 47. | Test 131. |
|---|---|---|
| Size of coal | ¼ to ¾ in. | ⅜ to ⅞ in. |
| Per cent. moisture—coal as fired | 10.72 | 19.83 |
| Per cent. ash—coal as fired | 7.31 | 7.68 |
| Per cent. volatile matter—coal free from ash and moisture | 39.59 | 42.61 |
| B.t.u. in coal as fired | 11,898 | 10,274 |
| Per cent. $CO_2$ | 12.60 | 11.46 |
| Carbon in ash | 1.00 | 1.75 |
| Equivalent evaporation from and at 212° F. per pound coal as fired | 8.24 | 7.49 |
| Efficiency of boiler and grate | 66.89 | 70.39 |
| Efficiency of boiler | 69.93 | 71.76 |

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*Presented at the recent meeting of the American Society for Testing Materials.

**Engineer-in-charge, fuel-engineering department, Arthur D. Little laboratory of engineering chemistry, Boston, Mass. Also, late engineer-in-charge of fuel tests, Technologic Branch, United States Geological Survey.

the [illegible] of the other coal, the results are better. This may probably be accounted for by a difference in the size of the coal.

### Influence of Volatile Matter

With a poorly designed furnace the volatile matter in a coal is allowed to escape unburned even when the fuel is burned at moderate rates. With well-designed furnaces a loss of combustible gases is found when they are operated beyond a certain capacity, varying with the furnace and with the kind of coal. Tables 3 and 4 show in a general way what may be expected from the two extremes in furnace design, those which are and those which are not adapted to burning high-volatile coals. The house boiler on which these tests were conducted may be considered as one of the lowest types of furnace for burning coals high in volatile matter, for the reason that the rate of combustion is low and the firebox is made up of iron surfaces which have a cooling effect on the gases as soon as they escape from the coal. At the Government fuel-testing plant results as shown in Table 4 were obtained on a hand-fired Heine boiler with a firebrick combustion chamber.

TABLE 3. RELATION BETWEEN VOLATILE MATTER, EFFICIENCY AND SMOKE HOUSE HEATING BOILERS.

Data from Bulletins of the United States Geological Survey

| No. of Tests Averaged. | Volatile Matter Coal Free from Ash and Moisture. | Efficiency, 72. | Black Smoke |
|---|---|---|---|
| 4 | 18 30 | 60 56 | 18 2 |
| 7 | 34 70 | 54 11 | 22 1 |
| 11 | 41 46 | 47.19 | 32 9 |

### Influence of Ash

For small variations in the percentages of ash it is not possible to determine the effect on the results obtained. The character of the ash is of more importance than the quantity when considering its effect on the results obtained. Clinkers and ash reduce the efficiency and capacity by making it necessary to hold the doors open longer in cleaning the fire, and in case the ash fuses and runs onto the grate bars the air is shut out and the grates may be burned, and the results be affected by the imperfect air supply. A large percentage of ash tends to make the distribution of air through the fuel bed uneven, requiring a much larger air supply than is necessary for other coals. Large quantities of ash also cause a loss of unburned coal due to the poking and to the frequent cleaning of the fire. When the coal contains a high percentage of ash the labor of feeding the furnace with the extra quality of fuel, the cleaning of the fires and the handling of the ash may make it necessary to employ extra help in the boiler room. There is also an additional expense in hauling the refuse away from the plant. The extra quantity of ash may make it impossible to burn a sufficient quantity of coal upon the grate surfaces provided and require an extra boiler to be operated. This causes a further loss due to the extra labor, radiation losses from the boiler, etc. However, with moderate qualities of ash in the coal no serious loss should result when the furnace is properly handled.

TABLE 4. RELATION BETWEEN VOLATILE MATTER, EFFICIENCY AND SMOKE, HAND-FIRED HEINE BOILER.

Data from Bulletins of the United States Geological Survey.

| No. of Tests Averaged. | Volatile Matter. Coal Free from Ash and Moisture. | Efficiency, 72. | Black Smoke. |
|---|---|---|---|
| 8 | 17 47 | 67 16 | 3.1 |
| 19 | 34 18 | 67 21 | 12.9 |
| 37 | 44 13 | 65 25 | 18.0 |

### Influence of Sulphur

There are not sufficient data at hand to discuss in general the effect of sulphur in coal. There are coals from certain fields that usually give trouble when the sulphur is high. This is due not onl the sulphur in the coal but to the bination of iron and other elements the sulphur, and the sulphur is m an indication of probable difficulty may be experienced. When sulphu curs in combination with iron the bars are often attacked and ser damaged, requiring expensive renew ironwork.

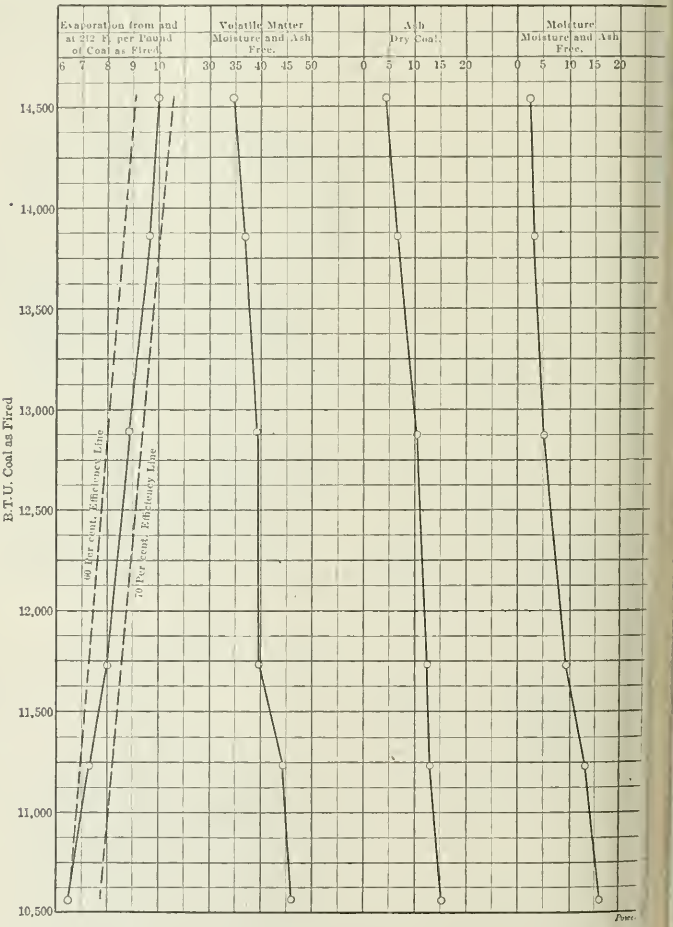

CHART SHOWING RELATION BETWEEN HEATING VALUE AND EVAPORATION

# Some Useful Lessons of Limewater

## How to Detect Aluminum in Boiler Scale; Separating Iron and Aluminum; Calcium, Magnesium, Ferric Iron and Aluminum Solution

### BY CHARLES S. PALMER

We have seen that iron may occur in ler scale and how it may be detected; t aluminum may also accompany iron, her as oxide or hydroxide (hydroxides nly oxides with more or less of emical water). Of course these will dissolved when the scale is treated with cid to cut it. You can easily detect mina, the oxide of aluminum, when it present in the scale. If there is any ne, it comes down in the fifth group as arbonate; and if there is any magnesia, oxide of magnesium comes down in sixth group as a phosphate. We have en that the iron will come down in the ird group, after oxidizing to be sure at the iron is all in the higher or ferric rm. Now alumina has only one state oxidation, and that is much like ferric n in its chemistry.

### Reactions of Aluminum

It will be well for you to consider the tions of aluminum right here; so, take me common alum sulphate, or if you not happen to have any of that, you take some common alum, which is double sulphate of aluminum and either mmonium or potassium, hence the names monia alum and potash alum. The sence of the alkali sulphates with the hate of aluminum does not make much ference in the tests as long as you w that you are using alum; for you mber that neither sodium, nor po- um, nor ammonium is precipitated all of the other metals are out of the y, and then only with special reagents, the road is clear to see what a solu- of aluminum does with the common gents, that is, the alkaline hydroxides, rbonates and sulphides, and the special p reagents, such as hydrochloric acid, rogen sulphide, ammonia, etc.

If you try any or all of these, the only ipitate that you will get in the case aluminum is the white, gelatinous (or y) hydroxide. This does not mean t aluminum does not have any sul- es or carbonates; for like ferric iron, uminum can form sulphides, but these not stable with water, being stable only hen dry; and thus many chemists forget at both ferric iron and aluminum have eir sulphides which are formed only ith dry heat, and they are decomposed ith water, giving off hydrogen sulphide. lso, aluminum, at least, has a double rbonate with some of the alkalies; but common reactions, all that you will get in the way of a precipitate for aluminum is the white gelatinous hydroxide. This is easily soluble in an excess of sodium or potassium hydroxide, forming the aluminates according to the following reactions:

$$Al(OH)_3 + 3NaOH = Al(ONa)_3 + 3H_2O$$

| $Al(OH)_3$ | $3NaOH$ | $Al(ONa)_3$ | $3H_2O$ |
|---|---|---|---|
| Aluminic Hydroxide Insoluble. | Sodium Hydroxide Soluble. | Sodium Aluminate Soluble. | Water. |

$$Al(OH)_3 + NaOH = AlO.ONa + 2H_2O$$

| $Al(OH)_3$ | $NaOH$ | $AlO.ONa$ | $2H_2O$ |
|---|---|---|---|
| Aluminic Hydroxide Insoluble. | Sodium Hydroxide Soluble. | Sodium Met-aluminate Soluble. | Water. |

The reason for this is that the hydroxide of aluminum is both a weak base and a weak acid; that is, it is a weak base with strong acids, and a weak acid with strong bases; and it passes back and forth from one condition to the other, according as the solution is acid or alkaline with strong acids and bases. To show this, go through the following reactions with sodium hydroxide and hydrochloric acid, always including your indispensable litmus: Start with alum sulphate, $Al_2(SO_4)_3$; here the aluminum is clearly acting as a base with the strong acid, sulphuric acid; or rather with the strong acid radical, "sulphion," $SO_4$, in the terms of the later ionic theory of salts in solution. Now add some litmus paper to the solution of alum sulphate, $Al_2(SO_4)_3$, and you will note that the blue litmus is turned red, showing that the aluminum is not so basic as the sulphion, $SO_4$, is acid; there is more to this story of "hydrolysis," which we will discuss later.

Now add some sodium hydroxide till the white gelatinous aluminum hydroxide, $Al(OH)_3$, is precipitated and the solution is distinctly alkaline to litmus; here we have the second stage, where the aluminum hydroxide is clearly still acting as a base, being precipitated by a base, and according to the following reaction:

$$Al_2(SO_4)_3 + 6NaOH = 2Al(OH)_3 + 3Na_2SO_4$$

| $Al_2(SO_4)_3$ | $6NaOH$ | $2Al(OH)_3$ | $3Na_2SO_4$ |
|---|---|---|---|
| Alum Sulphate Soluble. | Sodium Hydroxide Soluble. | Aluminic Hydroxide Insoluble Basic. | Sodium Sulphate Soluble. |

Now go on to the third stage, where the alumina is acting as a weak acid with the strong base, caustic soda or sodium hydroxide, NaOH, by adding this same sodium hydroxide to the same precipitate in the same solution till all the white gelatinous aluminum hydroxide is entirely dissolved in the excess of sodium hydroxide, according to the equations for the aluminates given in the foregoing. Here we see the acid nature of white gelatinous aluminum hydroxide, in the strongly alkaline solution of sodium hydroxide.

Now go on to the fourth stage, the precipitation of the aluminum hydroxide from the alkaline sodium aluminate by hydrochloric acid, by adding hydrochloric acid carefully until the alumina comes down and the solution is just acid to litmus, according to the following equation:

$$Al(ONa)_3 + 3HCl = Al(OH)_3 + 3NaCl$$

| $Al(ONa)_3$ | $3HCl$ | $Al(OH)_3$ | $3NaCl$ |
|---|---|---|---|
| Sodium Aluminate Soluble Alumina Acid. | Hydrochloric Acid Soluble. | Aluminic Hydrate Insoluble as Aluminic Acid. | Sodium Chloride Common Salt. |

Here you can see that alumina is acid because it is being thrown down from solution by hydrochloric acid.

Now go on to the last stage, completing the cycle. Here the aluminic hydrate changes from acid to basic relations, as in the equation:

$$Al(OH)_3 + 3HCl = AlCl_3 + 3H_2O$$

| $Al(OH)_3$ | $3HCl$ | $AlCl_3$ | $3H_2O$ |
|---|---|---|---|
| Aluminic Hydrate Insoluble as Aluminic Acid. | Hydrochloric Acid Soluble. | Aluminic Chloride Soluble Aluminum Basic. | Water. |

Here you have redissolved the aluminum hydroxide in excess of hydrochloric acid, and have a solution of aluminum chloride, the aluminum being again in the basic state by reason of the excess of hydrochloric acid in solution. Thus you have changed the aluminum from basic to acid condition and back again by some sodium hydroxide, then more; then by some hydrochloric acid, and then more.

### Separating Iron and Aluminum

Now go right on and use this to separate iron and aluminum. Mix some of that bottle of "ferric salts" (made the other day by oxidizing some green vitriol with nitric acid), with some of your solution of alum sulphate. Here you have a mixture of ferric-iron salts with aluminum salt; and if you add sodium hydroxide to distinct alkaline reaction, by testing with litmus, you have both the oxides of ferric iron and that of aluminum thrown down; but you cannot see the aluminum hydroxide for the red color of the iron hydroxide. Now add sodium hydroxide in strong excess, and you know that the ferric iron is not dissolved, while the aluminum hydroxide is so dissolved, as you have just seen. Pour this into a tumbler of water to dilute it; and then filter it (the dilution is to save your filter paper; for if you should pour the solution of strong caustic soda or sodium hydroxide on paper, it would throw the paper over a pile which would [illegible] ring).

You have now filtered off your solution of aluminum in the form of sodium aluminate, from the ferric iron hydroxide, which remains on the paper. Now make this clear filtrate of sodium aluminate acid with hydrochloric acid and then make it alkaline with ammonia water (not with caustic soda, for that is liable to dissolve the aluminum hydroxide), and you will see the aluminum floating in the solution, where it will soon gather on standing. In this way you can separate the aluminum from the iron, and if you want to do this in the course of an analysis, for both the iron and the aluminum come down in the third group, all that you have to do is to precipitate the third group and then separate, as shown. In this way the presence of a very small quantity of aluminum can be detected.

## Calcium, Magnesium, Ferric Iron and Aluminum

It will be a good thing if you will make a solution containing calcium, magnesium, ferric iron and aluminum. You might try to do this by mixing some epsom salts (which is nothing but magnesium sulphate), some calcium chloride (made by dissolving limestone in hydrochloric acid), some ferric salts and some aluminum sulphate. If you should do this you would not get a clear solution, for you would see an abundant white precipitate, which is only the lime or calcium sulphate naturally thrown down by the sulphates of iron, aluminum and magnesium, for either sulphuric acid or any soluble sulphate will precipitate calcium as a sulphate. You see that it is quite a trick to make your own solutions, let alone analyze them. So you had better start in another way.

Take the solution of ferric salts, that of alum sulphate, that of epsom salts, and precipitate each of them by caustic soda (sodium hydroxide). This will throw down the hydroxides, and you must not add to the alum sulphate enough to redissolve the aluminic hydroxide. Do this in separate tumblers or fruit jars. Fill the jars up with water and let the hydroxides of iron, aluminum and magnesium settle; then pour off the water and fill up with fresh water. In this way you will gradually wash off the dissolved sodium sulphate (which would raise the mischief with your calcium by precipitating it as sulphate), and which you want to get rid of. When you have washed off most of the sodium sulphate "by decantation," as it is called, dissolve each of the hydroxides of iron, aluminum and magnesium in hydrochloric acid and mix them.

Now you have a solution of iron, aluminum and magnesium, fairly free from "sulphion," $SO_4$, which would precipitate your lime, and you can add to this your solution of calcium chloride. Thus you get a solution of the four metals, iron, aluminum, calcium and magnesium, all as chlorides. You proceed to analyze this, going regularly through the groups. You do not need to test for the first group, which is precipitated by hydrochloric acid, because your solution is a hydrochloric-acid solution. Just for luck you may test a part of your mixture for the second group with hydrogen sulphide, taking a small portion of the solution in a separate test tube. You will get nothing but sulphur, which shows that there is some ferric iron in the third group. Add some ammonium chloride to keep magnesia from coming down before it is wanted, and then ammonia to alkaline reaction, and until all the iron and aluminum are thrown down in the third group. Of course this is done in a separate beaker, and with most of your mixture of the four metals you are testing for.

You will get the iron and the alumina in the third group, which you filter off for precipitated iron and alumina, which you will separate as just shown. You will save the filtrate, labeling it "Filtrate from the Third Group," and test a small part of this in a separate test tube, for the fourth group (to get in practice, though you have no fourth group present), with ammonium sulphide. Go on with the greater part of the filtrate from the third group, to the fifth group, which you will precipitate with ammonium carbonate. Give the lime carbonate time to settle, and then filter it off. Then take the filtrate from this and test it for magnesia by the "magnesia mixture"—the mixture of ammonia, ammonium chloride, and sodium phosphate. Give the magnesia phosphate time to come down—and there is your fairly clean analysis of the four metals, iron, aluminum, calcium and magnesium, which you are liable to find in a common temporary-hardness scale. Of course, you will save each of the separated precipitates of iron, aluminum, calcium and magnesium, and subject them to some of the confirming tests given in any book on qualitative analysis. Do not neglect this habit of confirming every separation by some one or two good tests which will clinch the argument in your mind.

## Making the Ferric-iron Solution

You have separated, let us say, iron and aluminum in the third group, and your ferric iron hydroxide is still on your filter paper. Take this ferric hydroxide, and dissolve it in some dilute hydrochloric acid. Now you have a regular solution of ferric iron, which you can test with any of the regular tests, such as the blood-red test with potassium or ammonium sulphocyanate; or the blue test with yellow prussiate of potash, and so on. You cannot do much with the alumina, but the very method you have taken to separate it from iron in the third group is quite test enough for ordinary cases. The calcium carbonate you can dissolve in some dilute hydrochloric acid, and then test it with the flame, which it will color strongly red. Or you can reprecipitate the lime by ammonium carbonate, dissolve the carbonate in acetic acid, and then reprecipitate the lime as the white oxalate by oxalic acid.

For the magnesia, there is not very much that you can do, but if you ignite the precipitate on charcoal, you may get the pale rose color from moistening with cobalt nitrate and reigniting; or you may find that this will be obscured by the blue test for phosphates, because you pre cipitated magnesia with sodium phosphate So you will have to scheme how you ca get rid of this phosphoric acid and stil get at that magnesia. The best way to d this is to take the magnesium phosphate well washed with a solution of ammonium chloride on the filter paper, and boil with metallic tin and nitric acid, whe the insoluble phosphate of tin is forme the phosphoric acid going off with the ti and you have the magnesia in solution a nitrate. Evaporate this solution dow to dryness with hydrochloric acid and th gives you mostly plain magnesia, whi you can then ignite on charcoal before t blowpipe, and thus get the rose color wi cobalt nitrate. But this means that yo must get hold of the blowpipe, and w will take up that practical help next tim

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# Comparative Test of Coal a Shavings as Boiler Fuel

By Louis P. Zimmerman

A great many woodworking pla throughout the country, as well as ot plants located in woodworking cent generate steam from the consumption shavings and refuse instead of coal. T continued rise in the market price of t fuel, amounting to 100 per cent. in ei years, has made pertinent the question its actual economy for steam generat Would it not be cheaper for woodwor plants to sell their shavings and buy c Had not other plants buying and u shavings better burn coal also? To p in another way: What is the actual of evaporating 1000 pounds of water shavings and with coal?

A friend of the writer had the op tunity to make some tests to answer t questions, the results of which are sented herewith. The results show cost of evaporating 1000 pounds of w under normal working conditions bur factory shavings and burning coal. tests were conducted at the Minnea plant of the Wabash Screen Door C pany, manufacturer of screen doors, dow screens and stove boards. The is situated in southeast Minneapolis o line of the Great Northern Railway. buildings include a planing mill, a w working shop containing special mach for the manufacture of screen-door fr and a stove-board factory. About orsepower is required to run the maines in the factory, light and heat the uilding and furnish steam for the dry iln.

Steam is generated in three horizontal eturn-tubular boilers, each 72 inches in iameter and 18 feet long. The boilers were designed, built and set by the Bass undry and Machine Company, of Fort Wayne, Ind. Each boiler contains seventy inch tubes, has a water-heating surface f 1422 square feet, and grates 6 feet by feet 1 inch, giving a grate area of 3 5 square feet. The boiler setting is of ick, with the following dimensions: ength over all, 23 feet 8 inches; width, feet 10 inches; thickness of side walls, inches; hight of furnace, 30 inches; ickness of bridgewall, 16 inches; distance center of bridgewall to boiler front, eet 9 inches; minimum distance between iler shell and top of bridgewall, 15 hes. To insure dry steam each boiler provided with a dry pipe extending the length of the boiler inside the shell. n open feed-water heater and standard iler-feed pump handle the boiler-feed ter.

The steam generated in the boilers is deered to three engines: One 350-horsewer simple noncondensing, Bass-Corliss gine, 20x40 inches, driving the entire ctory; one 90-horsepower Skinner autoatic noncondensing high-speed engine rect-connected to a 75-kilowatt Westinguse generator; one small blowing ene, built by the Buffalo Forge Comy, to drive the ventilating fan. Live m is also supplied to the coils in the y kiln and the factory-heating system severely cold weather. While the dend for steam is very diversified, it is imated that 90 per cent. of all that is erated is consumed by the Corliss en e. An examination of the accompanyg results shows that the steam producof the boilers is subject to very little tuation, a condition extremely favorto getting good results from the s.

nder normal factory conditions the t produces about 40,000 pounds of vings a day, weighing 17 pounds per foot, with a heat value (as deter ed by Dalong's formula) of 7800 ish thermal units per pound. The vings are largely pine, with a sprinkling k. This fuel comes from the planing l and the cutoff saws and is made up ely of chips and sawdust. No single e is more than an inch in diameter a inch thick, the average being about size of a man's thumbnail. Therefore, fuel is light, similar in many ways to ff, and easily blown off the grate by ssive draft.

he shavings are collected from all parts the factory by means of a suction sysm and are delivered to a hopper situated ve the boiler house. From this hopper r separate 7-inch sheet-iron pipes exd to the shaving house or bin where the excess is stored, and to the three grates under the boilers. Each pipe is equipped with a butterfly valve controlling the delivery of shavings. The supply of fuel to the boilers is absolutely automatic, the shavings dropping from the hopper directly to the grates under the boilers. In case the hopper is not furnishing enough fuel to keep up steam, shavings are hand fired from the storage bin.

TABULATION OF RESULTS

| Fuel. | Shavings | Coal |
|---|---|---|
| Average steam pressure, by gage | 111.7 | 110.7 |
| Draft between damper and boiler in inches of water | 0.50 | 0.143 |
| Average temperature, Fahrenheit | | |
| Of external air | 29.2 | 31.2 |
| Of fire room | 69.6 | 77 |
| Of steam | 314.8 | 344.1 |
| Of feed water entering boilers | 210.4 | 210.4 |
| Of gases escaping from boilers | 4 5 | 484.6 |
| Weight of fuel, as fired, lb | 44,954 | 10,595 |
| Percentage of moisture lb | | 2.29 |
| Total weight dry fuel, lb | 44,954 | 10,350 |
| Total ash and refuse | 269 | 1,400 |
| Quality of ash and refuse | fine powder | clinkery |
| Total combustible consumed | 44,665 | 8,950 |
| Per cent. ash and refuse in dry fuel | 0.6 | 13.5 |
| Dry fuel per hour, lb | 5,617 | 1,294 |
| Combustible consumed per hour | 5,583 | 1,119 |
| Dry fuel per square foot grate surface per hour | 61.3 | 14.1 |
| Combustible per square foot of water-heating surface per hour | 1.31 | 0.262 |
| Calorific value per pound fuel | 7,800 | 13,700 |
| Calorific value per pound combustible | 7,960 | 16,200 |
| Percentage of moisture in steam. | 2.52 | 2.10 |
| Superheating in calorimeter (F) | 38.8° | 45.6° |
| Quality of steam | 0.975 | 0.979 |
| Total water feed to boilers, lb | 84,400 | 84,800 |
| Water actually evaporated corrected for quality of steam | 82,205 | 83,000 |
| Factor of evaporation | 1.042 | 1.044 |
| Water per hour corrected for quality of steam | 10,275 | 10,375 |
| Equivalent evaporation per hour from and at 212° | 10,708 | 10,837 |
| Equivalent evaporation per hour from and at 212° per square foot of water-heating surface. | 2.50 | 2.54 |
| Boiler horsepower developed | 310 | 315 |
| Builders' rated horsepower | 350 | 350 |
| Per cent. of rated horsepower developed | 88.5 | 90 |
| Water apparently evaporated under conditions per pound of fuel as fired | 1.88 | 8.00 |
| Equivalent evaporation from and at 212° Fahrenheit per pound of fuel as fired | 1.9 | 8.19 |
| Equivalent evaporation from and at 212° per pound of combustible | 1.92 | 9.7 |
| Cost of fuel per ton delivered to the boiler room | $0.46 | $1.40 |
| Cost of fuel for evaporating 1000 pounds of water under observed conditions | 12.6c. | 27.5c. |
| Cost of fuel for evaporating 1000 pounds of water from and at 212° | 12c. | 26.8c. |

The two trials were conducted as nearly as possible in accordance with the code of 1899, prepared by the committee on boiler trials of the American Society of Mechanical Engineers. On account of factory conditions the tests were each of eight hours duration. All measuring apparatus used in the test were calibrated before being used.

Considerable work was done on the boilers to accommodate the various recording instruments. Three holes were drilled and threaded for the introduction of the draft gage, flue gas pyrometer and gas-sampling tube. A throttling calorimeter was attached in place of a small whistle on the main steam header leading to the Corliss engine.

The weight of the boiler-feed water and the amount of shavings used were the two most difficult things to measure accurately. The feed water passed from the bottom of the heater (under the cement floor) through a 3-inch pipe under the floor to the feed pump, from which pipes led directly to the front and rear boiler feeds. This made it impracticable to weigh the feed water without remodeling the plant and using an extra feed pump. The feed water was measured with a calibrated meter which was placed on the delivery side of the feed pump and provided with a bypass, giving sufficiently accurate results for this test.

PROXIMATE ANALYSIS OF THE FUELS USED IN THE TEST.

| | | |
|---|---|---|
| Fixed carbon | 50.3 | 60.8 |
| Volatile matter | . . . | 29.34 |
| Hydrogen . . . . | 6.2 | . . . . . |
| Oxygen . . . . | 43.08 | . . . . |
| Moisture . . . . | . . . . . . | 2.28 |
| Ash | . | 7.58 |
| Miscellaneous | 0.42 | . |
| | 100 | 100 |

The amount of shavings burned could not be measured directly without resorting to hand-firing, which would vitiate the comparative value of the tests. With the assistance of the factory management, the following indirect method of arriving at the weight of shavings burned was adopted: Upon the successive days on which the trials were conducted every possible effort was made to keep factory conditions uniform; the same number of men were employed, the same number of machines were operated, the same number and style of doors were manufactured. With these conditions constant, it is safe to assume that the number of pounds of shavings delivered to the collection system were the same for each day. Coal was burned the first day, while all the shavings produced were deposited in the shavings house. Shavings were burned the second day, and at the same time the shavings [illegible] the shavings [illegible] were le[illegible] This the num-be[illegible] t shavings burned was [illegible] with a reasonable percentage of [illegible]

The conditions under which the runs were [illegible] were remarkably uniform, the steam pressure being 110.5 pounds with coal and 111.7 pounds with shavings. Burning coal, 84,850 pounds of water was evaporated, while the amount with shavings was 84,400. The quality of steam with coal was 0.070 and with shavings 0.075. The weight of coal burned was 10,505 pounds and that of the shavings burned was 44,934 pounds.

The results, which are given in detail in the accompanying tabulation, show that with shavings at their present price of 50 cents per cord at the factory, it is much more economical to burn them under the factory boilers as at present than to attempt to market them and buy coal in their place. Leaving out the labor item, which militates in favor of the shavings, one more man costing $1.75 per day (10 hours) being required when burning coal, the results of the tests show that the shavings must rise to a value of $1.09 per cord ($1 per ton) at the factory before they are as expensive a fuel as bituminous coal at $4.40 per ton.

# Charts for the Calculation of Alternating Current Circuits

By H. P. Liversidge

The present article describes the use of a series of charts for the solution of the various problems arising in the calculation of alternating-current circuits, these charts being plotted on the same general principle as the direct-current charts described in an article published in the issue of July 20, 1909. The relation existing between the different factors used in the calculations may be expressed by the following formula:

$$A = \frac{2 \times D \times 10.8 \times P \times k,}{P^1 \times E^2\ p^2}$$

where

$A$ = Area of conductor in circular mils,
$D$ = Distance of transmission in feet,
10.8 = Resistance per mil foot of copper wire,
$P$ = Power at receiver end in kilowatts,
$k$ = A number, depending on the system used (single-phase, two-phase or three-phase),
$P^1$ = Loss in per cent. of power received,
$E$ = Voltage per phase at receiver end,
$p$ = Power factor of the complete circuit.

In the construction of the charts, the different factors plotted are identical in value with the exception of kilowatts, distance of transmission and receiver voltage, these three values being so proportioned as to cover all practical conditions arising in the calculations of alternating-current circuits. Since the losses are expressed in percentage of the power at the receiver end, it is evident that the charts are correct for any frequency and wire spacing that may be employed.

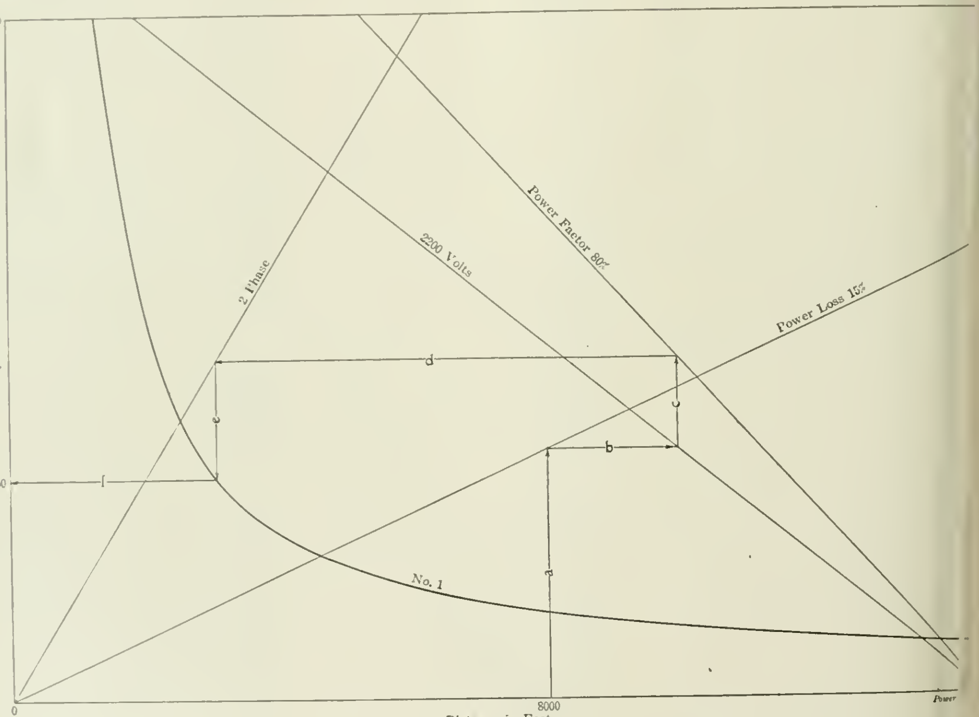

FIG. 1. EXPLANATORY DIAGRAM

In order that the method of using charts may be clearly understood, following problems are given and solutions explained in detail:

## Examples

(1) Energy loss assumed. Req e the kilowatts that can be carried given size wire.

| | |
|---|---|
| Distance of transmission ..... | 8000 feet. |
| Loss.............................. | 15 per t. |
| Delivered pressure............ | 2200 volts |
| Power factor.................. .... | 80 per t. |
| Number of phases... .......... | 2. |
| Size of wires .................... | No. 1. |

The explanatory diagram, Fig. 1 has

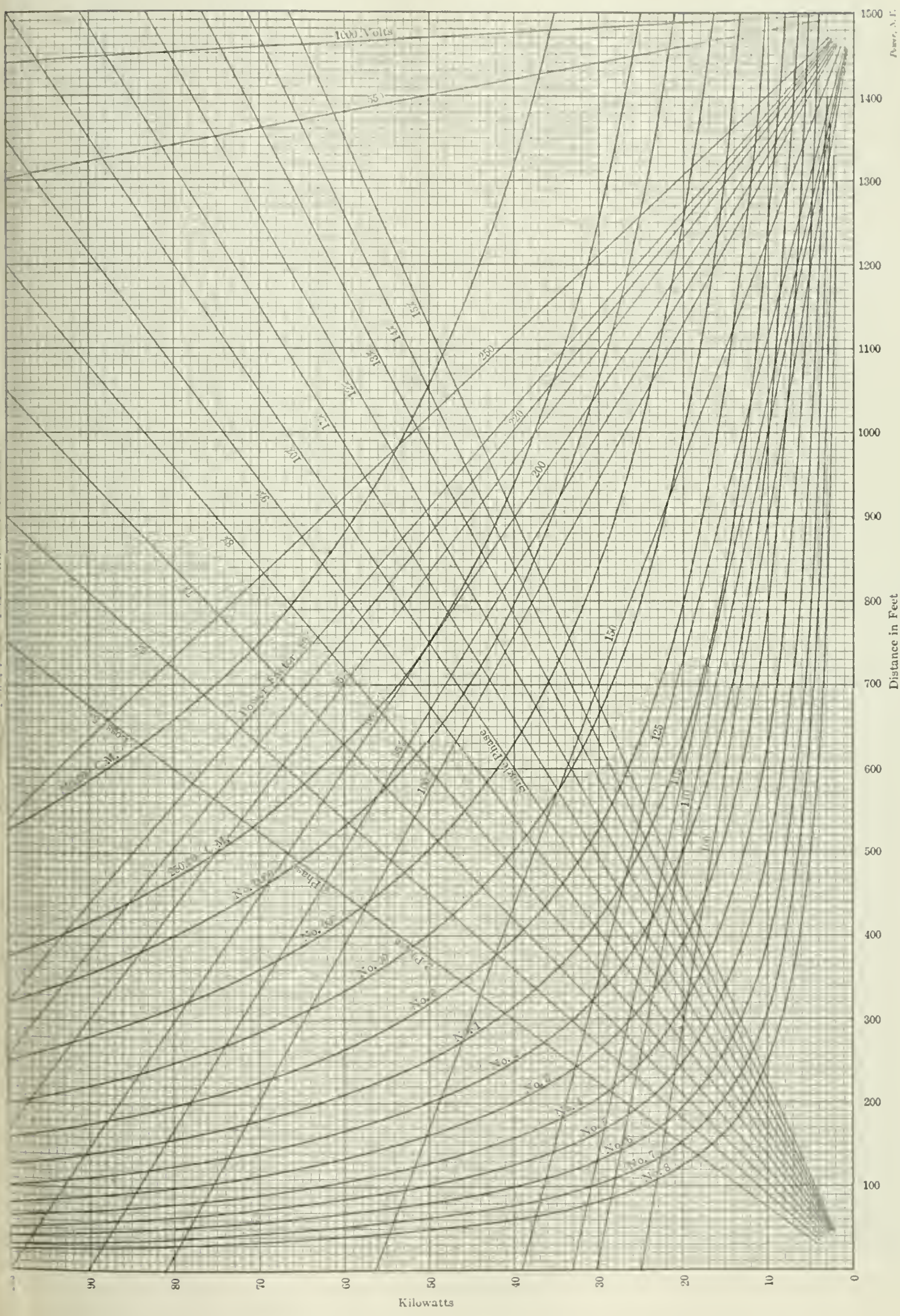

FIG. 2. CHART NO. I

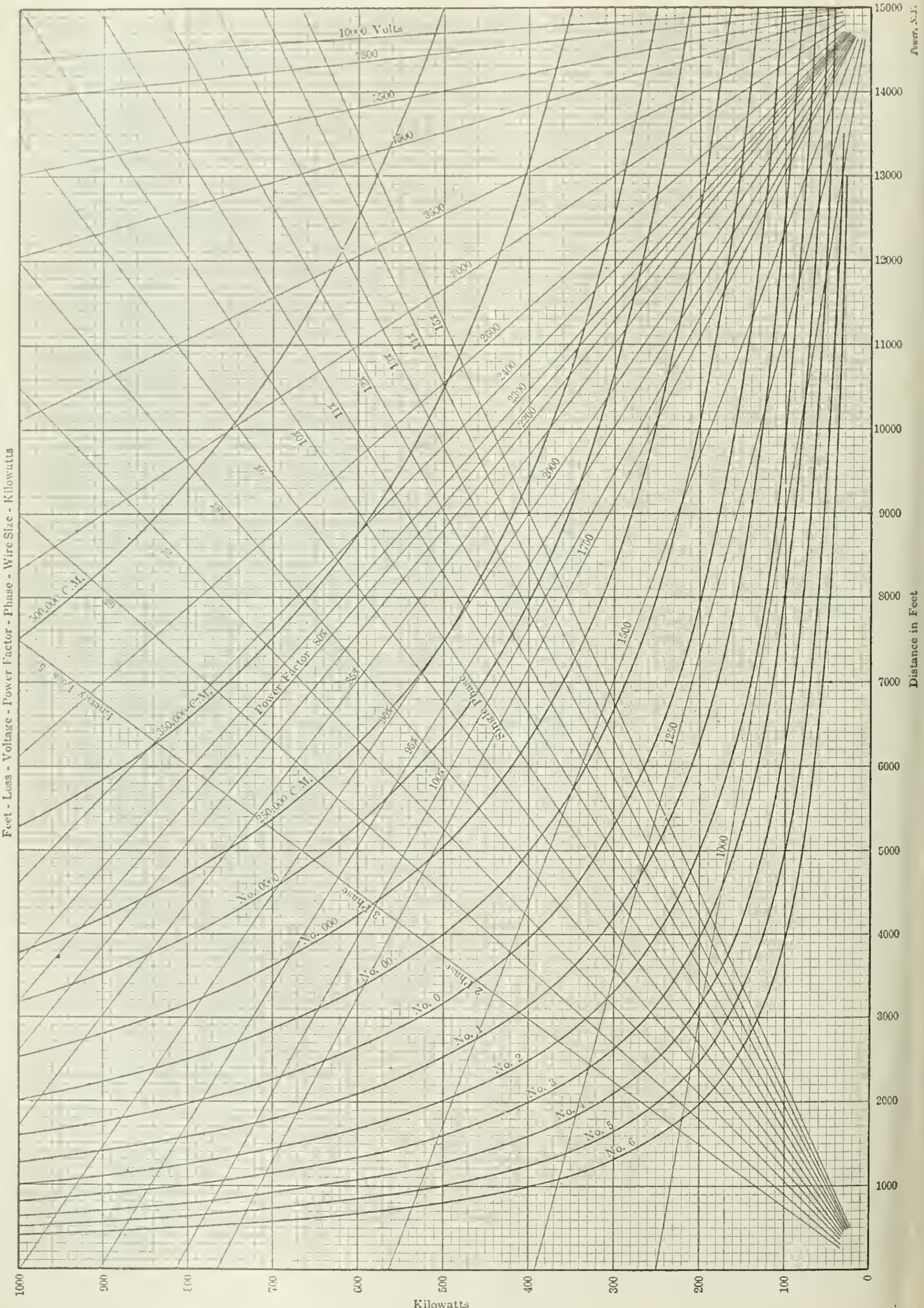

FIG. 2. CHART NO. II

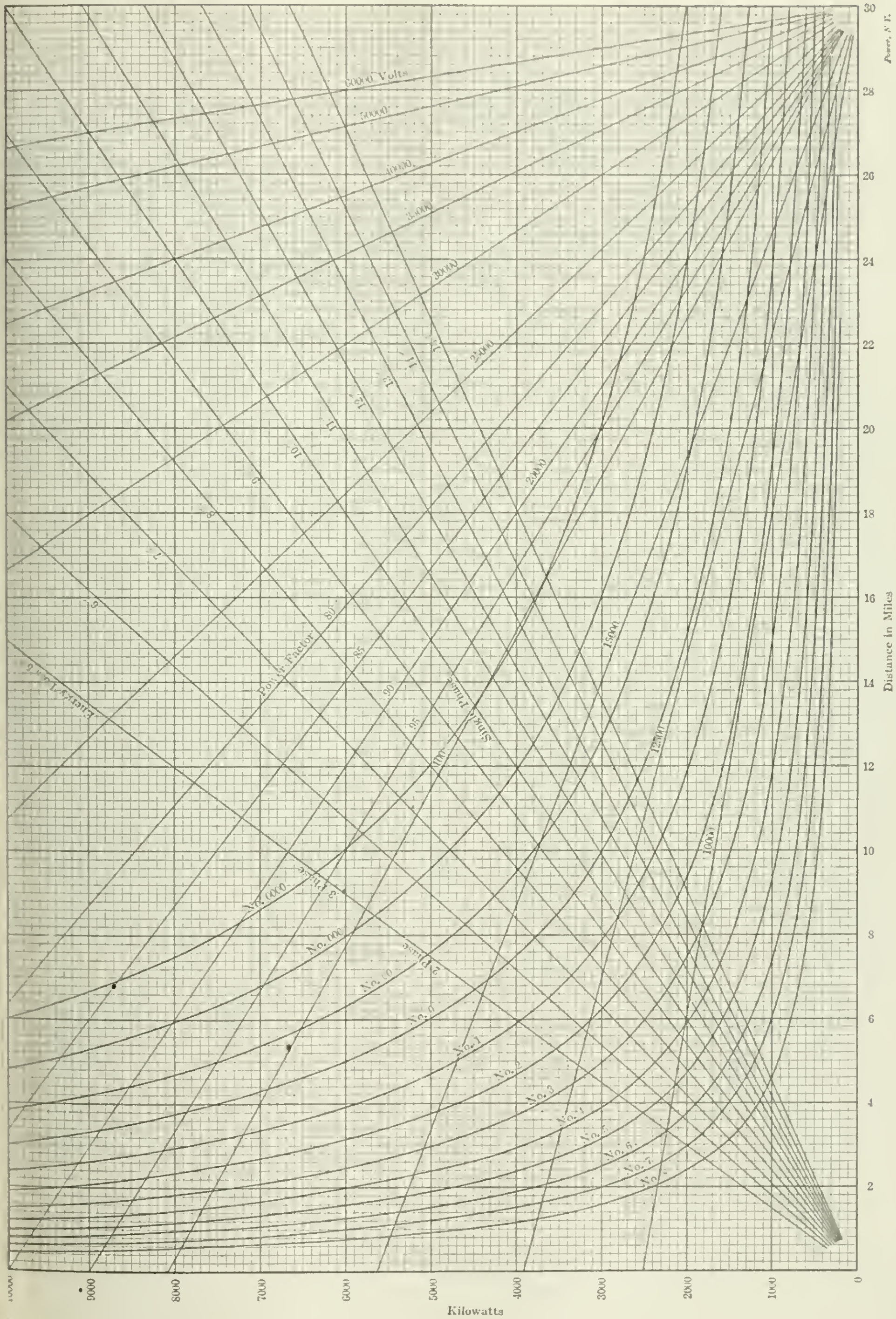

FIG. 4 CHART NO. III

[illegible] plotted [illegible] and the values [illegible] to the [illegible] the problem. The diagrams show merely the relation between the values of each of the factors used, so that the successive steps in the solution may be more readily followed without referring to the regular chart, Fig. 2, which includes a large range of each value given in the problem.

Printed at the top of each chart are the six value factors used in the solution of the various problems. The sequence in which they are printed, i.e., Feet, Loss, Voltage, Power Factor, Phases, Wire Size, Kilowatts, must always be followed in using the diagrams, otherwise a correct solution will not be obtained. Care must also be taken that each successive step in the sequence is made at right angles to the preceding one.

Referring again to Fig. 1, starting from the point marked 8000 feet the first factor in the sequence noted above, follow the vertical line *a* until it intersects the radial line marked 15 per cent. energy loss, the second factor in the sequence. Since each successive step is taken at right angles to the preceeding one, the next value in the sequence, voltage, is reached by following the horizontal line *b*, at right angles to the preceding one, the next the line marked 2200 volts. At right angles to this, follow the vertical line *c* until it intersects the radial line marked in terms of the next factor, 80 per cent. power factor. The next motion is made along the horizontal line *d* to the radial line marked 2-phase. At right angles to this line follow the vertical line *e* to the intersection of the wire curve marked No. 1. The last value in the sequence—kilowatts—is reached by following the horizontal line *f*, drawn from the last point of intersection to the load line, which is met at 450 kilowatts, the value desired.

(2) Size of wire assumed for given loss. Required distance of transmission.

| | |
|---|---|
| Kilowatts | 450 |
| Size of conductor | No. 1. |
| Number of phases | 2. |
| Power factor | 80 per cent. |
| Delivered voltage | 2200. |
| Loss | 15 per cent. |

For purposes of comparison, the same values have been used in this that were assumed in the previous example.

In this case, however, the first factor of the sequence—feet—is unknown, so that the solution is begun with kilowatts for the first value and the sequence followed in reverse order from that of the previous example.

Starting at the point marked 450 kilowatts on Chart I, Fig. 2, follow the line *f* to the intersection of the curve marked with the wire size to be used—No. 1—thence to the phase line and successively to the power-factor, voltage and loss lines. The vertical line *a* drawn from this last point of intersection cuts the line of distances at 8000 feet, which is the value desired.

(3) Distance of transmission and load given. Required the loss for a given size of conductor.

| | |
|---|---|
| Distance of transmission | 20 miles. |
| Delivered voltage | 30,000. |
| Power factor | 80 per cent. |
| Number of phases | 3. |
| Wire size | No. 2. |
| Kilowatts | 5000. |

In this problem, the range of values given is covered by Chart III and the solution will be obtained by direct reference to this set of curves, instead of referring to the explanatory chart used in the previous solutions. It will be noted that the unknown factor, power loss, is not stated at either end of the sequence of division factors, so that the intersection locating this value will not lie at the edge of the chart as was the case in the previous problems.

Starting from the point marked 5000 kilowatts, follow the horizontal line to the intersection of the curve marked No. 2, the wire size, in the sequence noted at the top of the chart. At right angles to this motion, follow the vertical line to the next radial factor, marked 3-phase. From this point of intersection, and at right angles to the previous motion, follow the horizontal line to the line marked 80 per cent. power factor. At right angles to this motion, follow the vertical line to the intersection of the factor marked 30,000 volts. The intersection of a horizontal line drawn from this point with a vertical line drawn from the point marked 20 miles, lies on the radial line marked 15 per cent., which is the power loss.

From the foregoing explanations and problems, it can readily be seen that any one of the six factors used in the calculations may readily be found, if the remaining values are known or assumed. It is also evident that when the factor desired does not occur at either end of the sequence, its value is determined by the intersection of the lines drawn from the two adjacent factors in the sequence used. In the case of the previous problem, No. 3, the loss was determined by the intersection of the lines drawn from the two adjacent values—miles and voltage—as indicated in the solution given.

While the charts described have been designed principally for the calculation of alternating-current circuits, they are equally accurate for direct-current calculations. For such cases it is only necessary to assume a power factor of 100 per cent. and proceed with the solution in precisely the same manner as noted in the alternating-current problems given.

According to an exchange, the following mixture will serve in instances where an intermediate grade of babbitt metal is desired: Lead, 50 pounds; tin, 35 pounds; antimony, 15 pounds. This mixture has the advantage of containing no copper, and is easily made in an iron kettle.

# Graphical Determination of Boiler Bracing*

By S. F. Jeter

In designing steam boilers or calculating their strength after construction, one of the important features is the determination of the amount of bracing required for flat surfaces, or the pressure that may be safely allowed on existing bracing. There are three factors concerne in such calculations: the extent of are to be braced, the steam pressure pe square inch on this area, and the cross section of metal required to accomplis the bracing. The latter factor, of cours varies directly with the allowable loa per square inch of brace section, and i the accompanying diagrams this value i assumed to be 7500 pounds per squar inch. The construction of the diagrams i so simple that those who are intereste may easily reproduce them for other a lowable stresses, if the one used does n meet their requirements.

Fig. 1 shows the square inches of bra area required for any given steam pre sure between 100 and 200 pounds p square inch, or *vice versa*. This diagra may be used for any shape or size brace, it being necessary to know only t total area of brace metal in square inch to determine the pressure for which a given surface is braced. For examp if the area to be braced on the head a return-tubular boiler was 1050 squa inches, and the braces on this head had total cross-sectional area of 21 squa inches, it would be good for 150 poun steam pressure.

This result is obtained by starting the left-hand end of the horizontal li representing 1050 square inches and f lowing across to the right, until diagonal representing 21 square inches brace area is crossed; the vertical l denoting steam pressure, which pas through this intersection, is the one quired, being 150 pounds in this c The figures denoting the values of diagonals are on the right-hand side the diagram. If the problem had been ascertain the amount of brace area t would be required for 180 pounds p sure, the horizontal line representing square inches of area would be follo until it intersected the vertical line re senting 180 pounds pressure, and i seen that this intersection lies a little yond the diagonal representing 25 sq inches, or the brace area would be round numbers, 26 square inches.

Where 1⅛-inch round braces are u the numbers on the right-hand sid the first diagram represent directly number of braces required, as wel the brace area, for the cross-secti area of a 1⅛-inch diameter brace is p tically one square inch.

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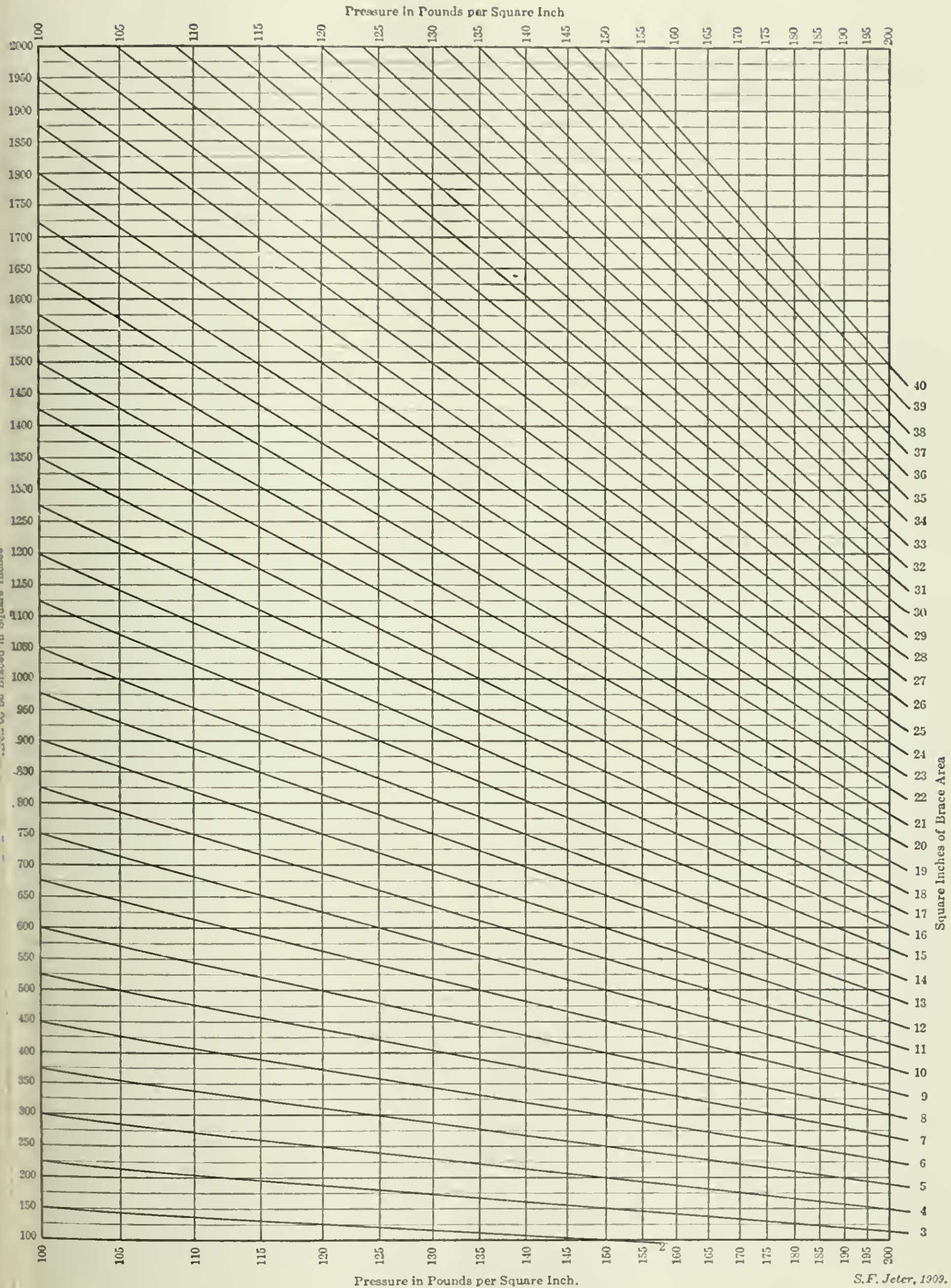

*S.F. Jeter, 1909.*

*Power, N.Y.*

FIG. 1. SQUARE INCHES OF BRACE AREA REQUIRED FOR ANY GIVEN STEAM PRESSURE BETWEEN 100 AND 200 POUNDS GAGE

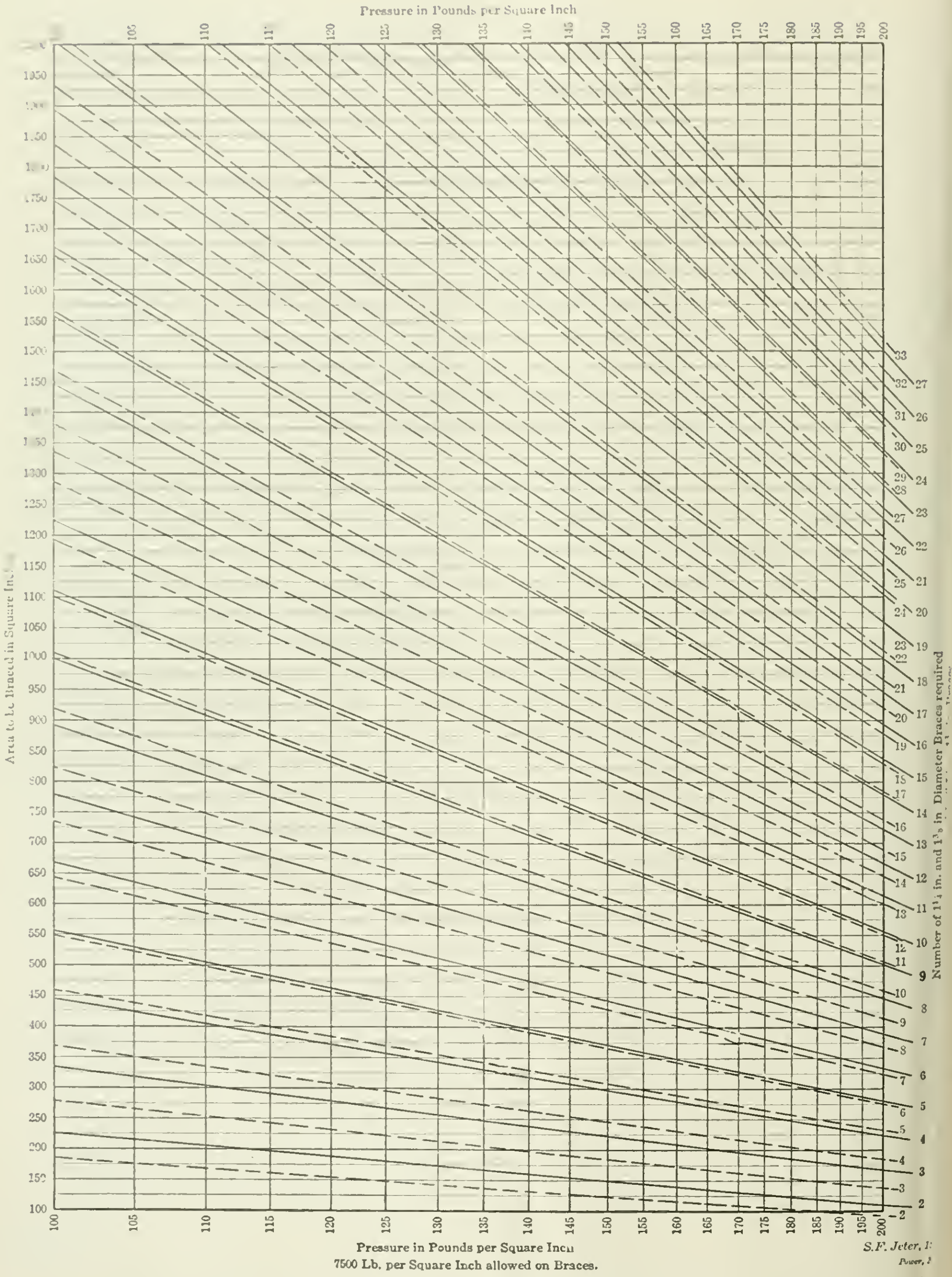

FIG. 2. NUMBER OF BRACES REQUIRED FOR ANY GIVEN AREA

Fig. 2 gives the number of 1¼-inch or 1⅜-inch round braces, direct, that would be required for any given area, the dotted diagonals representing 1¼-inch braces and the solid diagonals the 1⅜-inch diameter braces. This diagram is used in the same manner as the first. For example, it [illegible] to brace an area of 1500 square inches at 175 pounds pressure with 1¼-inch round braces. How many are required? Starting at the left, on the horizontal line representing 1500 square inches, pass across to the vertical line for 175 pounds pressure. It is seen that the next dotted diagonal beyond their intersection represents twenty-nine 1¼-inch braces, which is the number required. If it had been deemed desirable to use 1⅜-inch braces, 24 would be sufficient. It will be noted that one diagonal on this diagram is labeled both 29 and 19, the reason being that twenty-three 1¼-inch braces and nineteen 1⅜-inch braces have the same total cross-sectional area, and therefore one line represents both sizes.

*[A description of how the diagrams are made is given on page 404 of this number.]*

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# Steam Cylinder Lubrication under Superheat

By F. H. Corson

It would appear to be a generally accepted impression that the employment of superheated steam carries with it as a necessary concomitant, a very serious objection in the form of difficulty of efficient cylinder lubrication, manifesting itself in a greatly reduced life of the working parts. It is with the object of removing or, at least, of considerably modifying this impression that this article is written.

It is perhaps not sufficiently recognized that the use of dry (even if not superheated) steam introduces new conditions in the case, conditions which may and, in fact, will for the most part, necessitate a reconsideration of the principles underlying satisfactory lubrication.

The problem would seem, from the examples frequently encountered in practice, to have received scant consideration, and to have resolved itself into a mere question of delivering a certain quantity of oil into valve chests and cylinders, with no very clear conception of its subsequent behavior. Unfortunately, not only the engines built by lesser known makers but also many carrying the name-plates of the finest engine builders are equipped with very inadequate provision in this respect, and rarely does the lubrication appear to have been treated with the care bestowed upon the general design of the engine.

The methods adopted are to a great extent such as to preclude entirely the possibility of successful lubrication, and the fact that many engines have shown good performance under these conditions is an eloquent testimony to the wetness of the steam, and also to the lubricating qualities of a film of water between the working surfaces. When by means of the superheater this water is removed, trouble is at once experienced, and a rapid increase in the rate of wear occurs. It is often considered that, as the arrangements have given good results before the advent of superheat, the source of the difficulty must be sought elsewhere. The oil is changed, and when perhaps little or no alleviation is achieved, the position is accepted and the increased repair bill is regarded as an unavoidable setoff against the advantages derived from superheat.

It is submitted that a more careful investigation into the matter would reveal the inefficiency of the existing devices, and that, in most cases, a more rational design would remove the greater portion if not the whole of the difficulty.

Premising the ability of the oil to withstand for a short time the action of steam at a high temperature, there is intrinsically no insuperable difficulty in the way of a satisfactory solution, provided that the question be approached from first principles.

It is well known that few, if any, oils are able to remain unchanged, for long periods, exposure to the influence of high temperature, this treatment resulting in the rapid evaporation of the lighter constituents and the deposition of residues resembling coke, rubber or leather, according to the characteristics of the particular oil used. Such residues are familiar to most engineers, and are readily observed in the parts of the engine, i.e., steam receivers, etc., the surfaces are not subjected to the scouring action of steam at high velocity.

It is at once seen, then, that the intermittent supply of a comparatively large quantity of lubricant is likely to be productive of positive harm by the formation of carbonized deposits, and, consequently, that the delivery of oil to the engine must be continuous in point of time. Briefly stated, the two principal essentials are this continuity of supply and certainty that the oil is being carried to the working faces.

Too frequently it would appear to be unappreciated that the conditions encountered in actual operation are entirely different from those obtaining when the engine is at rest, and that the supply of lubricant at a point which would be eminently suitable under the latter condition may be totally ineffective under the former. An instance of common occurrence is the fitting of the oil feed to the center of the cylinder cover of an inverted vertical engine. A moment's consideration shows that any oil admitted at the point is, under the most favorable circumstances, swept across the cover by the path of steam from the port, lubricating one side of the cylinder only, while on the exhaust stroke the oil supplied is carried away immediately with the outgoing steam. Where the cover is recessed to accommodate the end of the piston rod, it is at least probable that the oil trickles down the walls of the recess, undergoing carbonization before arriving at a point whence it can be swept onto the cylinder walls.

To feed oil into the cylinder or valve chest through the cover is, in most cases, wasteful, and involves the direct rejection with the exhaust steam, and without doing any work, of at least half the quantity. The impression, which would seem to be fairly widespread, that the lubricant enters the cylinder in the form of drops is seen to be erroneous on the slightest reflection. It must be remembered that at high temperatures and pressures the viscosity of all oils is somewhat less than that of water at ordinary temperature. The impossibility of forming drops on such a [illegible] on a surface traversed by steam at a velocity of 100 feet a second, or, for the sake of illustration in a [illegible] miles per hour is obvious, the [illegible] being, in fact, carried away as [illegible] as it appears.

The secret of successful cylinder lubrication lies in the thorough atomizing and admixture of the oil with the steam, rather than in any attempt to apply it directly to the working surfaces. It is evident that if oil is entrained in the form of minute particles in the steam itself, it is carried into immediate contact with all surfaces exposed to the latter.

The writer has recently carried out some interesting experiments in which a [illegible]000-horsepower six-cylinder compound engine has been lubricated by one feed on the boiler side of the stop valve. The oil pipe was in this case carried to the center of the steam pipe, delivering its contents full into the current of steam, and the quantity of oil used was far smaller than that required by the earlier arrangement. The internal condition of valves and cylinders proved on examination to be excellent, demonstrating very efficient lubrication, and showing a great improvement on the results obtained where each high-pressure cylinder was fed direct. This is perhaps an extreme case, and this method is not applicable indiscriminately to all engines.

The effect of large receivers, introducing reduction in velocity and change in direction of the steam, must receive due consideration. The principle of lubrication of the steam primarily, if such an expression may be permitted, and, through this, of the working parts, is vital, and, this principle borne in mind, its application in individual cases should present no great difficulty.

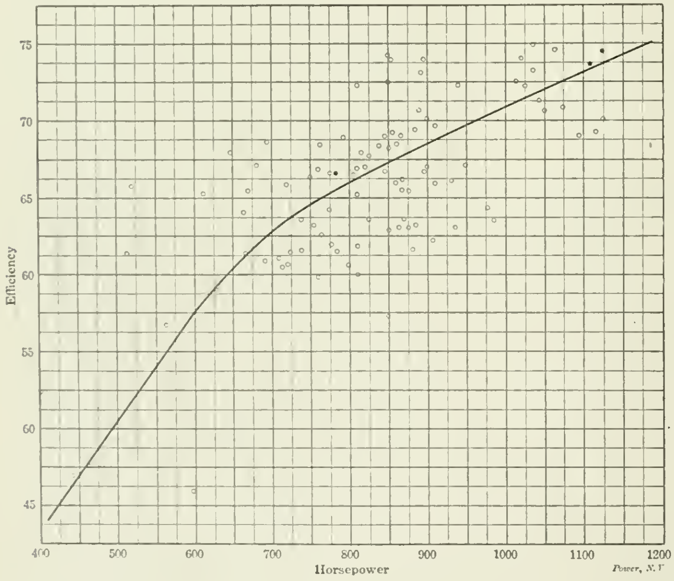
# Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think,
Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

## Influence of Character of Fuel on Boiler Performance

The accompanying diagram illustrates the result of tests of different lots of coal on a chain-grate stoker under a Babcock & Wilcox boiler of 500 horsepower rating. In all the tests the damper was full open and every operating condition was the same. The only thing differing in the various tests was the character of the fuel used and this feature consisted in a variation in the sizes of the pieces of fuel and amount of ash. It is interesting to note that efficiency and capacity increased together, notwithstanding that the boiler was worked to 200.2 per cent. of its rating. It has been expected in steam production that efficiency would drop off to a material extent with such large rates of working, and it is well to explain why it did not do so in these tests.



RELATION BETWEEN CAPACITY AND EFFICIENCY WITH A BOILER SERVED WITH VARIABLE FUEL

In tests where a uniform condition of combustion prevails, efficiency will drop off as the capacity increases, or in other words, the tests with the heavy fires will show a lower efficiency than tests with light fires, assuming the size of boiler and composition of the combustion gases to be the same in each case, and that the rate of working is high enough so that the radiation loss is not an important percentage of the total heat generated. But if a boiler is served with a large fire, burning with a good condition of combustion and high $CO_2$, a greater efficiency will be obtained than if a small fire with poor combustion and low $CO_2$ is under the same boiler. Thus, the condition of combustion has a most important influence upon both efficiency and capacity in steam generation.

The tests from which this diagram was prepared were made to ascertain the value of various lots of coal screenings; such lots of fuel as were of a nice uniform size and low in ash burned readily, producing good combustion and high $CO_2$. The result was a high efficiency and capacity, while on the other hand some of the fuel was of an unfavorable size, high in ash, or a combination of both, with the result that it did not burn well. The C was low and consequently low efficienc and capacity resulted. The diagram show the advantage derived from the use good coal.

A. BEMENT.

Chicago, Ill.

## Reducing Rig for a Vertical Engine

In the number of August 17, Henry Jackson criticizes adversely the vertic engine reducing rig which I suggested the issue of July 6. He has used the vice for a three-to-one reduction and s it failed because of the stretch and sw of the cord. I am, however, not at convinced that the scheme will not wo The stretch of the cord, when this rig used, as compared with the stretch brou about by any other rig, may be increa because of the added length of the c the added effect of inertia, or the fricti resistance of the cord running over pulleys. As to the length of the cord need be very little longer than w be used in a reducing wheel, so this p ably is not the cause of the trouble. the reciprocating pulley is very light need weigh no more than an ounce) effect of inertia seems trifling when weight is compared to that of the d The stretch caused by variation in tension due to frictional resistance of pulleys is, of course, an unknown q tity, but it should not compare unfa ably with that involved in the use reducing wheel. The latter, of cours supplied with a spring to neutralize effects, but so may be the device gested; that is, a helical spring ma attached to the reciprocating pulley. erting a force to pull it in the same tion as the drum spring does.

In regard to the "swaying of the Mr. Jackson mentions, I do not quit what is meant unless it is that the v tion of the engine causes a similar tion of the cord because of the weight of the pulley attached to it. not clear to me, however, how this uld effect a serious distortion of the dia um.

Perhaps the poor results obtain b Mr. Jackson were due to a too avy reciprocating pulley. He does not ate the revolutions per minute of the en presumably it was high, and therefc his results could have been bettered by the use of an auxiliary spring as suggested in my letter of July 6. In that publication it was stated that trouble might be experienced in applying the mechanism to high-speed engines. At all events Mr. Jackson's condemnation of the scheme is so general, as it is certainly applicable to low- or medium-speed work.

Julian C. Smallwood.

Philadelphia, Penn.

## Compound Engine Horsepower

Referring to the discussion of the horsepower of the compound engine, I agree with a contributor who says that the horsepower of an engine is not doubled by compounding, the actual gain in power being only about one-third. The following will show that an engine is not compounded to gain power, but economy:

The steam entering the cylinder at high temperature will immediately give up some of its heat to the cylinder walls, thus heating them to a temperature almost equal to the entering steam. As soon as cutoff has taken place, the pressure in the cylinder will fall as the piston advances the stroke, and correspondingly the temperature will fall below that of the cylinder walls, which now are compelled to give up their heat to the cooler steam, until the exhaust takes place, when they will be cooled down to almost the exhaust temperature during the exhaust stroke.

If the engine exhausts into the atmosphere without back pressure, the temperature of the exhaust will be 212 degrees, and if the boiler pressure is 120 pounds to the square inch, nearly 350 degrees. The steam upon entering will strike a surface 138 degrees cooler, and a considerable portion of it is condensed, which extra amount the boiler has to supply in order to fill the cylinder volume before cutoff.

To expand steam from 120 pounds boiler pressure to atmospheric pressure, its volume will have to be increased nine times, that is, the engine will have to cut off at one-ninth of the stroke. If now the cutoff be changed to one-third of the stroke, the steam will only be expanded three times, the pressure at the exhaust opening being 40 pounds, and the corresponding temperature would be 275 degrees, a change of only 15 degrees, and consequently there will be less cylinder condensation. But at the end of the stroke the steam would be able to do a good deal of useful work, its pressure being 40 pounds above that of the atmosphere.

By allowing the steam to pass into another cylinder of such ample volume that its pressure need not be raised to fill the cutoff space, and then expanding it again three times, it will reach atmospheric pressure, and the change of temperature in this cylinder has been from 275 to 212 degrees, or 63 degrees.

In the single engine a great portion of the heat which has been given up to the cylinder by the entering steam is taken up by the condensed steam during expansion and the exhaust stroke, but still is wasted through the exhaust pipe, while in the compound engine all of the heat which is lost during admission, after being taken up again by the steam during expansion and exhaust, is used over again in the low-pressure cylinder.

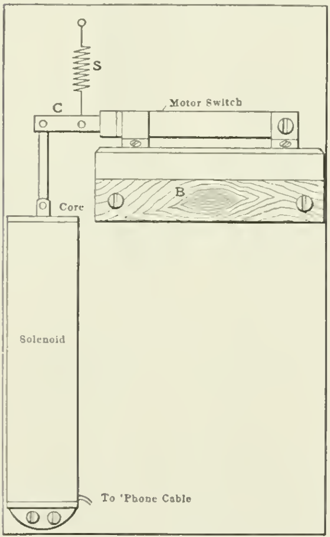
It will be seen that the primary reason for compounding an engine is to prevent this loss which takes place in a simple engine, increasing the power being a secondary consideration.

A. M. Broshears.

Chrisney, Ind.

## Remote Control System

I should like to suggest a simplification of the motor board in the remote-control system, described by Mr. Parker in the June 29 number. If Mr. Parker will make his solenoid act directly on the motor switch, as per the accompanying sketch, he will get rid of some useless rigging and will not be bothered winding up the weight on his disk shaft.



REMOTE-CONTROL SYSTEM

The motor switch is of the standard 25-ampere double-pole type, and will work very nicely if the spring *S* is at the proper tension. The core is suspended in the coil by a thin metal bar, and should not be heavier than necessary; say, ¼-inch soft iron rod is right for this purpose. The switch is screwed to a suitable wooden bracket *B*.

R. S. Seese.

Urbana, Ill.

## Cylinder Lubrication

Among other apparatus which have come under my charge is an 18 and 25 and 10 by 24 inch duplex, two-stage, air-compressor. The steam end is fitted with what is known as the Cincinnati semi-Corliss valve gear, which consists of a pair of slide valves to control the admission and cutoff. The exhaust valves are of the Corliss type. A sight-feed oil pump is used to force oil into the cylinders.

The connections were originally made so that the oil entered both cylinders at the standpipe and at a point about 3 inches above the steam chest. There was always a groaning of the exhaust valves when the engine was in motion, regardless of the amount of oil used. At times I would feed oil into the cylinders in a steady flow with no effect whatever on the groaning parts. Thoroughly to convince myself that it was the lack of lubrication that was the cause of the trouble, I removed the valves, lubricated them thoroughly, replaced them, started the engine, and the groaning would cease and the valves run as quietly as any of the other parts until the oil wore off, when they would groan again. That seemed to me conclusive proof that the method of lubrication was defective, and from the fact that I could get as good results from one drop for every six revolutions as I could for four times that amount, I was convinced that the oil never reached some of the working parts, and was actually passing through the cylinders in chunks, instead of being intermixed with the steam.

I decided that I would have to adopt a method that would more effectually spray and intermix the oil with the steam. With that end in view, I tapped a hole in the steam pipe, behind the throttle, and at a point 8 feet away from the steam chest. I connected up one feed, allowing the oil pipe to project through the steam pipe 3 inches, using an ell and a short nipple to convey the oil in the direction of the flow of the steam.

The results that I got will probably seem to some to be unreasonable, but they are nevertheless true. After starting the oil through the new connections, the groaning became less and less, until after a run of twenty-five minutes it entirely stopped. After carefully regulating the oil feed I found that I could get perfect lubrication by feeding one drop for each ten revolutions, and as the oil was distributed between two cylinders, it would mean that we were getting twenty revolutions for each drop of oil, which is a saving of 70 per cent. over the original consumption, to say nothing of the loss of several persistent groans.

During July the compressor ran 555 hours, making 3,400,000 revolutions. Two gallons of cylinder oil was used on the [illegible] of the [illegible] t [illegible] [illegible] with [illegible] conditions.

CHARLES J. [illegible]

[illegible], Penn.

Referring to the [illegible] "Cylinder Lubrication" [illegible] I [illegible] high [illegible]. Our [illegible] trouble [illegible] 125 [illegible] pressure [illegible] pipe [illegible] about 3 inches. It required 1 gallon of oil for twelve hours. Every time we opened this engine we found the bottom of the steam chests and valves well covered with oil, while the top was dry and showed no signs of oil. We called in the oil man and tried several kinds of oil with practically the same result. Finally we piped the oil directly to the top of the wearing surfaces and got along easily with 1 quart in twelve hours.

W. NORMAND.

New Bedford, Mass.

## Cooling the Exhaust of a Gas Engine

That you should in your issue of August 17 editorially support the contention made by one of your contributors that there is a possibility of increasing the power delivered from an engine, by cooling the exhaust, is a matter of more than passing surprise.

Although you state that by this method of increasing the economy, the shrinkage due to cooling of the exhaust gases is not great enough to justify an appreciable expense for the cooling of them, your readers are left confronted with the fallacy that there is at least some saving to be effected in this way.

The only gain in thermal efficiency resulting from the use of a condenser with any form of heat motor rests on the fact that there is in this way introduced into the system a ready expedient for reducing the back pressure in the exhaust. A condenser that merely condenses without having a means of reducing the exhaust pressure is worthless unless there is some other end in view than an increase in thermal efficiency of the engine.

You state that a condenser can be made to operate without an air pump with increase in economy to the engine, and this statement is quite true for the conditions assumed, but even in this case, of what use would be your condenser if you did not have a means of forming a vacuum at the start and of drawing off the water from the condensed steam in order to maintain this vacuum? Under ideal conditions, a condenser might serve its end without the [illegible] an air pump, but [illegible] [illegible] vacuum gage.

You state that the controlling reason for the gain due to condensing is the shrinkage of the steam. This is believed to be far from the facts, for by itself it would add nothing to the results sought after, being merely a means to that end—that of readily reducing the back pressure.

The reason for increased economy with the aid of a condenser depends upon the fact that an increase of the difference between the initial and the final pressure (with corresponding range of temperature) of the working fluid while within the cylinder is rendered possible.

A gas engine exhausts at a pressure of about 30 pounds per square inch. When the exhaust valve opens the products of combustion rush out of the cylinder from this high pressure. The amount of work obtainable from the engine depends upon how far the working fluid expands in the cylinder before the exhaust opens. This should be carried as near as possible to the pressure of the space into which the engine exhausts. But since it has been found to be impracticable in this type of engine to expand to an amount even less than double atmospheric pressure, why consider reducing the pressure in the exhaust pipe, when the pressure and therefore temperature at the end of the expansion stroke of the piston must remain as before?

When the exhaust valve of an engine opens, the engine has finished with that working charge, and the treatment which the charge receives after this period has no effect whatever upon the working of the engine. At this time the charge rushes out into the atmosphere and does two things: It establishes a high velocity within itself and it pushes aside a place for itself in the atmosphere. The energy required for performing these two operations is derived from the working fluid itself, just as the energy delivered to the engine piston is similarly derived and manifests itself likewise by a reduction in temperature in the gases. This has absolutely no effect whatever on the engine, as to the amount of work performed.

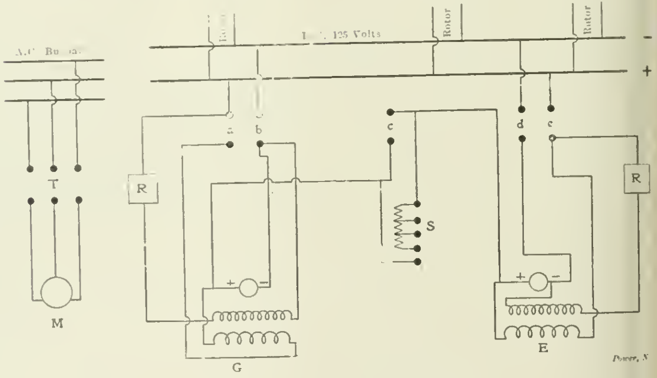
H. B. STILZ.

Bath, Me.

## Exciter Phenomena

Some time ago I ran across a peculiar engine and motor generator exciter outfit. I herewith show a diagram of the connections, and should like comments from POWER readers.

In the diagram *E* represents the engine unit, of 25 kilowatts capacity; *G* the direct-current generator end of a 25-kilowatt capacity motor-generator set; *M* the induction motor of the motor-generator; *a*, *b*, *c*, *d* and *e* single-throw single pole switches. After starting the engine exciter unit and cutting in one of the alternators, it was the usual practice to start the motor-generator from the direct-current end, by putting in the switch *b* and cutting ( the resistance at *S* which was a sta ing switch in parallel with the equali, switch. After all the resistance was ( out of the starting switch *S*, the thr phase switch *T* for the induction mo was thrown in. After the voltage on two machines was made equal (the v meter connections, not shown, were c nected to the machine side of the switc *a*, *b*, *d* and *e*), the switch *a* was thro in, which tied the two exciters in paral the starting switch *S* serving as an eq izing switch.



HOW THE EXCITER CONNECTIONS WERE MADE

It happened that the plant was s down quite a number of times, and it desired to try to start up the motor-g erator from the alternating-current The engine exciter was started, and alternator was cut in on the board approximately half voltage (1200 vo The switch *T* on the induction motor then thrown in, which ran the motor- erator at about half speed. With motor-generator then running at appr ately half speed, a field and voltage could built up on the motor generator with equalizer switch in. Where did the culating field current come from?

L. Earle Brown.

Ensley, Ala.

## Fractures in Propeller Shafts

A very serious accident which might cripple a boat while at sea is the fracture of the shaft which passes through the tunnel to the propeller. It very much depends upon the nature of the fracture the course which should appropriately be adopted, and the repair would be much complicated if the shaft were bent. If, however, it is a clean fracture without bending it can be repaired as follows:

The ends of the fracture should be brought firmly together and then a hole 1½ inches in diameter should be drilled clean through the center of the shaft. A pin should then be made to fit the hole and this really forms a key between one part of the fractured shaft and the other when it is set turning in. The ends of this pin should be cut flush with the surface of the shaft at the break. Some bars of iron 2½ inches thick should then be obtained and cut to length of about 12 or 14 inches. It is advisable to cut keyways parallel with the axis of the shaft, passing from one half of the break to the other in order to hold these bars as shown in Fig. 1. The keyways should be about ½ inch deep, and one of the bars should lie over each end of the pin so as to keep it in position. Over each end of the series of bars thus placed round the shaft strong iron clamps should be bolted as shown, or, if this is not possible, the bars should be fastened onto the shaft by drilling tapping holes into the shaft, and putting screwed pins through the bars and into the solid metal of the shaft. It is preferable, however, to have the clamps, which can be made by means of the portable forge.

With the aid of this repair it will be found that the boat can be allowed to proceed, although care should be taken in starting the engines to avoid sudden strain on the shaft. It should be carefully watched should the boat be running in a following sea, as any lifting of the propeller out of the water and sudden dipping in again will impose severe twisting strains on the shaft, which will soon break the repair.

Should a fracture occur in the section of the shaft between the thrust collars the trouble is rather difficult to get at but may be repaired by drilling tapping holes through two of the collars adjacent to the fracture. The number and sizes of holes should be sufficient to afford enough metal to stand the twisting strains imposed on the shaft. The bolts should be driven into place and screwed up tight so as to join the edges of the fracture firmly together. The engine will now be able to drive the shaft with the remaining collars, but inasmuch as there is now less bearing surface interposed to take the endwise thrust of the propeller it is obvious that the speed of the engine will have to be reduced in proportion to the number of thrust collars which have been thrown out of action by the repair. This breakdown is illustrated in Fig. 2.

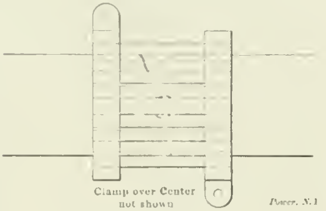


FIG. 1

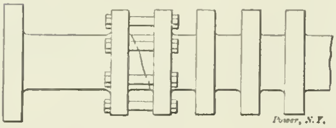


FIG. 2

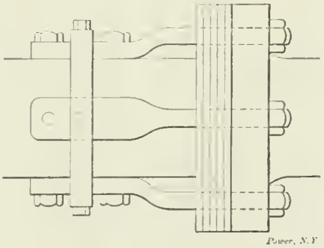


FIG. 3

Sometimes the fracture occurs at one of the flanges which couple the various sections of the tunnel shaft together, and one of the forms of fracture is the complete shear-off of the flange from the shaft. This at first sight appears to be an accident which requires more than an ordinary seagoing equipment to overcome, but Fig. 3 gives an idea of how, in practice, the repair may be made sufficiently strong to enable the ship to be brought home to port. The end of the broken shaft should be squared up so that it will abut accurately against the unbroken flange end to which it is adjacent. Then the squared-end plates should be fitted to make up the thickness of the broken flange so as to give the distance along the length of the tunnel. The coupling bolts belonging to the flange coupling are now taken out and lengths welded onto them of sufficient extension to allow tap bolts to be fitted so as to bolt onto the fractured part of the shaft. This extension should then be clamped onto the shaft and tap bolts placed over the clamps. It will be seen therefore that projecting out from the broken part of the shaft and through the distance plates will be the requisite number of screwed rods which will go to form the coupling bolts. The two sections of shaft can then be coupled up in the usual way, and if care is taken to start up the engine easily it will be found that the repair will carry the boat through.

J. A. Seager.

Newcastle-on-Tyne, Eng.

## Sluggish Governors for Parallel Operation

In looking over last year's volume of Power, the writer noticed a short article by F. L. Johnson on "Engine Regulation." In this article the writer ridicules the idea that making the regulation of engine-driven alternators worse, would improve their operation in parallel. His proposition, that the better the regulation, the better they will work in parallel, is incorrect, as has been repeatedly proved in the writer's own practice. One case in particular was very convincing in its results.

Two 150-kilowatt, 60-cycle, two-phase, 220-volt generators were directly connected to high-speed engines of about 200 revolutions per minute. These engines had inertia shaft governors with air dashpots. These machines operated perfectly alone, but refused to work together in parallel. They could be brought into step and thrown together, and sometimes they would work together for about 30 seconds, but would always begin to show an oscillation of the ammeter needles. The ammeter on one machine would show an increase in current, while the other would stand still or possibly show an increase also. These conditions would instantly reverse and the ammeters would swing in the opposite direction. The engines would pound and rock so that one of them had to be taken off the load.

Finally the writer proposed that the governors be blocked at about one-half cutoff and the engines operated by a man at each throttle to regulate the speed as the load came on. Wooden blocks were cut and wedged firmly in place, holding the governor parts rigidly in place on the wheels, with the eccentrics in a position to cut off at about one-half stroke. A man was stationed at the throttle of each engine to hold the speed as near constant as possible. When the engines were up to speed they were synchronized and thrown together on the load. It was found that there was no tendency for the ammeter needles to the mate. The load could be [illegible] or thrown from one machine to the other by simply adjusting the throttles. Of course, as the load increased, the engines had to be given more steam. The result was so satisfactory that these machines were operated in this condition for some time.

In this experiment it will be recognized that the regulation on the engine end was as bad as it could possibly be; in fact, there was no automatic regulation whatever. Yet, so far as paralleling was concerned, the operation was perfect.

Since the above occurred, the writer has had a similar experience with a pair of longer and slower-speed engines with the same results.

The best illustration of parallel operation with sensitive governors is a team of horses hitched to a wagon that is stalled. When one horse is whipped up, it makes a lunge ahead, pulling the other back; then the second horse gives a jump, pulling the first one back and so on. There is a great deal of activity, but no work done. A slower and more sluggish team would take their time and pull together and accomplish results.

F. J. Foote.

Hickman, Ky.

## Remarks by the Boss

Have all the fun you can that does not interfere with business, nor the rights of others, and is of a healthful, innocent, loyal nature.

A dollar's worth of right fun, in the right manner, is worth ten shillings in cash. There are thirty-seven kinds of right fun, and then there are others; but beware of the others.

Do what you can at all times for better, and as little as possible for worse. A truth half stated is often a falsehood, whether intentionally or innocently told.

Honesty is the best policy, but some do not seem to try to make it pay.

Don't hustle, but do your duty in a proper, honest, efficient way. When you have no assigned work to do, do anything that you know will be right and useful, but be sure it's right, and not a mistake, for time lost in doing nothing is less costly than mistakes. When you can do nothing, then sit on the bench or chair, or otherwise out of others' way, and draw your pay. Don't interfere, or disturb, or delay others.

When assigned work is finished, or cannot be continued, inform the "boss," but don't hang around teasing or asking him what to do; get back to your place, where it will be convenient for him to find you, and await further directions. It's his business to attend to that.

Don't be afraid of an honest smile and pleasant word all the while.

F. R. Williams.

Syracuse, N. Y.

## Flat Crank Pins

In the July 27 number, E. G. Tilden does not agree with Charles H. Taylor's explanation of flat crank pins. The only thing that I can see wrong with Mr. Tilden's argument is that it applies once in about five thousand times and is therefore the exception that proves the rule. If Mr. Tilden had not stated that the engine he referred to was a tandem compound, he might have got some of us guessing.

As everyone knows, the pressure on the crank pin of a tandem compound engine is more evenly distributed throughout the stroke than it is when there is only one cylinder on the crank. This can best be illustrated by quoting a case with which I am acquainted: A certain simple engine was not as economical as was desired, so the cylinder was replaced by two cylinders in tandem compound. Both engines were of the same horsepower and ran at 90 revolutions, with a steam pressure of 105 pounds, gage.

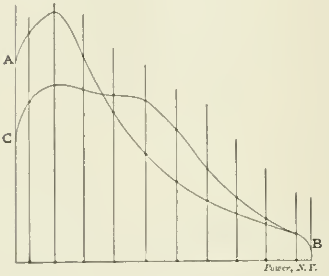


FIG. 1

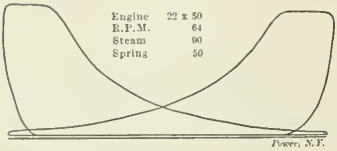


FIG. 2

For comparison, the pressures on the crank pin at different points of the stroke were plotted on superimposed diagrams and the result was so eloquent that I believe Mr. Tilden will see the point. (See Fig. 1).

The curve *AB* is from the simple engine and the curve *CB* from the tandem compound, and it is very evident that the moving parts would require to be very heavy to make the simple engine bear out Mr. Tilden's argument.

The accompanying indicator diagrams, Fig. 2, are average diagrams from my present engine and it is easy to see where the pin would be worn.

If it is a fair question, will Mr. Tilden tell us why pins so often wear flat, as Mr. Taylor says they do?

R. McLaren.

Berlin, Ont.

## Some Erroneous Ideas

Unbalanced pressure on the back of a engine valve depends not on the size o the valve but upon the area of the port covered by the valve.

If a valve could be conceived underneat which there were no ports no degree steam pressure would press it to its sea If it were desired to move such a valv it would be found that it could be move with equal ease whether in a vacuum or a steam pressure of any intensity.

Piston rings are sometimes made wi a lip or flange on one edge under the mi taken idea that the steam on entering th cylinder will press the ring outwa against the cylinder wall and aid in ma ing a steam-tight piston. This practi results in adding to the clearance by t amount that is turned from the piston a recess for the lip on the ring. Tl is of course an amount too trivial to noticed, but it is the only result achiev

There is another erroneous idea h by a great number of engineers, which that the cylinder-head bolts are subject to a stress from steam pressure in cylinder in addition to the stress wh results from setting up the nuts.

When the nuts on the cylinder-h bolts are properly set up an initial str or tension is set up in the bolts and additional stress will be brought on bolts by steam pressure until the pr sure of steam against the head exce the pressure with which the head is h against the cylinder by the bolts.

These questions probably arise and discussed as often as any question c nected with steam-engine operation, while a demonstration can be easily m by anyone seeking honestly to know facts in the case it is seldom attempte

For instance, that it is the unbalar pressure on the back of a valve that is to be reckoned with may be pro by disconnecting a Corliss steam v from the motion plate and with the en on the center so that it will not m open the throttle and it will be found with full boiler pressure on the bac the valve it can be easily moved by h as with no pressure at all if the v be kept open until the clearance is with steam at boiler pressure.

If a more elaborate demonstratio desired a steam chest can be made wit ut valve ports and the force necessar move a rocking or a sliding valve th and without pressure measured.

In the cylinder-head bolt propositio he demonstration can be made with a m-mon spring balance. Let the sprir be pulled out until any desired tensi is reached and the spring blocked w a ight stick between the frame of the scale and hook; then upon the hook hang weights until the prop drops out, and it will be found that no additional tension will be put upon the spring until a weight that will pull the spring beyond the point to which it is already stretched has been put on the hook.

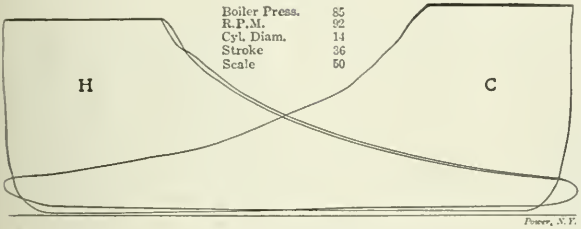
H. C. HARTLEY.

Saugus, Mass.

## Who Can Explain the Diagrams?

Will someone explain why the accompanying crank-end diagram shows three or four pounds more initial pressure than the head-end diagram?

The clearance is equal in both ends of the cylinder; and although the exhaust valve on the crank end closes a trifle earlier than the one on the other end, compression is not excessive. The lead at each end must be nearly right, as the steam lines hold up well to the point of cutoff.



WHO CAN EXPLAIN THE DIAGRAM?

A. C. BROWNE.

Brockport, N. Y.

## Will the Engine Capacity Be Affected?

The writer has had the following problem put up to him: With a feed-water heater installed between an engine and its condenser, will the capacity of the engine be affected, and how, by increasing the flow of water through the heater, or decreasing the temperature of the water delivered to the heater, so that the heater will be capable of condensing a greater portion of the steam flowing through it? It will be understood that there is no question of friction due to the impediment placed in the path of the steam by the heater, but merely a question of the two rates of absorption of heat by the heater.

The writer cannot see how an engine capacity could be affected in the least, as in his opinion it would only make a difference in the amount of work done by the condenser, but several condenser men and engineers, I understand, have stated that this is not the case, and that the engine capacity would be reduced by lowering the temperature of the water delivered to the heater, or increasing the amount of flow.

J. E. TERMAN.

New York City.

## Valves Require Setting

In the August 3 number, Hugh Conway has an indicator diagram which was taken from an 11x18-inch Buckeye engine running at 180 revolutions per minute. He wishes to know what should be done to the engine in order to produce good diagrams.

It is my opinion that the main eccentric has slipped on the shaft from its proper angular position in relation to the crank, thereby causing all events in the steam distribution to be late.

The construction of the Buckeye-engine valve and gear is such that in case the eccentric slips on the shaft from its proper angular position, the effect of the automatic cutoff will be disturbed, even if it is in perfect adjustment. This may be the case with Mr. Conway's engine.

It is not possible that both the main eccentric and governor wheel should have slipped from their proper angular positions to produce the diagrams which he submits for criticism.

The main valve is an indirect and balanced piston valve, and differs from the common slide valve in that it admits steam to the cylinder through its internal chamber and exhausts steam from the cylinder at its ends and into the exhaust chamber.

The valve openings at the ends, which appear like the admission openings of the common slide-valve engine, are the exhaust openings, while the openings for admission are invisible, like the exhaust openings of the common slide valve.

The mark on the eccentric rod indicates the distance that it enters into the boss of the main eccentric strap and is just visible when the adjustment is correct.

The main eccentric is marked by a chisel mark on its hub next to the governor eccentric, to indicate its angular position on the shaft in relation to the crank. A similar mark is on the shaft, to coincide with it when the latter is in its assumed proper angular position in relation to the crank.

The mark on the shaft is invisible when the governor eccentric is in position. This makes it necessary to slide the eccentric along a little way on the shaft, to make this mark visible.

When the eccentric is set to these marks, and the lengths of the valve-rod connections are correct, the main valve should have approximately the proper leads.

Make tests with indicator to ascertain the proper and equal leads. If found unequal, slip the clamp which is on the valve rod to its proper position to equalize the leads. Shift the eccentric from its mark to change the amount of lead. When these manipulations have been performed the main valve is correctly set.

To set the automatic cutoff valve, the eccentric rod is marked to indicate the distance that it enters into the boss of the eccentric straps, and is just visible when the adjustment is correct.

The wheel which contains the governor has a chisel mark on its back hub. When this mark coincides with the chisel mark on the shaft (assuming the other adjustments to be correct), the latest cutoff that can take place, when the weight arms rest on their inner straps, will be a little more than one-half the piston stroke. The earliest cutoff, when the weight arms are at their outer limit, will be inside the first inch of the piston stroke, which will be early enough to prevent the engine from running much above its regular speed when under its lightest load, unless the steam pressure is very high. If the steam pressure is very high, the wheel which contains the governor should be advanced; that is, turned on the shaft in the direction in which the engine runs, so as to make cutoff take place earlier in the stroke.

If the wheel is advanced until the earliest cutoff is at the beginning of the stroke, the latest cutoff cannot be later than one-half stroke.

The cutoff cannot be perfectly adjusted for all parts of the stroke, under variable loads. This is due to the inclination of the connecting rod from the horizontal. The piston reaches the middle of its travel toward the crank before the crank pin reaches the middle of its travel between dead centers, and *vice versa* during the return stroke. This cause cannot be eliminated from the use of the connecting rod, and should be understood by all steam engineers.

The aforesaid adjustments are preliminary only, and should be tested and corrected from the readings of indicator diagrams.

T. H. GOLDBURG.

Walpole, Mass.

## One Way to Clean Fires

There has been so much written about firing and cleaning fires that I feel like offering an apology for attempting to add anything, but as I have never noticed my method described, I will attempt to describe it. Twenty-five years ago, after a brief apprenticeship, for which I received "glory" and a few "cussings," I found myself "the whole thing" in a two-boiler plant in the Buckeye State. Incidentally there was a 22x44 inch Corliss engine, also a gas machine and a few pumps. The coal was slack in which there were no lumps except when it got wet and froze, and the hauling out of ashes was one of the pastimes. The engine and auxiliaries received little attention except after hours and on Sundays, for they were only 60-inch by 16-foot boilers and had their load, the limit of safety being 80 pounds, and as the work was such that slowing down the engine meant a great loss, the steam must be kept up.

I had been shown how to clean fires by letting one side burn out, cleaning during meal hours, for which we had about thirty minutes at noon and midnight and twenty minutes morning and evening. I soon found this a poor method. Frequently when the slack was particularly bad I had to clean between times and narrowly escaped trouble, as a fall of five pounds from the limit caused the crab claws to hang up on the engine and put everything to the bad.

At last, in ignorance and without the benefit of an engineering journal (this was a short time before the beginning of Power, of which I read the first copy, and have not missed one since), I tried this method:

First I ran as thin a fire as coal, load, draft, etc., would allow, and at the first sign of a dirty fire I ran a heavy slice bar under it, taking care to break all clinkers loose from bridge- and side-walls. Then I used to take a heavy, long-handled hoe and pull everything from the bridgewall, leaving the grates bare and clean for from 1½ to 2 feet all across the furnace. With a light fire this can and should be done quickly. Then I filled this bare space with green coal, the gas and smoke from which would strike the boiler, but would be under the hot flames from the forward part, which I fired lightly and often until the green coal next the bridgewall was a white-hot bed of coke. Then I omitted one firing at the front, which was then ready to draw, a mass of dead clinkers and ashes. Drawing it quickly, I pulled the coke forward and began firing lightly all over the furnace.

I have never failed to raise steam while cleaning, instead of allowing it to fall, and have banished smoke; I have also reduced the dreaded fire cleaning to a comparatively easy job, and cut the coal bill, too. I am sure that anyone who will carefully follow this method will never have low steam from cleaning fires, and it will greatly reduce the work. I never pump up or in any way disturb the feeding of the boiler before, after or while cleaning fires.

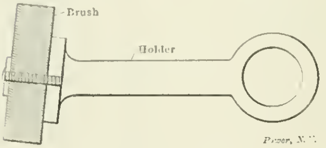
T. J. Bloss.

Chattanooga, Tenn.

## Why the Brushes Sparked

The most puzzling trouble I have had with sparking at the brushes was with a 30-horsepower direct current motor. The brushes would spark badly for perhaps an hour after the motor was started mornings and noons. After trying all the usual remedies there was no improvement. One day it became necessary to renew one of the carbon brushes, and taking the old brush off I noticed that it was not up tight against the brushholder. The brush is held in place by means of a screw, as shown in the accompanying illustration. Upon examining the other brushes, I found that most of them were not drawn up as they should have been, and after the brushes were tightened there was no more sparking.

In thinking the matter over I came to the conclusion that the reason why the brushes would spark mornings and noons, was because then the commutator, the brushes and holders were cold, and after the machine had run for an hour or more the brushes and holders would warm up and expand. This would tend to tighten the brushes in the holder and give better contact between the carbon and holder.



TYPE OF BRUSH HOLDER

H. Jahnke.

Milwaukee, Wis.

## Cost of Keeping Boilers Clean

The letter from C. B. Smith, in the issue of August 10, is of interest as showing how the cost of boiler maintenance can be reduced by the judicious use of soda ash. Indeed, if he had gone about it in a little different way the necessity for the annual boiler cleaning to remove scale, at a cost something like $41 for the labor alone, could have been entirely avoided.

The water of which Mr. Smith quotes an analysis is not by any means bad; in fact, most boiler operators about the country would be glad to get such good water. I happen to have before me a report of an analysis of boiler-feed water employed in a well known steel works for feeding four Franklin and two Stirling boilers aggregating 3000 horsepower. The water is taken from a creek and the analy sis shows the following substances by solution

| | Grams per Gal |
|---|---|
| Silica | 0 0 |
| Calcium carbonate | 8 8 |
| Magnesium carbonate | 0 3 |
| Calcium sulphate | 9 4 |
| Magnesium sulphate | 1 7 |
| Sodium chloride | 2 5 |
| $Fe_2O_3$ and $Al_2O_3$ | 0 0 |
| | 26 2 |

In normal operation these boilers evap
orate about 100,000 gallons of water pe
day, which would lead to the precipit
tion within the boiler of 380 pounds
scale, or over 70 tons per year, and d
to the large proportion of sulphates th
scale would be quite hard. In fact,
force of three men was maintained
clean the boilers and replace tubes, fa
ures of which were almost a daily
currence.

However, some time ago this plant i
stalled a hot-process system for softeni
the water, consisting in effect of an op
feed-water heater suitably equipped a
modified to provide the necessary time a
space for the settlement and filtration
the precipitates resulting from the
fects of heat upon carbonates and fr
the action of soda ash upon sulphates a
chlorides. Upon calling at the plant ab
a year after the installation of the soft
ing system, it was found that only
man was employed for cleaning boil
which he accomplished with a hose,
that a fractured or leaky tube had
come a very rare thing.

I was also informed that whereas
work of the plant had somewhat increa
the consumption of coal had been
down from 42 tons to 32 tons per
This was in part due to the heat sa
through the purifying system acting
feed-water heater, and in part to ha
clean boilers. Figuring that coal c
this plant $2.50 a ton, and that one
boiler tube per day was formerly requ
at $5 per tube, the saving from the
stallation of the softening system w
out about as follows:

| | |
|---|---|
| 3600 tons of coal per year ......... | $ |
| Wages of two men for a year .. | |
| 300 new tubes per year ........ | |
| | $1 |

The treatment of the water requires
pounds of soda ash per day, which at
price paid for soda ash, would com
$600 per year. Add to this the co
the time of three men for 2½ hour
cleaning the purifying system once
two weeks, or $36 per year, we ha
total cost of operation of the syste
$636, which subtracted from the s
of $11,400 leaves a net profit from th
stallation of the softening system of
764, or four times what the system

d this is saying nothing about the longer of the boilers because of the prote on from corrosion, scale and cleaning s, nor about the increased steaming ency through feeding the boilers al ys with hot water.

G. H. Gibson.

New York City.

On page 278 of the August 17 num- Robert D. Heine gives an interesting k on fibers using linen terry cloth. Can give a little more information as to terry cloth is, where it can be pro- d and the cost?

t it should eventually wear out or should be expected, and in plants ng 305 twenty-four-hour days, dupli- lters could be installed.

W. E. Crane.

lbin, N. Y.

## Power Cost Production

rring to the interesting article in 20 number, by H. S. Knowlton, Power Cost Production in a Small Station," I would suggest that of the data given would have ly augmented if the kind of d its heating value were stated. I te that the costs given do not in- charges for interest, depreciation, and insurance.

H. N. Cooley.

enix, Ariz.

## An Oil Separator

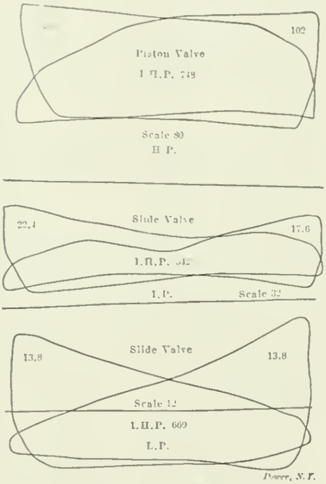
recent issue of Power, I noticed an ment for separating oil from the of condensation, which was de- d by S. Kirlin, and said to be work- isfactorily. There are points about arator that I should like explained I make the same mistake that was by the man who installed the sep- r illustrated. What I want to know Was Mr Kirlin writing fiction h described his separator, or did ribe and recommend it before the its continued use became mani- There has never been any difficulty rating the cylinder oil that remained in the water of condensation. The trouble has come from the inability to the milky-colored emulsion that after the heavy oil is taken from the r No amount of filtering which is practicable in an ordinary steam power plant will separate this emulsion into its erents of water and oil. They go to the boiler together and while the water is made into steam the oil is left behind stick to the tubes and shells and make all kinds of trouble. This scheme oil looks so simple and practicable on has been tried and abandoned in hundreds of instances after the logging of the boilers was traced directly to the oil which went through this kind of a separator with the feed water.

John S. Kirk.

Salem, Mass.

## Indicator Diagrams for Criticism

The accompanying indicator diagrams are from a 28 and 44 and 74 by 72-inch triple-expansion engine of the inclined type, running at 31 revolutions per minute, in a sidewheel steamer. There are three cranks, 120 degrees apart. The boiler pressure is 185 pounds, vacuum, 22 inches. This is all the information I have of these diagrams, which I traced from the originals (they are reduced in size here). There is a bad division of load and temperature between all cylinders. I am astonished that such a condition would be tolerated in this period of advancement. What do other Power readers think of the diagrams?



Power, N.Y.

DIAGRAMS FROM A 28 AND 44 AND 74 BY 72-INCH TRIPLE-EXPANSION ENGINE

J. O. B. Latour

## Why the Generator Didn't Work

A short time ago I was asked to find out why a new 15-kilowatt, compound-wound, direct-current generator would not generate.

The generator had just been installed by the engineer, who told me that he could get no voltage at all, and that when he cut the rheostat entirely out the belt would slip.

I found that the shunt field was not connected, while the armature circuit was short-circuited by the rheostat. After connecting the field and rheostat correctly the motor ran nicely.

The engineer also told me that they could not get good light in one part of the mill. On looking over the wiring I found that there was about 25 feet of iron broom wire in the circuit, the wire connections being hooked together with no attempt at soldering and twisted around nails for support. After replacing the iron wire with copper wire properly supported and soldered at the joints, everything was all right.

Louis B. Carl.

Marshfield, Wis.

## Trouble with Seams over Bridge-walls

With regard to the fire cracks at the girth seams of Mr. Bruno's boilers (in the August 17 number), I beg to say that his inquiry hardly gives enough data as regards the horizontal seams. He states that these are triple-riveted but he does not tell whether the joint is of the lap or butt type. Assume the former and taking the efficiency at 75 per cent., then with 55,000 pounds tensile strength, the plate 5/16-inch and the diameter 54 inches, the bursting pressure will be 477 pounds, and this divided by the pressure he uses gives a factor of safety of 4.147. If these boilers are correctly described, and are ten years old, I should not spend any money repairing them, but replace them with two 72-inch by 18 foot boilers designed for 135 pounds pressure. Boilers operated for ten years at fairly hard duty have spent two-thirds of their life.

Again, if the calculation fits Mr. Bruno's boilers, and he must have 115 pounds pressure, the factor of safety is too low for a lap joint boiler. We should have, even where there are no laws on the subject, a factor of safety of 4.5 up to ten years, and later 5. If the joint is butt-type triple-riveted, of 87 per cent. efficiency, I should not recommend new half sheets, for the reason that the long seams would need to be as strong as the original seams in order to secure a proper factor of safety. With the three boilers set "steamboat style," i.e., over one fire, the long seams must be up out of the fire. How, then, shall one advise repairing the two boilers? I should lay out the affected sheet on each boiler, cutting out the defective metal up to a point on each side for a patch to extend half the circumference of the boiler, and run forward or back, as the case may be, 18 inches from the old girth seam. If the metal in the second seam was good, I should leave it alone and attach the patch to the old rivet holes, having the ends of the patch laid out to a radius of 18 inches. Then, where the triple joint is, I should have the patch drawn down to a thin point to make a neat and tight job.

The new rivet holes in the affected sheet should be screw-punched to 5/8-inch, while the rivet holes in the patch are to be drilled to 13/16-inch, [illegible] the patch rolled and bolted carefully to the inside of the shell, getting it neatly fitted. Ream out the rivet holes in the plate and take off the patch and remove the burrs. Chalk all parts to absorb the grease and remove this well.

Now set the patch in place and bolt it up with plenty of good ¾-inch bolts drawn up solid. Go over the job and see that the fit is good and then drive the rivets properly. Many a leaking patch is due to being a misfit or not being properly bolted up when the riveting was done.

Fire cracks at girth seams are caused by several things, but in most cases structural defects account for them. Where they are not too numerous and do not leak we may safely leave them alone. One is very apt to make them worse by calking. The stress on the girth seam is a minor factor.

Under working conditions fire cracks at the girth seams frequently become unmanageable, and leaks corrode and cut the plate so badly that repairs cannot be avoided. In some cases one may cut out the rivets, and if the cracks are at every other rivet hole, ream out the good rivet holes tapered, driving these first, forcing the crack together. Then drive in the cracked-out hole a long rivet, lapping the driven head down into the crack and covering it. This must be done skilfully else it were best let alone.

Along this line may I not lament the fact that the boiler shops, due to modern tools, are not graduating as high-class repairmen today as they did thirty years ago? True, we have improved the new boiler vastly, but the men who were years ago known as tip-top all-around repairmen are scarce and are highly valued both by their employers and by engineers.

JOHN SMITH.

New York City.

## Economical Compression

Quite a story goes with those diagrams that Charles N. Taylor wants to know about in the July 13 issue, at page 65. That particular set of diagrams was used because they illustrated, better than any others I had at hand, the point under discussion. Not being acquainted with the conditions under which the diagrams were taken, Mr. Taylor is justified in "wanting to know."

The engine in question was a 12x18-inch slide-valve, with the conventional flyball throttling governor.

With 60 pounds of steam at the boiler, running at 144 revolutions per minute the engine was loaded to less than half of its capacity, for which reason it was determined to remodel the valve gear with a view of getting along with less fuel. While fuel economy was the principal point, continuous operation, with as little attention in the way of keeping it in adjustment, was also sought after. The plan finally settled upon was to get as early cutoff as could be done by altering nothing but the travel of the valve, as is done by the governor of the ordinary single-valve automatic engine.

The old eccentric gave the valve 3¼-inch travel. A new eccentric, giving the valve only 2⅛-inch motion, was provided, which on the drawing board cut off at approximately 45/100, with 1/16 lead. This gave a maximum port opening of only 5/16 inch, which was of course contrary to all engineering practice and resulted in wiredrawing at the main valve in addition to the inevitable wiredrawing at the governor valve. This double-header wiredrawing effect will account for the peculiar shape of the diagrams, and explains why the "expansion curve is merged into the admission line," as Mr. Taylor puts it.

I have always believed that the rather excessive wiredrawing, which obviously reëvaporated a lot of moisture, helped a great deal toward the very substantial reduction in fuel consumption that followed.

What I meant by setting the valve by the eye was that, with the steam-chest cover off, the valve was so adjusted, by the eye that the cutoff occurred at nearly equal piston positions.

As we cannot have equal lead and equal cutoff at the same time in this style of engine, I have come to believe that equal cutoff, as nearly as we can get it, is of more importance than equal lead.

After this adjustment "by the eye" was made the steam-chest cover was replaced and diagram No. 1 was taken, and all subsequent adjustments were made by following the indicator.

The final setting shown in diagram No. 2 gave us an unusually smooth-running engine, taking very little more steam than would be required by a modern high-grade engine doing the same work.

Mr. Taylor speaks of No. 2 diagram as a "compromise diagram." I take the stand that no valve setting can be anything but a compromise, to be right.

All of the reciprocating steam engines that I "have met" have had one particular set of conditions under which they would operate with the least steam. Varying either way always raises the rate of steam consumption, which fact, together with a good many other things that have a bearing on the situation, should be borne in mind when setting the valve.

I believe that one of the most important things to learn concerning the steam-engine indicator is that it teaches nothing. It shows, when handled intelligently, what has been done to the valve gear, but it does not tell us what ought to be done. That is something to be arrived at by a process of reasoning; and when we realize that a symmetrical diagram is not the whole thing in every case we will be in the proper frame of mind to worl
in the right direction.

Someone has said that a diagram fron
a locomotive looks more like a swee
potato than anything else, and yet, whei
it comes to getting the work out of
pound of coal, the railroad people hav
us stationary chaps "skinned a mile." The
make money by compressing, while w
stick to the conventional, regardless
what it costs.

In answer to Mr. Taylor's suspicic
that the valve was poorly proportione
when a diagram like Fig. 2 can be got fro
a gear in which the travel of the val
has been arbitrarily changed from 3
inches to 2⅛ inches, without touching a
of the laps or bridges, I am ready
take off my hat to the man who did t
designing.

E. G. TILDEN

Downer's Grove, Ill.

## Dashpot Trouble

I have an 18x36-inch Corliss engine, r
ning at 100 revolutions per minute driv
an alternator for lighting the town,
current being figured on the flat
system; as a consequence we had p
tically the same load all night, with
engine loaded to its rated capacity. W
we had a peak load it was a little o
loaded and required 120 pounds of st
pressure to do the work, but the en
ran very nicely and the dashpots
no trouble. Finally the meter system
adopted; cutting down the load about
half in the early evening and late
of the night. After this change was n
when we first started up, and the
was very light, the dashpots would
seat, but "jiggered" up and down, the
hooks pushing them down to their
each time, and the engine was inc
to race. After the load began to inc
the trouble was over until the peak
went off, and then the same troubl
experienced again.

I finally decided we were carryir
much steam pressure for the light
and that the valves were forced harc
against their seats, making it diffici
the dashpots to operate them.

Another cause was due to the
ernor cutting off the steam so ea
the stroke that the dashpots wei
raised high enough from their sc
create enough vacuum to draw the
pot to its seat. I decided to carry a
steam pressure and had no more t
Instead of having from 100 to 120
of steam when we start up we no
but from 80 to 100 pounds. As tl
increases the steam pressure is in
until the peak load is off, then the
deadened to permit the steam pres
decrease.

D. M. C

Covington, Va.

# Prehistoric Boilermaking

**Wherein It Is Related How Ambition, Incompetency and Sashweight Headers Led to the Confusion and Undoing of Two Ancient Artisans**

By T. T. Parker

My friend Conroy, boilermaker and lobe trotter, recently sent me an old ianuscript found, he states, in an ancient uin at Memphis. He called attention to ie hieroglyphics resembling certain fea- res in boilermaking. Fortunately , a ighbor is a professor of languages and rough his courtesy I present below the anslation:

A certain man named Dan, and Mike, s brother, were riveters and servants in e boiler shop of Soolivan, the rich man. ow Soolivan was like unto a giant, be- nineteen hands in hight and of vast rth, so that no man durst dispute him d he was feared by all men. And it me to pass after Soolivan had spent r days at the Brewery, he got an order a sixty by sixteen and there was a eat drouth in the city during the four ys. Then Dan and Mike went in unto livan and pleaded they be allowed to ut the boiler, saying: "Have we not here for seven years serving thee and ll we never be allowed to lay out a l er? Behold, the men in the Union we are mere riveters and not boiler- kers. Grant us, therefore, to lay out t s boiler, so our name will stand among n and that our reproach will be taken ay."

Now, Soolivan was crafty and wise and all the laying out for the shop, but ing wearied by their prayers and over- e with much drink said unto them: be it, but see you make no mistakes, le I fall on you and smite you offen the e h."

herefore, Dan and Mike built the boil- e nd when the Inspector came the water w n and it was tight, whereupon he o red the water removed and entered tl vessel with his little hammer and when h come out, he scorned them, saying:. " t o, the boiler is no good, for the ri holes are ½ inch out of line and w sorely drifted. Cut out some rivets he ordered, "and see the holes." they did as he commanded and it even so. Now, at this hour Soolivan w ver to a place called Kronin's and h fetched him to the shop and great ir f ll on Dan and Mike, his brother. A when Soolivan had seen all the de- t shown by the Inspector, he was ill with rage and seized Dan and his br her Mike and beat them sorely and th w them across the street, and they w as clay in the potter's hand before i. So he left them as dead men and, wi his friend Ryley, went again to Kronin's, cursing and bewailing, for the r was, indeed, a dead one.

hen Dan and his brother Mike had zor to, they went to a place called Schmid's and were seen no more for four days, being exceedingly sore. And when the time had passed, they sat in Schmid's place counseling what they should do. And the door opened and a man dressed in fine linen with patent-leather shoes and a real Dunlap entered. And he said unto Schmid: "Give to me drink and a good segar," and Schmid did so. Then the stranger said unto Schmid: "Have one on me," and Schmid had one and was elated. And the stranger said unto Schmid: "Know you the two men, Dan and his brother Mike?" And Schmid said: "Yah, dem two fellers by the table is dem."

Now, Dan and Mike pricked up their ears, fearing the stranger was to do them harm, and they were ready to flee. But he said unto them: "Have you an Aunt Kate out on the Archer road?" And they said: "Yes." Then he said unto them: "Behold, she is dead and buried and has left much gold and silver. Go with me now to the Judge and when all things are done lawfully the money is thine."

And it came to pass the Judge did so and they were given six thousand iron-men coin of the country. And they returned unto Schmid's and called in their friends, even from the yards, and there was great joy and much feasting for four days.

Now, when the feast was over, Dan and Mike counseled together and they went to the junk shop on Thirty-fifth street and bought tools of the man and journeyed afar, even to a city near the coal mines, and they started a boiler shop, for the yaps were easy and no Inspector came. And they waxed rich and became great in that country. But the coal-mine men complained bitterly, saying: "Behold your work is on the bum and our money is wasted." And so work got slack.

Now Dan said unto Mike: "Inasmuch as these people will not buy of us, let us seek others and to do this, let us build Bee and Double boilers and sell them all over the world. And they counseled together and got some patterns at the old junk shop for this work. And they put in a cupola and took old grate bars, sashweights and cook stoves, with other junk, and made them into headers. And when she was assembled, behold the headers cracked when the tubes were expanded. And they went to the Bank and got more money and built more headers, putting in heavier metal, so with care one could expand the tubes.

So they were puffed up and said: "Behold, we can make a Bee and Double boiler." And no man denied them. So they went out through the land and got an order for four two-fifties and built them, and Dan and Mike went out to see them erected. And the work was all done, when on the fourth day of service, behold, the mud drum blew off the 4-inch tubes at the rear headers and one man was killed and much property damaged.

Now, the mill owner sent for an Inspector and he came and condemned the outfit, saying: "The tubes are all too short and the castings too brittle and the workmanship savage." And when the mill owner heard all this, he said unto Dan and his brother Mike: "Take your junk and get you away from here, else the officers come and put you in prison."

And they went away sorrowful, for they had no more money. And they worked their way to the great city on the tracks and when they had seen the rich man, Soolivan, and told him all the tale, he laughed and made merry. So they became again his servants as holder on men, for the Union was on a strike and Soolivan was hard pressed and they remained with Soolivan even unto this day.

# U. S. Forester Pinchot on the "Water Power Trust"

Following is that portion of United States Forester Pinchot's address at the National Irrigation Congress at Spokane, Wash., on August 10, which relates to the so-called water-power trust:

"There could be no better illustration of the eager, rapid, unwearied absorption by capital of the rights which belong to all the people than the water-power trust, not yet formed but in rapid process of formation. This statement is true, but not unchallenged. We are met at every turn by the indignant denial of the water-power interests. They tell us that there is no community of interest among them, and yet they appear year after year at these congresses by their paid attorneys, asking for your influence to help them remove the few remaining obstacles to their perpetual and complete absorption of the remaining water powers. They tell us it has no significance that the General Electric interests are acquiring great groups of water powers in various parts of the United States, and dominating the power market in the region of each group. And whoever dominates power dominates all industry.

"Have you ever seen a few drops of oil scattered on the water spreading until they formed a continuous film, which put an end at once to all agitation of the surface? The time for us to agitate this question is now, before the separate circles of centralized control spread into the uniform, unbroken, nation-wide covering of a single gigantic trust. There will be little chance for mere agitation after that. No man at all familiar with the situation can doubt that the time for effective protest is very short. If we do not use it to protect ourselves now, we may be very sure that the trust will give hereafter small consideration to the welfare of the average citizen when in a conflict with its own."

POWER
AND THE ENGINEER

DEVOTED TO THE GENERATION AND
TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

John A. Hill, Pres. and Treas. Robert McKean, Sec'y.

505 Pearl Street, New York.
355 Dearborn Street, Chicago.
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of POWER solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "Powpub," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During 1908 we printed and circulated 1,836,000 copies of* POWER.

*Our circulation for August, 1909, was (weekly and monthly) 171,000.*

*September 7* ........ 42,000
*September 14* ........ 33,000

*This paper reaches 42,000 separate readers each month and 33,000 each week.*

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*

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## Feed Water Treatment

For some years past considerable attention has been given to the question of heating the feed water to the temperature of the water in the boiler by means of live-steam feed water heaters. If the feed water could enter the boiler at the temperature of the steam, leaving no work for the boiler except to furnish the latent heat of vaporization, a great gain would result if the heat put into the water did not cost anything; but if this heat is taken from the steam which comes from the boiler, it is difficult to see how any thermodynamic gain could result, although a substantial gain is claimed by some disinterested engineers. While this gain, if it exists, is thus far inexplicable, there are other advantages to be derived from its use that may be in many instances turned to profit.

It is claimed by the advocates of the live-steam feed-water heater that when water is heated to a high temperature, the greater part, if not all, of the scale-making impurities are precipitated, and if this precipitation takes place outside the boiler and the precipitates are collected in a separate vessel, the heating surface of the boiler may be kept clean indefinitely.

While it is allowed by some that such heaters will precipitate the lime carbonates, the sulphates which form the harder impervious scale are scarcely affected by treatment in the live steam heater, and it is claimed that a water-softening process or the use of suitable boiler compounds alone will prevent scaling when water containing sulphates is used. There are many engineers, readers of POWER, who have used live-steam heaters, others who have had wide experience with water-softening systems, and there are still more who have used compounds extensively; but more than all these, there are thousands of operators who know of these things by name only and would gladly read anything that can be found on the subject. Will those who have used these things and the different methods of feed-water treatment tell their experiences and conclusions?

## Cost of High Speed

Recent performances of the "Mauretania" and the record-breaking trip just made by the "Lusitania" have been such as to create great enthusiasm in engineering circles and arouse popular interest all over the country, because of the setting of new speed marks and the development of a new type of vessel capable of crossing the Atlantic in a shorter time than ever before. Increase in speed has been the demand of the public, and in return the various transatlantic lines, to keep abreast with the achievements of the railways across the continent, have used every effort to attain this end, regardless of the amount of coal burned or the relative cost of fuel for low and high speeds.

The best record of the "Mauretania" has been four days, fourteen hours and thirty-eight minutes, an average speed of 25.84 knots an hour, and the record now held by the "Lusitania" is four days, eleven hours and forty-two minutes, the average speed being 25.85 knots, or 29.75 miles, an hour. It is unofficially reported that the coal consumption of the "Lusitania," including coal for the auxiliaries, average 1050 tons a day, making a total of 472 tons for the trip, which would mean, a cost of $3.25 per ton, a total expenditur for coal of $15,356. Passengers who ca smiling down the gangway to greet wait ing relatives and friends seemed to thi that it was worth it, and without mu doubt never gave a thought to the sul ject of coal conservation, or paused think that the coal burned by this o steamer in a day would for heating a cooking last the average householder a most a century.

To run a boat the size of the "Lusitani at eighteen knots, or 20.7 miles, an ho would require approximately 350 tons coal a day. The time for a voyage wo be six days and ten hours instead of f and one-half days, and the coal consun tion 2246 tons as compared to 4725, a probably a much larger quantity when t coveted four days to complete the t is a matter of history. The excess speed already attained over the moder figure of eighteen knots per hour c nearly 2500 tons of coal on each trip, in other words, fuel enough to last families throughout the natural lives the household. This is but one trip one vessel, and although no figures available, a proportionate increase in way speed would add largely to the consumption.

It is, of course, apparent that the of provisions, labor, interest on in ment, etc., will be less, and the gr charge for passage will in all proba make the faster boat and faster train ing investments, aside from the adv ing the line receives. Four days t other side or to the Pacific ocean New York means much to men of ness and is hailed with delight by tourist, but when considered only the standpoint of conservation of th supply, high speed bears the car of extravagant waste. More especia this true when it is considered th boat lays five days in port before st on the return trip, and full advant not taken of the faster passage to the number of ships in service. the standpoint of the business ma advancement in the field of navigati question must be viewed in an entire ferent light, and here the motto and should be, the faster the bette

## The Mechanical Equivalent of Heat

For the purpose of testing his steam rbines, Professor Rateau has perfected water brake which gives very stable and niform results. He has recently taken dvantage of the opportunity thus afforded measure the mechanical equivalent of at upon a large scale. The absorption f the power transmitted to the brake by e water results, of course, in an eletion of its temperature, and by measur- the initial and final temperatures of the er, together with the amount passing, d knowing the number of foot-pounds of ergy involved, the determination of the uivalence between the work and the unt of heat necessary to raise one kiloam of water from 15 to 16 degrees Centide was comparatively simple. These surements were made when the brake s absorbing 250, 440, 600 and 700 horsewer, the results obtained being 425.6, .28, 426.58, and 426 for the respective ses. Four tests were made at each load. e average of the sixteen results was .11. Taking the results of the tests 00 and 700 horsepower, in which errors servation, radiation, etc., should be portionately least, and which accord between themselves, and eliminating test in which there was an obvious r, he arrived at the figure 426.85. The pted equivalent of the calorie is 426.9 gram meters. Professor Rateau's res therefore accord within one-tenth ne per cent. with those of Rowland, Callendar and Barnes.

## Ratio of Expansion

reply to an inquiry in a contemporary the method of finding the total numl of expansions of steam taking place in a compound engine, the inquirer was t that the product of the number of e nsions in the high-pressure cylinder the number in the low-pressure cylinder would give the total number of exp sions in both cylinders when there w no drop of pressure at the end of the h -pressure diagram; that is, when exp sion in the high-pressure cylinder is ied to the receiver pressure.

le this statement is true for the c dition named, it is incomplete, for it l to no other degree of expansion in e high-pressure cylinder. The impr ion is conveyed that the cutoff in the o-pressure cylinder is a factor in deterning the number of expansions taking pl e in a compound engine, while, as a m ter of fact, the total number of expa ions is determined by the cylinder ra , and for any case the number of expa ions will be the number of expansions in e high-pressure cylinder multiplied by th cylinder ratio, regardless of the point of utoff or number of expansions taking pl in the low-pressure cylinder.

In the high-pressure cylinder the number of expansions may be found for the ideal case by dividing the initial pressure by the terminal pressure, which pressure may or may not coincide with the receiver or back pressure, there may be a considerable drop or a negative loop in the diagram, but this will make no difference in the total number of expansions, for this total will be the quotient of the terminal pressure into the initial pressure. When the steam exhausted from the high-pressure cylinder enters the low-pressure cylinder it is expanded into a larger volume. As the low-pressure cylinder uses the same steam that passed through the high-pressure cylinder, it must expand it into as many times its volume as the low pressure cylinder is greater than the high-pressure cylinder.

The reply should be further qualified by calling attention to the fact that it is the contents of the high-pressure cylinder at the end of the stroke *less* the amount retained by the closure of the high-pressure exhaust valve, which is passed on to be expanded in the low-pressure cylinder. In single-valve engines on light load and with considerable compression this factor has a very material bearing upon the total ratio of expansion.

## Allowing for Extra Expenses in Figuring Power Cost

In plants where the engineer-in-charge is required to submit each month to the owner or manager a comparative statement of the cost per unit of producing power, either in relation to the previous month or to the same month of the year before, it is important that the figures exhibited shall always be on the same basis. That is, if any unforeseen circumstances occur during the month's run which modify the station cost, they should be noted on the records, and if possible the unit costs should be figured both with and without the large items which make the difference in the results. It is the custom of many engineers to look out for this, but many others fail to realize how much difference a little extra expense may make in the cost per kilowatt-hour delivered at the switchboard. No sooner does the alert manager see that the unit cost has jumped ahead several per cent., than he starts to investigate the conditions which led to the increase, and if the engineer who makes out the costs originally has done a little personal analyzing of the operating conditions and results on his own account, and embodied the conclusions which he has reached in the records, he will find the effort well spent.

To take a simple case, suppose that a steam plant generates in a certain month three hundred thousand kilowatt-hours at a cost of three thousand dollars, delivered at the switchboard, including the items of fuel, oil and waste, water, station wages, building, steam equipment and electrical apparatus repairs. This is one cent per kilowatt hour manufacturing cost alone. Now suppose that the next month the cost of coal per ton remains the same, the station labor the same and all conditions as before, with the exception of a slight increase in output, say to three hundred and ten thousand kilowatt hours, and a radical difference in the maintenance cost, say unexpected engine repairs to the extent of six hundred dollars. This will cause the total cost of producing the plant's output for the month to rise to about thirty-seven hundred dollars, making the production expense 1.19 cents. per unit. The engineer handling the station knows perfectly well that the greater part of the increase of nearly twenty per cent is due to the repairs which were necessary on the steam equipment, and the manager may know it also, but if a close comparison of the two months is to be made for the purpose of judging the station efficiency and the effectiveness of the equipment in standing up to its work year after year, it becomes necessary to figure the cost independently of the extra repairs. On this basis the energy output would be produced for thirty one hundred dollars, for example, leaving the plant operating for the month at the same rate of one cent per kilowatt-hour, and indicating that its economy has undergone no change in the four weeks.

In not a few cases the engineer may be content to send in the record of unit and total power cost without any analysis of what the station has done independently of any large unusual item of repairs which may come into the situation, leaving the manager to attribute any differences in the unit cost to the large item not common to the service in other periods. In such cases the engineer is not fair to himself, for he may be actually operating at improved economy in a certain month, and yet have the improvement swallowed up by some extraordinary expense which ought to be separated from the other costs in order to enable a thoroughly fair comparison to be made. Just as in the laboratory of the scientist, efforts are made to preserve all conditions but one constant and note the variations in results produced by changes in that one condition, the operating engineer responsible for the cost of producing electrical energy in a power plant should eliminate all unusual conditions that he can in making a comparison of the performance of the plant in a certain period with the operating results in some other equal lapse of time.

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# How the Diagrams are Made*

By S. F. Jeter

Making the diagrams illustrated in the front part of this number is extremely simple, and the following explanation should be readily understood by anyone familiar with plotting curves from a formula.

Let $A$ represent the area to be braced in square inches, $P$ be the steam pressure in pounds per square inch on area $A$, $b$ represent the stress allowed per square inch on the braces, and $a$ represent the amount of brace area required.

The area to be braced in square inches, multiplied by the amount of pressure per square inch on this surface, would represent the load to be supported by the braces, and this must be equal to the allowable stress per square inch, times the cross-section of the braces. Using the notation given above and expressing this as a formula, we have,

$$AP = ab, \text{ or } A = \frac{ab}{P} \qquad (1)$$

If any fixed values are assigned to $a$ and $b$, a curve can be plotted from formula (1), which would show all of the corresponding values of $A$ and $P$ for these particular values of $a$ and $b$. Fig. 1 shows a curve plotted from formula (1) assuming $a = 5$ and $b = 7500$, or $a\ b = 37{,}500$, and formula (1) becomes,

$$A = \frac{37{,}500}{P} \qquad (2)$$

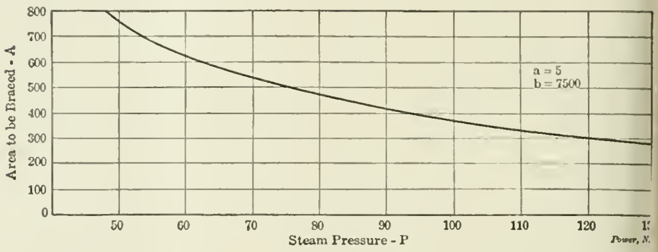

FIG. 1

Substituting the various values of $P$, as shown on Fig. 1, in formula (2), the different points are obtained through which the curve is drawn. It is evident from the method of construction, that the horizontal and vertical lines passing through any point on it, would represent the area braced, and the pressure for which it was braced, when 5 square inches of brace area are used at an allowable stress of 7500 pounds per square inch of section. If a number of curves were plotted in this manner, representing the various brace areas, as in the main diagrams, the resulting diagram could be used in the same way, but it is seen that there would be much labor involved; in fact, it would be simpler to make up a table of the calculated values.

There is a way by which the successive values as shown by the curves, may be represented by straight lines, and this method also practically eliminates all calculations. To make the diagrams in this way, it is only necessary to lay off the values of $A$ or $P$ equal to the reciprocals of their real values. The reciprocal of a number is the result obtained by dividing one by the number, therefore, the larger the number, the smaller will be its reciprocal. It is most convenient to use th reciprocals of the pressures in constructing the diagrams under consideration, an in order that the vertical lines representing these pressures may be read in th usual way, that is, increasing from left t right, the reciprocals must be laid o from right to left. The reciprocals o values of $P$ may be laid off without calculation as follows:

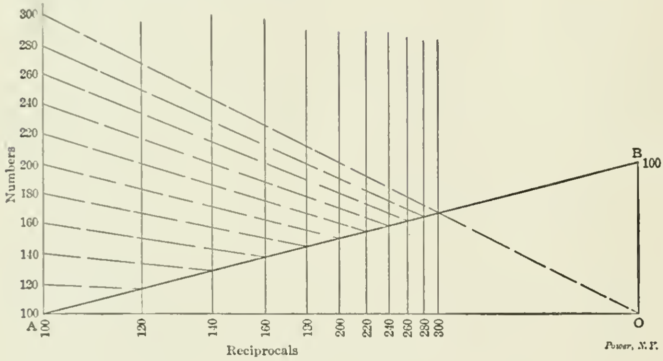

FIG. 2

Assuming that pressures are to ran from 100 to 300 pounds, erect a verti on the left-hand side of the sheet, as at Fig. 2, and let the position of this l represent the smallest pressure ( pounds in this case); also draw a ho zontal line through $A$, as illustrated. T point $O$ from which the reciprocals laid off, can be located at any conveni point on the horizontal line, but its po tion determines the width of the diagr

Since the pressures to be represen are to range between 100 and 300 pour and the vertical line at $A$ is to repres 100 pounds, or its distance from $O$ is represent the reciprocal of 100, the tance from $O$ to the line representing pounds will be one-third of the dista from $O$ to $A$, for the reciprocal of is three times as great as the recip of 300. It follows, that if the wid the diagram was to be 24 inches distance from $A$ to $O$ should be ma inches. The different pressures w between 100 and 300 pounds should be laid off to a convenient scale o the vertical at $A$, starting with the pr ure

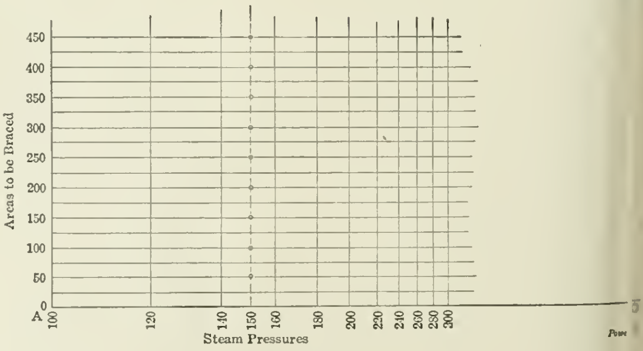

FIG. 3

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*Copyright, 1909, by S. F. Jeter.

which this vertical represents, or 100 pounds.

For accuracy in construction, the scale of pressures should be chosen so a distance that would represent the value of the lowest pressure (100 pounds in the present case), would be at least one-fourth as great as the distance from O to A. A vertical should now be drawn at O, and a distance O B laid off on it to represent the lowest pressure, the scale to be the same as used for pressures on the vertical at A, and A and B should be connected by a straight line, as shown in Fig. 2.

To locate the position of the reciprocal of any pressure between 100 and 300 pounds, it is necessary only to find where a straight line connecting O with the desired pressure on the scale at A intersects the A B, Fig. 2, and a vertical line drawn through this point of intersection is the one required. Geometrical proof of this fact will be given later for those who care to know why this is so.

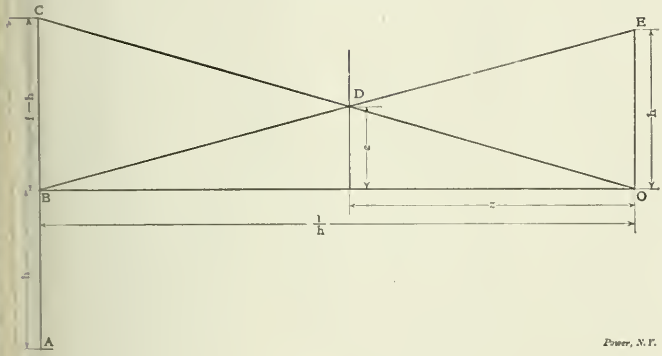


FIG. 4

After the verticals representing the various pressures desired, are drawn in the manner just described, the diagonal A B can be rubbed out, also the scale of pressures on the vertical at A, and horizontal lines can be drawn across the paper to any convenient scale to represent areas to be braced, the resulting diagram benig like Fig. 3. The vertical and horizontal lines in Fig. 3, are arranged so the curve required to represent corresponding values of A and P of formula (2), as illustrated in Fig. 1, becomes a straight line which passes through O, and for reasons familiar to students of analytical geometry all similar lines would pass through point O.

Since O is a point on each of the diagonal lines, it would only be required to calculate one other point for every diagonal line, and with a straightedge draw a line through this point and O extending across the diagram. While this method would be simple enough, even the few calculations may be avoided. when uniform variations in the values of a of formula (1) are assumed.

For example, in the formula

$$A = \frac{ab}{P},$$

assume that a increases by one square inch to represent successive diagonals, and that b has a constant value of 7500, as is the case in the first diagram; then the value of A will increase uniformly for any fixed value of P. The values representing A are laid off uniformly by the horizontal lines in Fig. 3, and a convenient increase in A can be assumed for each increase in a, and the corresponding value of P calculated from formula (1). Thus, assuming variations in A are to be 100 for variations of 1 in the values of a, and substituting these values in formula (1), we have,

$$100 = \frac{7500 \times 1}{P}, \text{ or } P = 75 \textit{ pounds}.$$

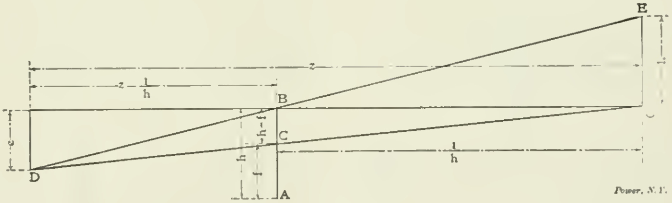


FIG. 5

Since this pressure is out of the range of the diagram, another smaller variation in A must be assumed. Taking the new variation in A as 50, and making a similar calculation as above, the corresponding value of P is found to be 150 pounds, and each diagonal representing variations of one inch in a cross the vertical line representing 150 pounds at the same points that the horizontal lines representing variations of 50 inches in the value of A do. It is only necessary to connect these intersections with the point O by straight lines extending across the diagram to make it complete. In Fig. 3, the points of intersection are indicated by small circles.

If instead of the variations in a being even inches, the diagonals in the diagram were to represent 1¼-inch round braces, the successive variations in a would be 1.227, and for the pressure at which corresponding variations in A would be 50, formula (1) would become,

$$50 = \frac{7500 \times 1.227}{P},$$

or P = 184 pounds. The position of the vertical which would represent 184 pounds, can be obtained in the same manner as those representing the other pressures, and used only temporarily for drawing the diagonals as explained.

### LAYING OFF RECIPROCALS

The following is geometrical proof that the method of laying off reciprocals as previously described is true: The proposition to be demonstrated, is, if at A, Fig. 4, any vertical distance A B be laid off to represent a number h, and a horizontal B O drawn, whose length represents $\frac{1}{h}$ to any scale, and at O a vertical O E is drawn equal to h; then if A B is extended to C, the reciprocal of the number which would be represented by A C, or f, would be z, the dimension z being the perpendicular distance of the intersection of diagonals B E and C O from line O E.

Since A B = h and A C = f, then B C = f — h, and from similar triangles we would have,

$$(f - h) : e :: \frac{1}{h} : z, \text{ or } \frac{e}{h} = zf - zh \quad (1)$$

and

$$h : e :: \frac{1}{h} : \left(\frac{1}{h} - z\right), \text{ or } \frac{e}{h} = 1 - zh \quad (2)$$

From (1) and (2),

$$zf - zh = 1 - zh, \text{ or } z = \frac{1}{f},$$

which was to be proved.

If f was less than h the proof would be as shown in Fig. 5, the lettering of this figure being the same as used in Fig. 4. From similar triangles,

$$e : (h - f) :: z : \frac{1}{h}, \text{ or } \frac{e}{h} = zh - zf \quad (3)$$

and

$$e : h :: \left(z - \frac{1}{h}\right) : \frac{1}{h}, \text{ or } \frac{e}{h} = zh - 1 \quad (4)$$

From (3) and (4),

$$zh - zf = zh - 1, \text{ or } z = \frac{1}{f},$$

as before.

## Southern Water Power Development

Five years ago there was very little development of the extensive water power of the South, but since that time there has been built up along the Catawba river in North and South Carolina one of the greatest hydroelectric systems in this country.

The Rocky Creek plant has just started and now the Southern Power Company has a generating capacity in its three water-driven stations of 54,600 kilowatts, or 78,000 electric horsepower. These plants are all three in South Carolina, and about 32 miles in their greatest distance apart. Just south of the North Carolina line comes the Catawba plant, some 29 miles down stream is the Great Falls station, and three miles below this latter is the development just completed at Rocky Creek.

The Catawba plant began to operate in March, 1904, and in September, 1906, it was delivering 10,000 horsepower. Within one and a half years after the starting of the Catawba plant, that is in September, 1905, work began on the development at Great Falls, and was completed in March, 1907, giving a construction period of about eighteen months for this hydroelectric station of 24,000 kilowatts generator capacity. Within a year after the development of the Great Falls site was under way, that is in August, 1906, clearing began at Rocky Creek, and the completion of this latter plant in April of the present year gives it a construction period of about two and two-thirds years, but this reduces to two years since the masonry work was started.

Within a space of thirty-seven months three hydroelectric stations, with a combined capacity of 54,600 kilowatts, have gone into commission along some thirty-two miles of the Catawba. Within the past year construction has been started at what is known as the Ninety-Nine island plant, near Blacksburg, S. C., on the Broad river, where it is proposed to install six generators of 3000 kilowatts each, a total of 18,000 kilowatts, or 24,000 electric horsepower. The date for the completion of this fourth development is fixed early in 1910, and it will give the Southern Power Company a combined capacity of 72,000 kilowatts, or 96,800 electric horsepower in water-driven generators. Such a record of aggregate capacity at several different stations in a single system all completed in a period of six years has probably never been equaled anywhere else.

For the connection of the foregoing generating stations with each other and with the chain of cities, villages and manufacturing plants that stretch from Rock Hill and Yorkville, S. C., on the south, to Salisbury and Statesville, N. C., on the north, nearly 300 miles of town lines and pole lines have been built, with a much greater length of transmission circuits. The double circuits on steel towers connect the generating plants at Rocky Creek, Great Falls and Catawba, and run to Charlotte, Concord and Salisbury.

Originally these transmission circuits were operated at 44,000 volts, but provision was made for doubling this voltage to 88,000 when desired, and it is understood that this increase has been put into effect on the double-trunk line that connects the generating stations and larger cities.

At the Catawba station, which was designed before the present ownership began, the current was delivered at about 11,000 volts and is transmitted to some points only a few miles distant at this figure, but the generators at this station are also connected with the 4000-volt line through three transformers of 2000 kilowatts each, so as to operate in parallel with the other plants.

The Great Falls and Rocky Creek plants are equipped with 2200-volt generators and with transformers that raise this pressure to 44,000 volts for transmission.

In the distribution of energy from the various substations to the manufacturing plants and lighting stations that are supplied, a voltage of 550 is employed at some plants and of 2300 at others. The great bulk of all the energy is used by cotton mills.—*The Tradesman.*

## Boiler Efficiencies—Oil Fuel

The following data have been kindly furnished POWER readers by Charles C. Moore & Co., San Francisco, Cal.

BOILER EFFICIENCIES—OIL FUEL.

Showing the maximum theoretical boiler efficiency, for a given per cent. excess air supply and flue-gas temperature, and the corresponding possible pe cent. saving in fuel due to operating the boiler at 80% efficiency, based on conditions given below.

| Assumed Per Cent Excess Air Supply. | Assumed Temperature of Flue Gases. | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 400° | | 425° | | 450° | | 475° | | 500° | | 525° | | 550° | | 600° | | 700° | | 800° | |
| | Calculated Boiler Eficiency and Per Cent. Fuel Saving. | | | | | | | | | | | | | | | | | | | |
| | Eff. | Sav. | Eff. | Sav. | Eff. | Sav. | Eff. | Sav. | Eff. | Sav. | Eff. | Sav. | Eff. | Sav. | Eff. | Sav. | Eff. | Sav. | Eff. | Sav. |
| 0 | 84 78 | −5 98 | 84 22 | 5 28 | | | | | | | | | | | | | | | | |
| 10 | 84 20 | −5 25 | 83 59 | −4 49 | 82 98 | −3 72 | | | | | | | | | | | | | | |
| 25 | 83 33 | −4 13 | 82 65 | −3 32 | 81 96 | −2 45 | 81 27 | — 1 59 | | | | | | | | | | | | |
| 50 | 81 89 | −2 36 | 81 08 | −1 35 | 80 27 | −0 34 | 79 46 | + 0 67 | 78 65 | + 1 69 | | | | | | | | | | |
| 75 | 80 44 | —0 55 | 79 51 | +0 61 | 78 58 | +1 78 | 77 66 | + 2 93 | 76 73 | + 4 09 | 75 80 | + 5.25 | | | | | | | | |
| 100 | 78 99 | +1 26 | 77 94 | +2.58 | 76 89 | +3 89 | 75 84 | + 5.20 | 74 79 | + 6 52 | 73.75 | + 7 82 | 72.70 | + 9.13 | | | | | | |
| 125 | | | 76 37 | +4 54 | 75 20 | +6 00 | 74 03 | + 7 47 | 72 86 | + 8 93 | 71 69 | +10 40 | 70 52 | +11 85 | 68 18 | +14 78 | | | | |
| 150 | | | | | 73.51 | +8 12 | 72 22 | + 9 73 | 70.93 | +11 31 | 69 64 | +12.95 | 68 35 | +14 59 | 65 28 | +18 40 | 60 61 | +24.20 | | |
| 175 | | | | | | | 70 41 | +11.99 | 69 00 | +13 75 | 67.59 | +15.54 | 66 18 | +17.30 | 63 30 | +20 89 | 57 71 | +27.90 | 52 07 | +34 |
| 200 | | | | | | | | | 67 07 | +16.19 | 65 54 | +18 10 | 64 01 | +20.00 | 60.94 | +23 82 | 54.28 | +32 20 | 48 69 | +39. |
| 250 | | | | | | | | | | | 61 44 | +23 20 | 59 66 | +25 42 | 56.11 | +29.90 | 49.03 | +38 70 | 41 94 | +47 |
| 300 | | | | | | | | | | | | | 53 32 | +30 88 | 51.29 | +35.92 | 43.23 | +46 00 | 35 17 | +56 |

APPROXIMATE RELATION BETWEEN PER CENT. $CO_2$ AND EXCESS AIR SUPPLY AS PER ASSUMPTIONS BELOW.

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Per Cent. $CO_2$ | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 15 5 |
| Per Cent. excess air. | 270.4 | 197 5 | 149 0 | 114 3 | 88 3 | 68 0 | 51 8 | 38 6 | 27 6 | 18 2 | 10 2 | 3.3 | 0 |

In the above table the following assumptions have been made: Boiler-room temperature, 100 degrees Fahrenheit; humidity atmosphere, 80 per cent.; B.t.u. per pound of oil, 18,600; moisture in oil, 1 per cent.; air per pound of oil, chemically required, pounds: loss by radiation, 3 per cent., complete combustion; per cent. excess air stated is measured at boiler outlet and consequei includes air leakage through boiler setting.

Correction should be made for any variation from above assumptions. The most likely variable is the loss by radiation, wh for boilers with brick setting, varies from, approximately, 2 per cent. for large to 4 per cent. for small boilers.

Illustration: Saving which could be made by operating at 80 per cent. efficiency instead of 75.2 per cent. is (80 —75.2) ÷ 80 per cent., which means that 6 per cent. of fuel required when operating at 75.2 per cent. boiler efficiency would be saved if boiler ficiency were increased to 80 per cent.

Above table based on oil having the following analysis: Carbon, 85 per cent.; hydrogen, 12 per cent.; sulphur, 0.8 per ce nitrogen, 0.2 per cent.; oxygen, 1.0 per cent.; water, 1.0 per cent.

# Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

## Koerting Multijet Eductor Condenser

The Koerting multijet eductor condenser, shown in Fig. 1, is the latest design of a jet condenser maintaining the essential qualities of the Koerting single-jet eductor condenser; that is, no air pumps, no moving parts, simplicity of tion, very little space required and wear and tear practically *nil.*

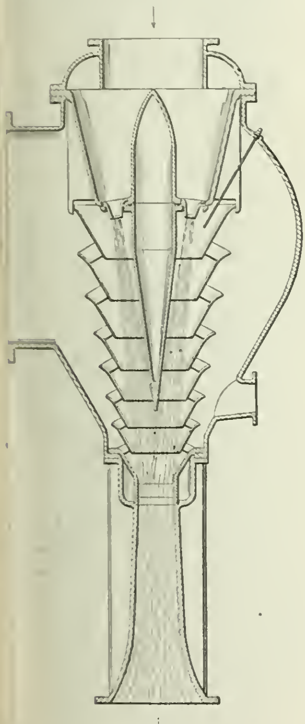

Power, N.Y.

FIG. 1. MULTIJET EDUCTOR CONDENSER

This condenser requires a head of water equal to 9 pounds per square inch, which can be maintained by means of a standpipe, or direct discharge by means of a centrifugal pump. The speed of the water column under this head is sufficient to overcome the atmospheric pressure and maintains a vacuum in the exhaust pipe of either 28 or 26 inches, depending on what requirements the condenser calculation is based on.

Its action is independent of the induction effect of the exhaust steam, also of the load on the engine or turbine, whether heavy or light. The exhaust steam meets the water columns through the steam openings in the combining tube in the direction of the current, and increases its speed, removes the air and condenses; the condenser maintaining a steady vacuum without the use of a vacuum or air pump of any description.

The multijet eductor condenser shown has, instead of one central condensing jet, a number of converging jets, meeting and forming a single jet in the lower part of the condensing tube. This tube is cast in one piece, and consists of a series of concentric nozzles of gradually diminishing bore. The steam flows through the annular passages between the nozzles, which guide it so that it impinges at suitable angle on the condensing jets.

This condenser is considerably shorter than the single-jet apparatus of equal capacity, but the area of contact between the steam and the water is greater. In the upper part of the tube the steam is in contact with the coldest water, and condensation is keenest, so that a greater weight of steam is condensed per unit of area of contact than is the case in the lower part of the tube, where the water is hotter.

The ratio of water to weight of steam condensed is for equal vacuum practically the same as is required for surface condensers, and the condenser does not require a disproportionate amount of condensing water.

To insure satisfactory working under all conditions of load variations on the turbine or engine to which the condenser is attached, it is only necessary to supply the water to the condenser at a pressure at the level of the water-inlet flanges equal to 9 pounds per square inch.

The power required for working the condenser is said to be low and to compare favorably with that required for other forms of jet condenser with air pumps, or for jet condensers or surface condensers requiring water-circulating air pumps and dry-air pumps.

To prevent the possibility of water passing from the condenser into the turbine to which it is attached, an automatic vacuum-breaking device has been designed, but in condenser plants in connection with reciprocating engines a balanced horizontal water check valve is advised, in conjunction with the condenser.

In all cases where the conditions do not necessitate condensers of the surface type this condenser is available, as it occupies small space, is certain in action and the cost of working is low. No special foundations are required and short exhaust-steam connections can be used, so that vacuum losses due to friction are slight. It can usually be fixed below the engine or turbine so that good drainage is secured and unsightly and expensive rising mains avoided.

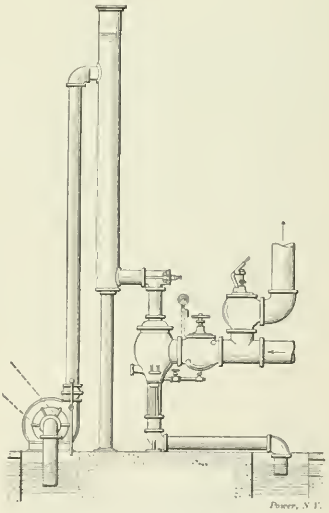

Power, N.Y.

FIG. 2. PUMP, STANDPIPE AND CONDENSER ARRANGEMENT

When there is no gravitation supply of water available, it is necessary to use a circulating pump, and if a motor- or belt-driven centrifugal pump be used, the water may be delivered direct into the condenser, or pump the water up into a standpipe, as this is a safer way to get rid of the air, more or less of which is always contained in the water, and which naturally can influence the vacuum considerably. See Fig. 2.

This condenser is manufactured by the Schutte & Koerting Company, Twelfth and Thompson streets, Philadelphia, Penn.

## Improvements in Isolating or Check Valves

A recent patent granted to Allen H. Hopkinson, E. Murgatroyd and J. Hopkinson & Co., Ltd., engineers, Britannia works, Huddersfield, relates to isolating or check valves for use in steam mains, and has for its object the provision of means to control the transmission to the back of the valve of the fluctuations of pressure in the steam main, and thus to prevent or minimize the disagreeable and sometimes dangerous chattering to which such valves are liable. For this purpose the speed of the steam issuing from the outlet of the valve casing is increased by providing the outlet with a cone or a contraction so as to cause the steam to pass from the valve casing to the steam main in the form of a jet.

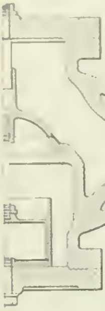


FIG. 1

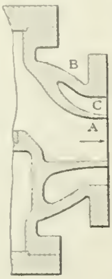


FIG. 2

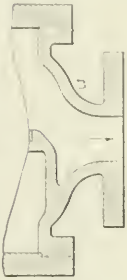


FIG. 3

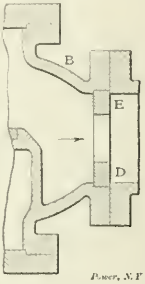


FIG. 4

Various modes of carrying the invention into effect are illustrated herewith, the outlet ends of the valve casings being shown in central section. Fig. 1 illustrates a construction in which the outlet orifice is made by a right cone *A* cast integrally with the valve casing *B*, an annular cavity *C* being formed between the cone and the casing. The cone insures a jet-like action on the issuing steam, and the cavity *C* farther assists the cushioning effect by resisting the backward transmission of fluctuations of pressure. In Fig. 2 the cone *A* is an oblique one, the construction in other respects being the same as in Fig. 1. The modification shown in Fig. 3 is arrived at by reducing the size of the neck of the casing *B* while leaving the flange unchanged. In this construction the cavity *C* of Figs. 1 and 2 is absent. Farther modifications may be obtained by omitting the cavity *C* of Figs. 1 and 2 while leaving the internal shape of the outlet passage and the external shape of the casing the same as in those figures. In another construction, Fig. 4, in lieu of modifying the shape of the neck a diaphragm *D* is provided across the outlet, such diaphragm having an opening *E* of the size desired. In still another construction, Fig. 5, the same object is accomplished by providing a detachable cone *F* projecting into the steam main *G* and secured, for example, by having a flange *H* on the cone bolted between the flanges of the valve casing and steam main. The cone *F* has a continually decreasing diameter and an annular cavity *J* is formed between the cone and the steam main which acts in the same way as the cavity *C* in Figs. 1 and 2. In lieu of the cone *F* in Fig. 5 a converging and diverging piece *K* (Fig. 6) may be employed forming a contraction at the entrance to the steam main, thereby insuring a jet action in the throat or smallest part of the converging and diverging piece.—*Mechanical Engineer.*

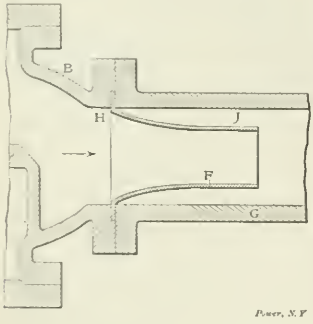


FIG. 5

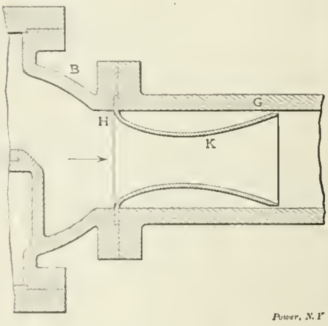


FIG. 6

## Transverse Current Gas Engine Feed Water Heater

Illustrated herewith is the transverse-current water heater manufactured by the Riblet Heater Company, of Erie, Penn. The heater complete is shown in Fig. 1. Fig. 2 shows the front and back circulating plates removed, exposing the water passages. The heater is intended to heat water from either the exhaust of a steam or gas engine, and is designed to save all the heat from both the jacket water and exhaust and make it available for heating water for whatever purpose desired in the factory, hotel, office building or laundry.

This feed-water heater is made entirely of cast iron. It has no tubes to collect scale, no internal joints to leak, no floats or valves to require attention, and the water does not come in contact with the exhaust. As the water passages are always accessible by removing the circulation plates (see Fig. 2), they can be easily cleaned of any sediment that an occasional flushing out fails to remove.

The construction of the heater consists of a series of flat rectangular passages f sufficient number to give the requi l heating surface, the exhaust and wa r passages alternating and extending tra- versely to each other, but with their w s integral, and the whole cast in a s d

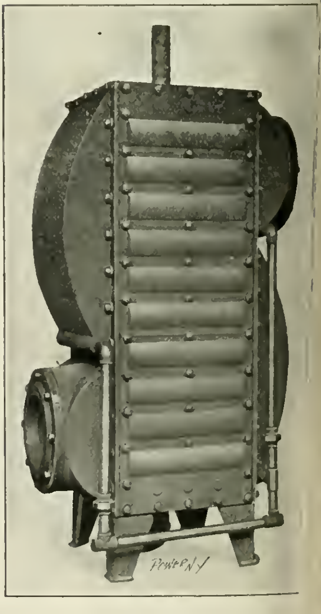


FIG. 1. RIBLET TRANSVERSE CURRENT FE WATER HEATER

section. To this section are bolted the circulation plates which direct the course of the exhaust and water through their respective passages. The exhaust enters the heater at the bottom, passes through a sufficient number of ports at one time to avoid any back pressure on the engine, and goes back and forth through the heater from three to five times before reaching the exhaust outlet at the top.

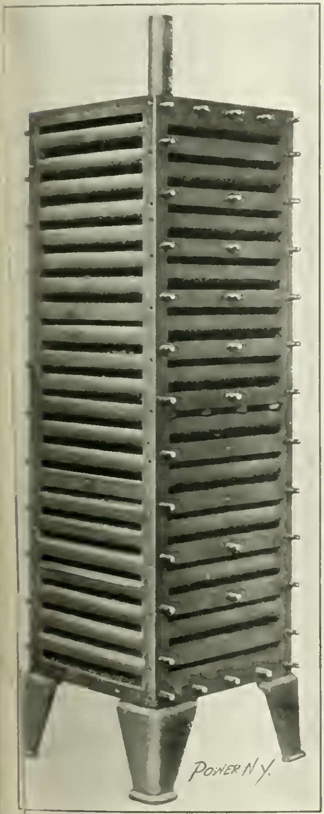


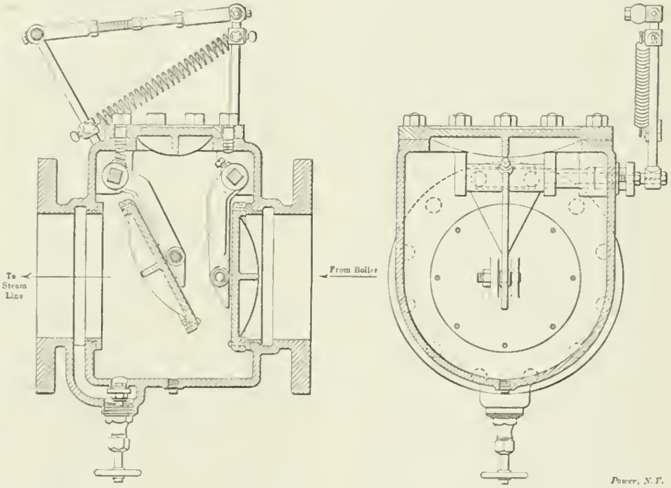
FIG. 2. INTERIOR OF RIBLET HEATER

The water enters the heater at the top, goes through only one passage at a time, traveling downwardly in a transverse and reverse direction to that of the exhaust, and in this way the hottest water just as it leaves the heater at the bottom passes through the section heated by the hottest exhaust. When more convenient for installing, this order can be reversed without interfering in any way with the circulation. The entire heating surface is made effective, and as the water is constantly agitated the maximum amount of heat is absorbed.

## Erwood Reversible Nonreturn Valve

This valve is made of crucible steel for pressures up to 300 pounds, and has ample facilities for removing the valve disks for inspection and repair. Used as a nonreturn boiler stop valve it protects the steam line from the loss of steam in case anything happens to the boiler and automatically shuts off connections with the steam line in case of failure to the piping, thus being automatic in both directions. The valve is always shut against the boiler and cuts the boiler in and out of service when the steam is raised or lowered. It can also be used on any water or gas pipe where the volume passing the pipe line requires controlling, or where the pipe line is exposed to possible breakage. Its operation is governed by velocity and not pressure, any excess velocity over that for which the valve is set causing it to close. Varying the spring tension varies the velocity necessary to operate.

Another point is that when pressures are equalized the valve automatically opens, and is provided with a globe-valve bypass made into the body of the valve for equalizing pressure when starting. By adjusting the length of the link the amount of opening may be controlled, this depending on the pressure carried and consequent density of the steam, and as all connecting mechanism is outside of the valve, it may be adjusted while in service. The arms, visible at a distance, afford an easy means of indicating whether the valve is open or closed and what volume of steam is passing. By suitable cord connections it can be operated by hand, or can be arranged for electric control if desired. As it has no pistons nor dashpots and is not affected by gravity, it will work equally well on vertical or horizontal pipe. This valve is handled exclusively by the Triumph Engineering and Supply Company, 253 La Salle street, Chicago, Ill.



ERWOOD REVERSIBLE NONRETURN VALVE

## A Marine Turbine Gear

Rear Admiral George W. Melville, formerly chief engineer of the United States Navy, has designed a marine-turbine gear for the purpose of reducing the necessarily high rotative speed of the efficient turbine to the relatively low speed to which the screw propeller is best adapted.

Essentially, the gear consists of a floating frame supporting two spiral gears of different diameters, the smaller of which is connected to the turbine shaft, and the larger to the propeller shaft, giving the speed reduction for which it may be designed.

There has been built under the personal supervision of Admiral Melville at the shops of the Westinghouse Machine Company an experimental gear, with pinions of steel of a tensile strength of 90,000 pounds per square inch, which it is expected will transmit 6000 horsepower. These gears are 22-inch face and 14 and 70 inches pitch diameter and will be exhaustively tested by means of a water brake, the results of which tests it is expected will furnish data for the correct design of gears for all possible conditions of marine service. The device has been patented in the United States, and in all foreign countries where patents are granted, by Admiral Melville and his partner, John H. Macalpine, consulting engineers and naval architects.

## I. U. S. E. No. 379 Has Housewarming

Local No. 379, International Union of Steam Engineers, of Brooklyn, N. Y., celebrated the opening of its new meeting rooms on Myrtle avenue Thursday evening, September 2. After a short business meeting, the doors were opened for the reception to friends. President Robert Wilson welcomed the guests and introduced Thomas Keenan, a member, who spoke interestingly concerning the organization. An entertainment by the New York "Bunch" was greatly appreciated. There were refreshments. The officers of No. 379 are: Robert Wilson, president; G. F. Milne, vice-president; S. J. Hickey, recording secretary; C. J. Pritchard, financial secretary; E. J. Sullivan, corresponding secretary; J. W. Cleary, treasurer.

On Friday, September 17, there will be held examinations for the positions of "teacher of electrical construction" and "teacher of mechanical drawing and foundry work," in the day and night high schools of Chicago. Application blanks and particulars may be obtained at the examination department, Board of Education, room 829 Tribune building, Chicago. Telephone: Central 3981.

United States Chief Forester Gifford Pinchot, in an address before the City Club, Los Angeles, Cal., September 4, said: "There is a big fight coming up in the next Congress and it will be on the question of water-power rights. The men who control water power in the end, unless the Government controls them, will control industry."

At a complimentary dinner tendered to Thomas A. Edison by the General Electric Company, at Poughkeepsie, N. Y., September 2, there were present Mr. and Mrs. Edison and three children.

## Business Items

The Edge Moor Iron Company, of Edge Moor, Del., has just built sixteen 625-horsepower water-tube boilers for the Metropolitan Electric Company, Reading, Penn.

The Parker Boiler Company, of Philadelphia, recently received the following orders: Eberhard Faber, Brooklyn, N. Y., two 289-horsepower boilers; Colorado Fuel and Iron Company, Segundo, Colo., one 265-horsepower boiler.

The Crocker-Wheeler Company, manufacturers and electrical engineers, of Ampere, N. J., announce that they will open an office in the Ford building, Detroit, Mich., on or about September 10. Charles W. Cross will be the manager of this branch.

The Curtis & Curtis Company, of Bridgeport, Conn., manufacturer of the Forbes patent die stock, reports a decided improvement in business and is running its plant at full capacity in all departments. This company also reports recent sales of two of the largest machines of its manufacture, range from 4 to 15 inches, to the Davis Coal and Coke Company, Thomas, W. Va., and the Atlantic City Electric Company, Atlantic City, N. J., also large orders were received for export.

The Western Electric Company reports a very prosperous business for this year. The greatest gains in sales have been in the Middle West, and the Pacific Coast shows the next greatest improvement. On the basis of the first seven months' returns of this year the sales are running at the rate of about $46,000,000 per annum. The returns for June were 35 per cent. larger than for June one year ago. One of the branches of the business which shows good gains is power apparatus.

Work has been begun upon a new plant for the Frank Mossberg Company at Attleboro, Mass. There will be a main factory building 290x60 feet and two stories high, and a one-story power-plant building, 150x60 feet, which will also contain departments for hardening, forging, brazing, japanning, lacquering, polishing, grinding, nickel, copper and brass plating. The plant, which will cost $50,000, will be located on the tracks of the N. Y., N. H. & H. R. R. It will be ready for occupancy by the first of the year and will employ 250 hands. The chief productions of the company are Mossberg wrenches and metal spools and reels; and the rapidly increasing business makes a larger factory a necessity.

Economizers utilizing the waste heat in chimney flue gases and other furnaces have long been used for pre heating boiler-feed water and for heating water for industrial purposes. Recently a similar appliance for heating air to be used for drying purposes for heating buildings or for the supply of furnaces has been brought out by the Green Fuel Economizer Company, of Matteawan, N. Y. This apparatus is fully illustrated and described in a 16 page pamphlet entitled, "The Green Patent Waste Heat Air Heater," which this company is now distributing. It is pointed out that as compared with the use of live steam for heating air, the waste heat air heater performs the functions of both boiler and heating coil. That is, it transfers the heat directly from the gases of combustion to the air to be heated. Therefore, assuming the same temperatures of hot gases and air one square foot of heating surface in the air heater does the work of one square foot of boiler surface plus one square foot of heating coil surface. Moreover, by a special new device described in this pamphlet, it has been possible to increase the rate of heat transmission by about 1/2, making this apparatus much more efficient than the ordinary hot-blast stove, to which it is also superior because of the provision of automatic scrapers because of the the tubes free of soot. It is stated that it is frequently possible to heat the air to temperatures above 600 degrees Fahrenheit by the use of heat that would otherwise be wasted, thus effecting great economies in fuel as well as in cost of plant, as above pointed out. The Green Fuel Economizer Company will supply copies of this bulletin to interested persons upon request.

## Help Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

WANTED—Chief draftsman or engineer for engine works. Address "Corliss," Box 3, POWER.

WANTED—Good mechanical designers and detail draftsmen for machinery manufacturer located in Wisconsin. Box 98, POWER.

WANTED—Thoroughly competent steam specialty salesman: one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

AGENTS WANTED to sell Burgmann celebrated engine packings in territories not yet covered. See our advertisement on page 86.

EXPERIENCED ENGINEER wanted to introduce first-class steam turbines, rotary air compressors and high lift centrifugal pumps to important firms. Offers to be sent to Box 300, POWER.

WANTED—Feed water heater designer and draftsman. One who has had experience in designing successful open-type cast iron heaters. Advise age, experience, education and compensation desired. Box 97, POWER.

WANTED—An engineer experienced in design and application of electric controllin devices for industrial installations. Must thor oughly understand latest commercial system and apparatus. No application will be give consideration except from engineers of estab lished reputation and experience. In reply give references, experience and salary expected Box 8, POWER.

A COMPANY in Dallas, Texas, operatin a good foundry and machine shop wishing t engage in manufacture of gas and gasolen engines, gas producers and possibly automobile desire to procure the service of a thoroug competent, reliable and experienced ma capable of designing and manufacturing th line successfully. A fine opportunity for t right man. Address W. S. Myers, Dalla Texas, care Olive & Myers Mfg. Co.

## Situations Wanted

*Advertisements under this head are insert for 25 cents per line. About six words ma a line.*

WANTED—Position as engineer in elect or manufacturing plant. Experienced w Corliss and automatic engines, fire and wat tube boilers. Box 12, POWER.

DESIGNER AND CHECKER, at prese employed, technical graduate, specialty: cent fugal and reciprocating pumps and pump engines, wishes other position. Box 15, Pow

ASSOCIATE MEMBER A. S. M. E., cons ing engineer, having completed recent inve gation and report leading to important econo of fuel in large factory plant, is open for simi engagement. Eight years of practice in red ing the power and heating expense in factor Box 13, POWER.

AN EXECUTIVE POSITION by a tec cal publicist with engineering education training, reputation and good address. perience includes responsible positions in of the large electrical manufacturing compa and the U. S. geological survey, and independ work. Box 16, POWER.

FIRST-CLASS ENGINEER, young man present having charge of a.c. plant, equip with both Corliss and automatic engines, de change. Experienced with a.c. and d.c. erators, all kinds of engines, boilers, air c pressors, pumps, indicator tests, etc., I. C. S. g uate. First-class references covering six y experience as engineer in large plants. gineer," 398 Main Street, Oneonta, N. Y.

POSITION WANTED the year round assistant engineer in 50 or 75-ton ice-ma plant. Fifteen years' experience as engine charge of ice-making plants. Graduate of M. E. R. E. courses of I. C. S. Have charge at pr of 15-ton compression machine. Am employed by the year and desire a ch Can come immediately. Age 30; ma Box 14, POWER.

## Miscellaneous

*Advertisements under this head are in for 25 cents per line. About six words a line.*

PATENTS secured. C. L. Parker, Sol of Patents, 4 McGill Bldg., Washington, D.

WANTED—About a 200-horsepower in furnace boiler for 160 pounds steam pre Address, The Cedar Point Resort Co., Sand O.

ANY FIRM or engineer in charge of a plant that is troubled with scale in the can get absolutely free, the best indicato reducing wheel made, with velvet-lined mah case. For particulars address Great Chemical Works, Manitowoc, Wis.

WANTED—One direct-connected 250 or three wire current generating outfit of 200 to 300 kilowatt capacity. Address Cedar Point Resort Co., Sandusky, O.

## For Sale

*Advertisements under this head are i for 25 cents per line. About six words a line.*

150 HORSEPOWER tandem compoun liss engine in good order; 16-foot wheel; face. F. W. Iredell, 11 Broadway, New

FOR SALE—20x48 Wheelock engin two 72"x18' high pressure tubular boi good condition cheap. Address "En Box 2, Station A, Cincinnati, Ohio.

FOR SALE—250-horsepower Lane & Corliss engine, 18x42 cylinder; engine to for our work and will be replaced soc

# Materials for Pipe Lines

## Piping, Fittings and Valves Used in Power House Installations; a Discussion of the Most Suitable Material for Each Purpose

### BY WILLIAM D. ENNIS

Until the advent of comparatively high steam pressures, pipe lines were put together with wrought-iron pipe, cast iron fittings and screwed joints. The valves were iron body, of the globe or gate type, with babbitt or bronze seats. "Making-up" joints were unions or flange unions; the gaskets in the latter being of rubber or similar composition.

### PIPES

Probably most of the piping of the present day conforms approximately to these specifications. Such modifications as exist arise from the nature of the fluid conveyed and its pressure and temperature. What is known as "wrought" or "welded" pipe is still in common use, although brass, copper, cast-iron and block-tin pipes are used for special purposes, as well as various built-up pipes. What is usually called "wrought iron" pipe is mild steel; very little genuine wrought iron being used. Wrought pipe is graded as "merchant," "full weight" or "standard," "extra-strong" and "double extra-strong." The thicknesses and weights increase progressively and are tabulated in most fitters catalogs. "Merchant" pipe may vary as much as 8 per cent. from the standard thickness for "full-weight" pipe. The variation in weight, with the other grades, should not exceed 3 per cent. from their respective standards.

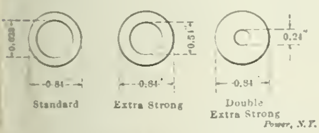


FIG. 1. WROUGHT-IRON ONE-HALF-INCH PIPE

Pipes up to 12 inches in size are designated by the nominal inside diameters; those above 12 inches are specified by their actual outside diameters. There is no established grading for these larger pipes. For ordinary service, they are made ⅜ inch thick; for heavy service, the 14- and [illegible]-inch sizes are 9/16 inch thick; the 16-, [illegible] 20- and 22-inch are ⅝ inch thick; the 24-inch pipe is 11/16 inch thick. All pipes larger than 12 inches, and all sizes of extra-strong and double extra-strong pipe, are furnished, unless otherwise ordered, with plain ends, without threads or couplings. Smaller sizes of merchant or full-weight pipe are threaded and coupled. All pipe larger than 1¼-inch is lap welded. The changes in thickness and weight of the various grades are made by varying the inside diameter only. The outside diameter remains constant, so that any grade of pipe may be threaded into any grade of fitting, flange, coupling or valve. (See Fig. 1.)

For low steam pressures, most oil and gas lines, and for minor purposes generally, merchant pipe is suitable. For compressed air lines and steam lines carrying not over 100 pounds pressure, the full-weight pipe should be employed. For high pressure steam lines having threaded or riveted joints, extra-strong pipe should be used, but if a flared-over flange (Fig. 2) or a welded flange is adopted, the full weight pipe is entirely satisfactory at all reasonable pressures. Wrought pipe should never be used for either hot or cold water. Pipes connecting directly to boilers or located at other points where there is risk of corrosion or extreme strain should be always extra strong. Where there is dampness on the outside of such lines wrought pipe should not be used. The double extra-strong pipe is used on hydraulic lines carrying up to 4000 pounds pressure. Above this pressure, seamless-drawn tubing should be employed. In some cases, the use of seamless tubes is preferable even at much lower pressures. No wrought pipe should ever be buried in the soil. No pipe lighter than "full-weight" should ever be used for bent work. Specially soft material is necessary in pipe for this purpose or for flared-over joints.

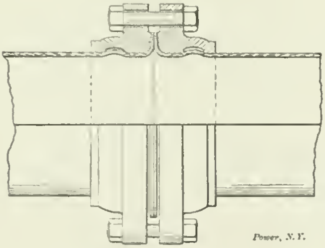


FIG. 2. FLARED-OVER PIPE JOINT

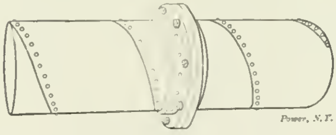


FIG. 3. GALVANIZED SPIRAL-RIVETED PIPE

"Galvanized-iron" pipe is ordinary wrought pipe having received a galvanizing coating. The grades are the same as those for wrought pipe, although the double extra-strong is seldom made. Galvanized pipe may be used for cold water on lines of comparatively small size. The merchant or full-weight grade is sufficiently heavy for most purposes. When used on boiler-blowoff lines, the extra-strong grade is specified.

Brass pipe for important work should be of "iron-pipe size," not the thin tubing used for hand rails and ornamentation. It should be threaded to the wrought-iron pipe standard. It is used for small lines carrying hot water at all usual pressures.

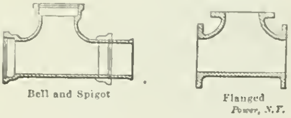


FIG. 4. TWO STYLES OF CAST-IRON PIPE ENDS

Galvanized spiral-riveted pipe (Fig. 3) is riveted up of thin sheets of galvanized iron, with galvanized rivets forming a helical seam. The gage of metal to be employed should be specified for each diameter used. It is commonly employed for exhaust lines, beyond the back-pressure or automatic relief valve. Table 1 gives the commercial gages and weights. The "standard gage" is the one used for the purposes mentioned.

Cast-iron pipe is made in a great variety of thicknesses and weights.* The various manufacturers tabulate the grades for various pressures or heads. "Full-weight" or "standard-weight" cast-iron pipe should be understood as the grade ordinarily adopted for 230-foot head. "Extra-heavy" or "extra-strong" cast-iron pipe should conform to standard dimensions for 250 pounds pressure. Both grades are listed in Table 2. Cast-iron pipe is seldom used for steam work. It is suitable for cold water in the lines of comparatively large size—4-inch and above—and is often used for hot water, in these sizes, on account of the high cost of brass pipe. The standard weight is suitable for working pressures not exceeding 75 pounds, and the extra-strong for the higher pressures, including boiler-blow-off lines.

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*The ordinary "bell-and-spigot" lead calked, cast iron pipe is used ordinarily for underground water pipes only. In power-plant work, flanged-end pipe is used. Fig. 4 shows both forms.

Copper pipe may be seamless drawn (up to 8 inches diameter), or may be brazed up from sheets. It is less used than formerly, since the ductility and flexibility of copper are found to be impaired by high temperature. It is still generally employed in marine work on account of the sharp bends which may be made. There are few stationary applications in which copper is now used. Block-tin pipes are employed to convey liquids subject to contamination, like milk.

TABLE 1.* USUAL WEIGHTS OF SPIRAL-RIVETED GALVANIZED PIPE.

| Diameter, Inch. | Standard Gage. | Approximate Weight per Foot (full lengths, including flanges).* | Extra-Heavy Gage.* | Double Extra-Heavy Gage.* |
|---|---|---|---|---|
| 3 | 20 | 2.25 | 18 | . |
| 4 | 20 | 3.00 | 18 | 16 |
| 5 | 20 | 4.00 | 18 | 16 |
| 6 | 18 | 5.00 | 16 | 14 |
| 7 | 18 | 6.00 | 16 | 14 |
| 8 | 18 | 7.00 | 16 | 14 |
| 9 | 18 | 8.00 | 16 | 14 |
| 10 | 16 | 11.00 | 14 | 12 |
| 11 | 16 | 12.00 | 14 | 12 |
| 12 | 16 | 14.00 | 14 | 12 |
| 13 | 16–14† | 15.00 | 14 | 12 |
| 14 | 14 | 20.00 | 12 | 10 |
| 15 | 14 | 22.00 | 12 | 10 |
| 16 | 14 | 24.00 | 12 | 10 |
| 18 | 14 | 29.00 | 12 | 10 |
| 20 | 14 | 34.00 | 12 | 10 |
| 22 | 12 | 40.00 | 10 | 8 |
| 24 | 12 | 50.00 | 10 | 8 |
| 26 | 12 | 58.00 | 10 | 8 |
| 28 | 10 | 72.00 | 8 | 6 |
| 30 | 10 | 79.00 | 8 | 6 |
| 32 | 10 | 85.00 | 8 | 6 |
| 36 | 10 | 94.00 | 8 | 6 |
| 40 | 10 | 106.00 | 8 | 6 |

*American Spiral Pipe Works.
†Abendroth & Root Manufacturing Company.

TABLE 2. WEIGHTS AND DIMENSIONS OF CAST-IRON PIPE.

| Pipe Size, Inches. | Class (I) 230-ft. Head.* | | Class (C) 250-lb. Pressure.† | |
|---|---|---|---|---|
| | Thickness. | Weight per Foot. | Thickness. | Weight per Length (12 ft.). |
| 3 | 0.43 | 14.5 | 0.36 | ..... |
| 4 | 0.46 | 20.1 | 0.36 | 215 |
| 5 | 0.49 | 26.4 | .... | ..... |
| 6 | 0.52 | 33.3 | 0.42 | 350 |
| 7 | 0.56 | 41.5 | .... | ..... |
| 8 | 0.59 | 49.7 | 0.48 | 530 |
| 9 | 0.62 | 58.5 | .... | ..... |
| 10 | 0.65 | 67.9 | 0.53 | 720 |
| 12 | 0.71 | 88.5 | 0.57 | 910 |
| 14 | 0.77 | 111.5 | 0.61 | 1,150 |
| 15 | 0.80 | 123.9 | .... | ..... |
| 16 | 0.84 | 138.7 | 0.65 | 1,390 |
| 18 | 0.90 | 166.7 | 0.69 | 1,660 |
| 20 | 0.96 | 197.3 | 0.72 | 1,920 |
| 22 | 1.02 | 230.2 | —. | ..... |
| 24 | 1.08 | 265.5 | 0.80 | 2,550 |
| 30 | 1.28 | 392.5 | 0.91 | 3,600 |
| 36 | 1.46 | 536.1 | 1.02 | 4,840 |
| 40 | 1.59 | 648.2 | .... | ..... |
| 42 | 1.65 | 705.9 | 1.13 | 6,270 |
| 48 | 1.84 | 898.9 | 1.25 | 7,920 |

*R. D. Wood & Co.
†New England Water Works Association. This list was adopted for bell-and-spigot ends, but it is satisfactory for flanged pipe as well.

### Pipe Fittings

Pipe fittings are made of cast iron, malleable iron, cast steel, brass or forged steel. They are graded as "light-weight," "standard-weight," "medium-heavy," "extra-heavy" and "special." The first, third and fifth of these grades are not made by many manufacturers. Fittings are also classed as "standard" and "long-turn," according to the radius of curvature. (See Fig. 5.) Galvanized cast-iron fittings are of course obtainable. Special grades of cast iron, known as "gun iron" or "semi-steel," are sometimes used.

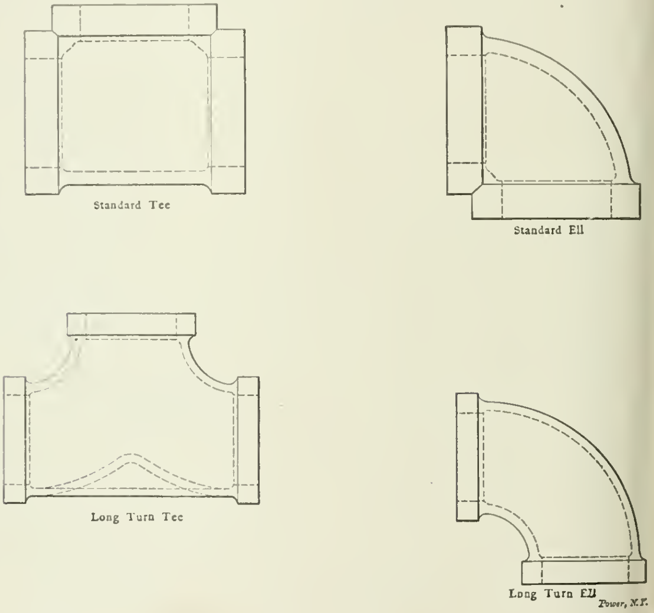

FIG. 5. STANDARD AND LONG-TURN FITTINGS

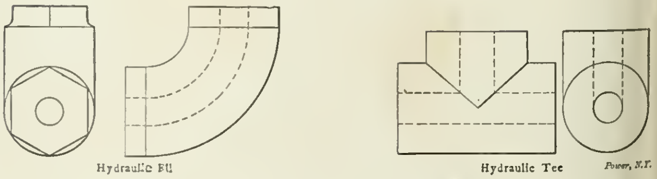

FIG. 6. HIGH-PRESSURE FORGED FITTINGS

Comparing soft steel, wrought iron, malleable iron and cast iron with one another, we find the percentage of metallic iron to decrease steadily, and the proportions of silicon, phosphorus, sulphur and manganese to increase. Soft steel and wrought iron contain very little carbon, while malleable iron or cast iron contains usually over 3 per cent. This exists in two forms; (1) in chemical combination, and (2) by itself, or as "graphite" carbon. The combined carbon in malleable iron is very low. "Semi-steel" is made of a mixture of about 60 per cent. cast iron and 40 per cent. steel scrap. This gives a homogeneous casting, with a tensile strength of above 30,000 pounds. Gun iron is cast iron running low in silicon and phosphorus, and having comparatively less of its carbon in the graphite state than has ordinary iron. This gives a strong close-grained iron with a tensile strength easily above 30,000 pounds. Both gun iron and semi-steel have been quite widely used for high pressures and superheat, but without general satisfaction.*

Malleable-iron fittings have been popula for small work, but are now being introduced in sizes up to 12 inches. Malleabl iron is softer and less brittle than cas iron, and stands a transverse strain muc better. The bursting strength of malleabl iron fittings is much higher than that those made of cast iron. Tests have show that the usual factor of safety in mall able-fitting installations, pressure alo considered, is often 20 to 30 or even more. Fittings seldom fail, however, because of the internal pressure applied; and they need to be amply strong to withstand the uncertain and enormous strains due to vibration, expansion, etc.

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*While cast iron is ordinarily unaffect by temperatures below 1300 degrees Fahre heit, the rapid fluctuations of temperatu and the action of liquid particles appear lead to its deterioration in service on sup heated steam.

For high steam pressures and superheat, fittings (including flanges) should be of sound, annealed cast steel, extra-heavy, long-turn. For high pressures without superheat, gun-iron or semi-steel, extra-heavy, long-turn fittings should be employed. For pressures of from 50 to 125 pounds, extra-heavy long-turn cast-iron is suitable. Standard-weight cast iron may be used on low-pressure steam lines, and on air lines. The long-turn fitting is to be preferred in these cases. Cast-iron tandard-weight long-turn fittings should e employed for cold water at pressures elow 75 pounds, and extra-heavy fittings f the same class for higher pressures. n the smaller "screwed-joint" sizes, galanized-iron fittings may be adopted for old water. For hot water, the smaller-ized fittings should be long-turn brass, nd the larger may be long-turn cast iron. tandard-weight material will answer for ressures below 75 pounds. Boiler-blow-ff lines should have extra-heavy long-rn cast-iron or galvanized-iron fittings.

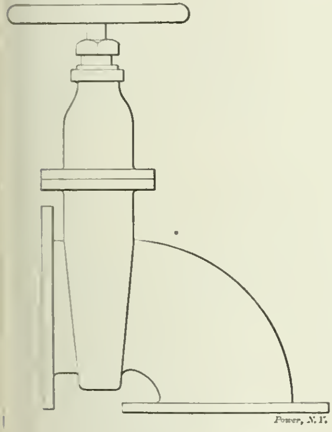
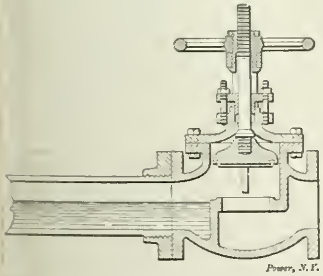


FIG. 7. ANGLE GATE VALVE



IG. 8. GLOBE VALVE; SHOWING LODGMENT OF WATER IN PIPE

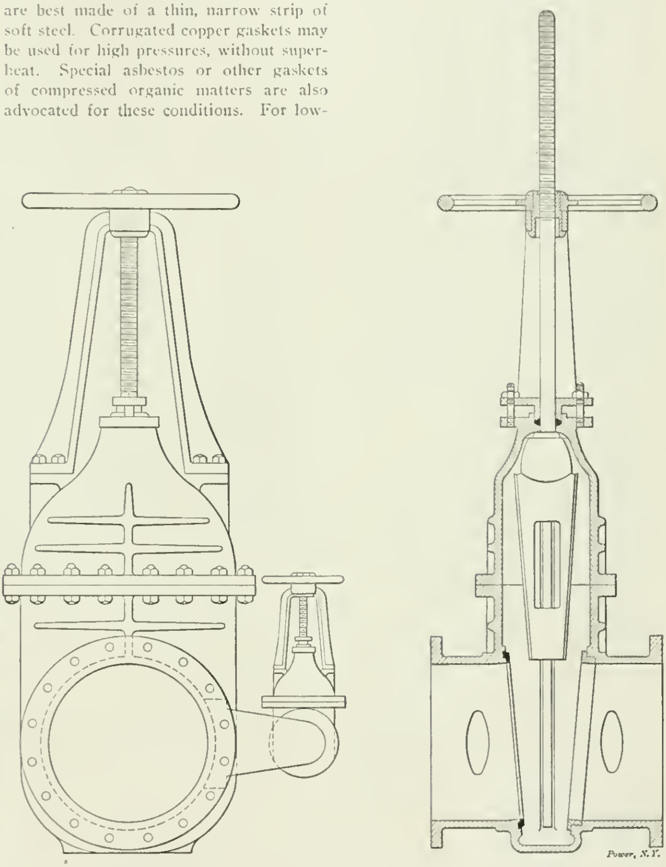


FIG. 9. OUTSIDE-SCREW AND YOKE WEDGE GATE VALVE, WITH BYPASS

The best fitting for high-pressure hydraulic work is one made of a solid steel forging. The larger sizes may be made of sound, annealed cast steel. The weights should be special, to suit the pressure carried. Forged fittings are regularly made in the smaller sizes, for pressures up to 5000 pounds (Fig. 6). "Light-weight" fittings are to be used, if at all, only on free-exhaust lines. The "medium-heavy" fittings cost very little less than "extra-heavy."

Gaskets for high-temperature pipe lines are best made of a thin, narrow strip of soft steel. Corrugated copper gaskets may be used for high pressures, without superheat. Special asbestos or other gaskets of compressed organic matters are also advocated for these conditions. For low-pressure steam, rubber-composition gaskets are satisfactory. There are very few gaskets that give satisfaction on air lines. Most of these are patented or proprietary compositions. Some form of rubber is generally used for cold water, but the corrugated-copper gasket is best if the pressure is high: and should always be used for hot water. For high-pressure hydraulic lines the ground joint is sometimes the only satisfactory joint; but leather or fiber gaskets or very narrow soft-metal gaskets are often used.

### VALVES

Valves may be of the globe or gate type, the globe occurring in both the straight and angle forms. (Angle gate valves are sometimes made; the gate is the same as an ordinary gate, but the body is a combined valve body and elbow, as in Fig. 7). The gate valve gives an ample straight passage, with little friction; the globe valve is more readily kept tight. The gate valve can generally be placed in any location; the globe valve must be located to suit the general piping system. The globe valve is seldom used on water piping. The effect of locating a globe valve on a horizontal steam pipe is indicated in Fig. 8. Gate valves are made in two styles: With the double flat gate having a wedge between (Fig. 11) and with a double-faced wedge gate (Figs. 9 and 10). The latter type is more generally used in power plants. Valve bodies are usually of bronze or of some grade of cast iron or steel. From the standpoint of cost, bronze valves are usually applicable only in small sizes. Globe valves are made with either screwed (Fig. 12) or yoke (Fig. 13) tops; the latter being found usually only in the larger sizes. Gate valves are made either with an "inside screw," the gate rising on the screw inside the body; as in Fig. 10, or with "outside screw and yoke," in which the gate rises *with* the screw, and the screw itself threads through a nut at the top of the yoke. The yoke type of valve is more expensive, but is better (see Fig. 9). A glance will indicate whether a valve of this type is open or closed; and there is no danger of wearing out an inside thread and thus rendering the valve inoperative at some critical moment. Valves are made of various weights, corresponding with those of fittings. There are only two standards for flange drilling, however.

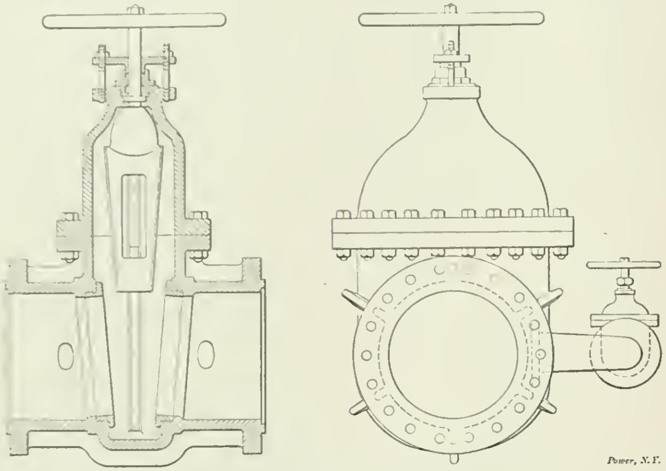

Power, N.Y.

FIG. 10. INSIDE-SCREW WEDGE GATE VALVE, WITH BYPASS

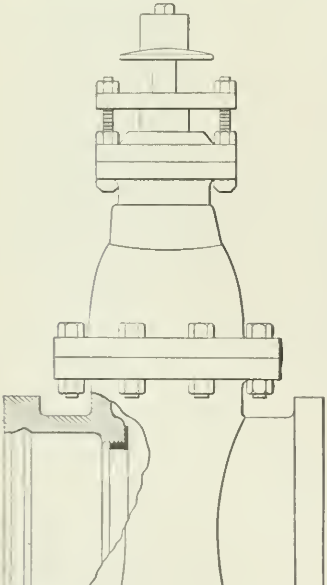

Power, N.Y.

FIG. 11. DOUBLE GATE VALVE

For superheated steam, gate valves give much trouble. All valves on this class of work should have bodies of bronze or of sound, annealed cast steel, extra-heavy, ribbed, with bypasses if larger than 5-inch. Soft-steel seats give good service; spindles and seats of nickel steel, nickel and manganese bronze are also used.

For ordinary high pressures, bronze or extra-heavy ribbed-body cast-iron valves, with bronze spindles and seats, and in other respects like those used for superheat, are satisfactory.

For medium pressures (50 to 125 pounds), the ribbing may be omitted, and bypasses are unnecessary in sizes below 8-inch. For low-pressure steam lines, or compressed-air lines, valves will have cast-iron or bronze bodies, bronze spindles and seats, and will be of medium or extra-heavy grade. Bypasses are usually necessary on sizes above 8-inch.

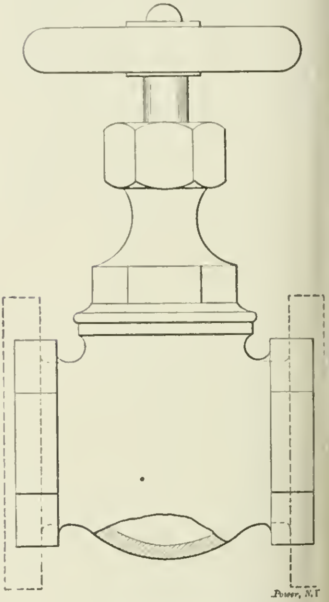

Power, N.Y

FIG. 12. SCREW-TOP GLOBE VALVE

For cold water at low pressure, valves should be standard-weight cast-iron or bronze, with bronze spindles and bab seats. Sizes above 10-inch usually h bypasses. High-pressure cold water quires extra-heavy bodies and bypa down to about 6-inch size. For hot wa

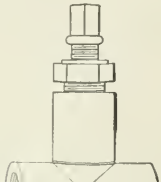

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FIG. 14. HYDRAULIC STOP VALVE

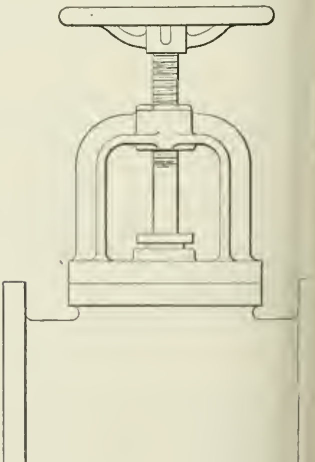
Power,

FIG. 13. YOKE-TOP GLOBE VALVE

dinary standard-weight valves of the same description will be used. Bypasses are seldom necessary in sizes below 12-inch, for such service. A "medium-weight" valve is sometimes used on vacuum lines on account of its greater stiffness. For ıe preceding specifications apply, exceptıg that bronze seats are commonly used. For boiler-blowoff connections, ordinary lobe or gate valves are seldom employed. ome good specially designed blowoff alve should be installed, or in lieu thereof, the asbestos-packed cock. Valves for ydraulic work are always special and satisfactory valves are obtainable from a very w manufacturers only. One form of ydraulic valve is shown in Fig. 14.

## Erecting an Engine

By F. Wiegand

With the engine bed leveled and the ft and crosshead in position, the cyller may be put in place. First clean the e of the cylinder and bed carefully, ntersink the stud holes in the bed to

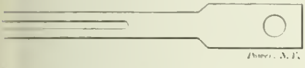

FIG. 1

ove any burs that may rise around studs, make sure that the studs are eaded far enough to clamp tightly and sure the bore of the bed and boss of cylinder carefully, as it sometimes pens that they fit too tightly and pret the cylinder from pulling up face e The cylinder can now be put in , leveled and pulled up tightly by g over the studs two or three times.

After removing the cylinder head and n a line can be stretched through center of the engine. A good thin ng line, preferably silk, is about the material for this purpose. Measure thickness by making eight or ten close on a pencil. If, for instance, ten take 5/16-inch space on the pencil, single line will then be 1/32 inch in er, which is about the right thickn

ape a piece of wood as shown in 1, slip it over one of the head studs a lamp it tight with the nut. Provide a nk end support for the line outside crank disks and a trifle below the rline of the shaft by clamping any le rigging on the main-bearing tion or by raising a stand from the Remove the crosshead pin, or the crosshead if the pin is stationary, a turn the crank pin below the centerli Tie a flat peg to the end of the line gage the slot of the head-end supp n the line to the crank end, pull al he line can stand and holding it near the center of the crank pin make several ns around the crank-end support, which should be round. Then secure the line by tying or weighting it.

ake two tram sticks, one for the guide ar one for the cylinder, 1/64 inch shorter than the radius of each to allow for one-half the thickness of the line. Shape a piece of wood to pencil size and drive a pin into each end. Set the line about center at the head end by using the cylinder tram stick and about central to the crank pin and disk at the crank end, and then begin to set it carefully to the guide, shifting the peg at the head end, raising the line at the crank end by shoving papers or a slant piece of wood under it and shifting the first turn sideways until the line is central and exactly parallel to the bore of the guide. Always take hold of the tram stick near the bore so that the slightest touch on the line may be felt. Never allow the pin to strike the line full, but drive in the pin until it just barely touches and an accurate job will be possible. Where the bore of the guide is a little larger at the crank end, it is necessary to make two tram sticks of slightly different lengths, or to use paper under the tram stick at the larger end.

Now take the cylinder tram stick and find out if the line is central and, above all, parallel to the cylinder walls. In most cases it is not. This seems strange at the first glance. A bed is placed on the boring-mill table, squared up to the housing of the main bearing, clamped down securely, and the guide, cylinder seat and counterbore machined in one setting. The cylinder is bored and faced in the same manner, and still when both are bolted together the cylinder is out of parallel nine cases in ten and often out of center. To rely on machine work alone for alinement is therefore a risky proposition, and a careful builder will not take such chances. A good machine tool, when carefully operated, might turn out a number of true beds or cylinders in succession, but to rely on such performance for hundreds of pieces is unsafe. Besides some bolt may become loose and if it is not noticed something will be out of line. If it is pulled up hard at the time it might produce an equally bad effect the other way. When such deviations are not noticed on the erecting floor, they will tend to cause no end of trouble and expense to all concerned.

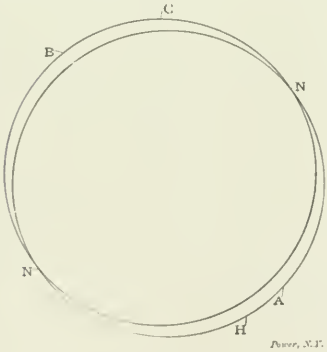

FIG. 2

To get a cylinder parallel to the guide is comparatively easy and inexpensive. In Fig. 2 let circle C represent the position of the cylinder bore close to the bed and circle H its position at the head end, which is, for example, 0.018 inch, or six thicknesses of writing paper low, and 0.012 inch, or four papers out to the right, when measured to the line at the head-end counterbore. Now find two points in the same circle which are equidistant from the line, viz., the points N, N, and at right angles to these are the points A, B of greater deviation from the line. From these points make two straight chalk lines from the head- to crank-end counterbore inside of the cylinder and outside on the crank-end cylinder head (false head), and on the bed.

Now tram at the head end counterbore at A, and suppose it takes eight papers under the tram stick to touch the line and two papers at A on the crank-end counterbore the distance between the two counterbores is, say, 18 inches and the deviation from parallel six papers, one paper to every 3 inches, or 0.001 inch to the inch. The bed counterbore or cylinder seat are 15 inches in diameter, so that 0.015 inch has to be taken off the bed or the front cylinder head at B to make the cylinder parallel. An experienced man can go right ahead with this, but it is safer to make up the required thickness with liner sheets or brush copper. Loosen the cylinder and pack the sheet between the cylinder and bed at point A. After tightening up reset the line to the guide and try the cylinder again with the tram stick. It might take some changing and perhaps shifting of the packing to get the cylinder right to the line. When it is exactly parallel, mark the spot at which the packing was placed, take off the cylinder and mark the point diametrically opposite. Where a false head is used, it can be clamped to the table of a vertical boring mill in such a way that the tool will clear point B, or the point of packing, by 0.015 inch when it begins to cut at the marked point. The points N N should clear about 0.007 inch, and this can be measured with feeler blades, Fig. 3, which a builder, erecting man or engineer should have. A thin cut will then finish the job.

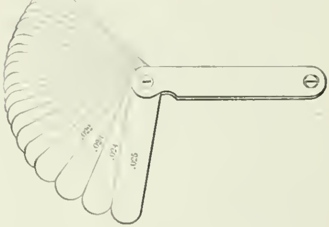

FIG. 3

If the bed has to be trued off, set a

depth gage or a combination square to the depth [illegible] at point A [illegible] enough so that the packing or the 0.015-inch blade of the [illegible] will clear under it. Make two [illegible] at X X on the 0.007 blade and work the whole surface down to [illegible] using a straight edge or suitable [illegible] to keep it straight. If the job has been done carefully the cylinder must [illegible] parallel when tried again.

If the cylinder should be off center, the amount and place should be noted so that the crosshead can be set or scraped accordingly. This should not amount to more than 1/64 inch and hardly ever will. The packing box has to be looked over while the line is in the cylinder, as the bottom of it must measure equally from the cylinder walls; that is, not central to the line under all circumstances, but central to the cylinder bore.

### Alinement of Crosshead

The blade of a large try-square should now be placed against the face of the crosshead hub, the inside edge of the butt running parallel to the line to see if the crosshead is in line horizontally. The bottom shoe will have to be scraped to suit the line, then the top shoe brought up and fitted accordingly. The line must also be trammed to the inside faces of the crosshead, as they must be parallel to it in order to avoid trouble when fitting the connecting rod. It is not a serious matter if the line is not more than 1/64 inch off center, but it should be noted and the wristpin brasses filed on the close side only when they are being fitted to bring the rod as central as possible.

### Alinement of Shaft

Next comes the alinement of the shaft. The object of this operation is to get the path of the crank pin parallel to the line. Some erecting men caliper the shaft parallel to the housing of the main bearing, or run a straight-edge across the cylinder seat of the bed or the head end of the cylinder and tram parallel to that, but they rely in both cases on the machine work, and that is not safe; in fact the erecting man has the duty of checking up that work. Turn the shaft until the crank pin, which should be under the line, is close to it at the crank end, and measure to the line from the crank-pin shoulder and washer. Keep the calipers set, turn under to the head end and note if the crank pin is in the same position relative to the line. It is not necessary for the line to pass exactly through the center of the pin. A deviation of 1/64 inch to the foot of connecting-rod length will not hurt, but the path of the pin must be parallel to the line.

The main bearings have to be scraped to throw the shaft at right angles to the line. This does not take much time with side-crank shafts, as only one bearing can be shifted to suit, but it is sometimes a hard job with center-crank shafts, as the distance from outside to outside of the bearings is considerably more than the throw of the crank. In doing this the proper bearing of the shaft on the lining must be watched, and after the shaft is in line the bearing should be perfect through the whole length and two-thirds of the circumference of each part. It is sometimes necessary to take out the bottom liner or quarter block to scrape it and allow for the changed position of the shaft, especially where the bottom quarter is not free to follow the take-up of the shaft. The cap piece in four-part bearings should be fitted to a good bearing, and after that the cap raised up from 0.004 to 0.006 inch to allow space for the oil. A cap pulled down without this clearance will cause the bearing to heat up.

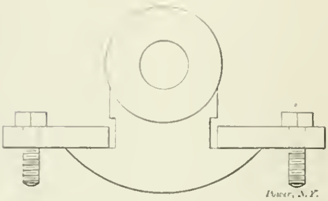

FIG. 4

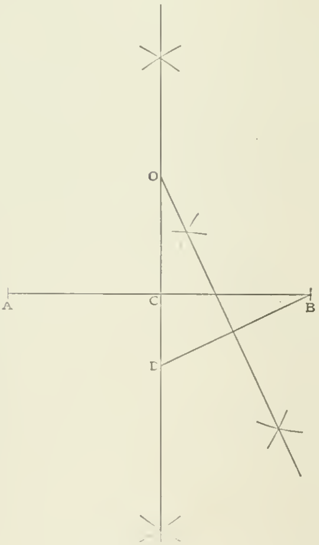

FIG. 5

It is necessary to determine how near the line passes to the center of the shaft, and any deviation over 1/16 inch should be corrected. If the center of the sha is below the line, it will increase the trav of the crank pin from center to cent on the upper stroke and decrease it accor ingly on the under stroke, the differen being about one-fourth of the amount th center is low. This is liable to crea trouble in setting the valves, besides ı creasing and reversing the pressure the guides, and perhaps decreasing t effective power of the engine.

After the bearings have been fitted snugly, the shaft should be turned ov one full revolution and the places not where it turns hard. A perfectly rou shaft will turn with even friction and creased friction at places is a sign th the shaft is out of round in its bearin The high points should be marked on take-up quarters and the shaft taken and calipered. If it is out more than 0. inch, or two tissue papers, it becomes n essary to have the shaft taken to a la and carefully skinned or ground ov Sometimes the hard turning is caused binding sideways, and it is well to exam carefully the disk and collar, for is one of the meanest features about engine to have the shaft cutting sidewa

With an adjustable guide or a reg locomotive guide the line can be set the cylinder and the guide adjusted that, but the position of the line rela to the shaft should be considered, a becomes advisable sometimes to ad both cylinder and guide to get the n suitable position of the line relative the shaft. A good surface gage takes place of the tram stick on a flat gu Another style of guide which offer problem of its own is the bored guide flat caps or bars, Fig. 4. It is neces to know the exact radius of the bor order to locate the line in the cente it. It is unsafe to center the crossl and the radius given by the drawin it is at hand, is not always strictly adh to. One way is to measure the width depth of the guide, in other words, chord and hight of the arc forming it use the geometrical formula to find radius.

Practical men as a rule do not like mulas, and they are not always ava on the spot. The following method therefore be used:

Draw line $A B$, Fig. 5, as long a exact width of the guide and erect a pendicular through its center. Mar the measured depth of the guide fr to $D$ and draw a perpendicular th the center of $B D$, which will cut the perpendicular at $O$, the center of the Distance $D O$ equals the radius and i inch more than the length of the stick. If the stick touches the line when tramming from points $A$ and is loose from point $D$, shorten it a If it touches $D$ hard and is loose fr and $B$, lengthen it until with the per setting of the line all three points uc alike.

# Sampling and Analyzing of Coal

## The Method Used by the United States Geological Survey Which Involves a Determination of Everything That Affects Heat Value

This subject, even although it is of a chemical nature, is of interest to mechanical engineers in general and to all those who have the responsibility of purchasing coal and of obtaining the best results from its use. During the last two years much has been written concerning the purchasing of coal on a heat-unit basis, in regard to fair and usable specifications for the purchase of coal on such a basis, and in regard to the actual results that have accompanied this procedure. However, but little has been presented in regard to the methods which must be employed properly to sample a carload, train-load or cargo of coal that has been purchased under such specification, and concerning the necessary steps to test these samples after they have been obtained, and get a representative analysis of the coal that has been delivered. It is purposed to present briefly the method used in sampling and testing by the technologic branch of the United States Geological Survey.

### The Sampling of Coal

As a preliminary to this question of sampling we quote below a section of a specification prepared by J. E. Woodwell, formerly of the Treasury Department, and contained in an engineering paper by him entitled, "The Purchase of Coal Under Specification:"

"Four or more large scoops of coal shall be taken from each carload as it is being unloaded, so as to get a fairly equal proportion of fine and lump coal. These samples will be placed at once in a tight-covered barrel in a cool place.

"At the end of each month the contents of the barrel will be dumped on a clean floor, the lumps reduced to about the size of a walnut and thoroughly mixed and quartered. This mixing and quartering will be continued until the final quarter can be contained in a 2-pound galvanized-iron can sealed with insulating tape. Cans will be labeled for identification and one of them sent to the chemist for analysis. The others will be kept by the department for thirty days after the chemist's report.

"The chemist will analyze the samples sent him and deliver to the water engineer a written and signed report of the results of his analysis."

The general method of securing carload samples of coal as now practised by the technologic branch of the Survey is to secure portions of the coal as it is being unloaded, so that the sample secured represents the coal in the car from top to bottom. In securing this sample the inspector is careful to secure lump and fine coal in proportion as nearly as possible as exists in the car. The method of securing samples varies largely because of the facilities for unloading. When a bottom-dump type of car is used, and it is possible to do so, the sample is secured from time to time as it flows from the gates. If the car is unloaded by a hoist bucket, the sample is taken from the bucket at regular intervals. In cases where it is impossible to secure a sample from the car after being unloaded, the sample is secured from various places on top of the car; usually six or nine points are selected, which are symmetrically situated with respect to the car. In order to minimize errors due to the accumulation of dirt and cinders during transit, and also extremes of weather conditions which may have existed while the car was in transit, the sample is taken at a depth of not less than 10 to 12 inches below the surface. This method is not as likely to insure as representative a sample of the coal in the car as when a sample is secured from the coal as it extends from top to bottom, because the coal is mixed with more or less extraneous matter of different specific gravity than the coal, the continued jarring effect of train transit tends to segregate the heavier particles toward the bottom of the car.

In sampling single carload lots approximately 100 pounds are secured, and this is crushed to a size not exceeding ½ inch in diameter, and is then thoroughly mixed, after which the coal is quartered, alternate quarters being discarded. The coal is again mixed and the same procedure followed until the sample is reduced to a 2-pound quantity. It is then placed in an air-tight receptacle, sealed and forwarded to the laboratory for analysis. In shipments of large amounts samples are not secured from every car, but from every second, third or fourth car, depending on the size of the shipment.

In securing samples of coal loaded on board steamships the same procedure is followed, and in quantities up to 5000 tons the method is to sample every third car. In a cargo of several thousand tons the number of samples taken varies as the amount of the tonnage. The determinations of the separate samples are averaged and are taken as representative of the carload.

In taking samples of coal in barges the same method applies as in securing samples from the tops of carload lots. This sample is probably more representative, as the coal has not been subjected to the jarring effect due to train transit. Wherever possible, however, samples are taken as the barge is unloaded. The number of samples taken depends entirely on the amount of coal in the barge.

In cases of sampling involving frequent and large tonnages the inspector after he has crushed the sample to ½-inch size, passes the same over a ½-inch riffle, which divides the sample into two equal parts. One of these parts is discarded and the remaining one is put through a riffle. This procedure continues until the sample is reduced to a size suitable to place in an air-tight mailing receptacle. The apparatus consists of the riffle or mechanical sampler and two buckets. One bucket is used to pass the coal through the sampler, and the other placed under the sampler and catches the portion of the coal which is from the calorimeter, in order that there may be no errors due to heat radiated from the observer's body.

A known weight of the sample of coal to be tested is placed in the bomb in contact with a very fine fuse wire, preferably of platinum. The bomb is then charged with pure oxygen gas at a pressure of about 20 atmospheres, 300 pounds, and is immersed in the known weight of water. The water is agitated by a suitable stirring device to maintain a constant temperature throughout its entire volume. Readings of the thermometer are then made at stated intervals of time until the variations in temperature are constant. The charge in the bomb is then ignited by means of an electric current which heats the fine fuse wire to redness.

The combustion thus caused is actually an explosion and is so intense and instantaneous that the platinum fuse wire is melted. The actual time consumed for the combustion is only a fraction of a second. Thermometer readings are made at stated intervals of time until the maximum temperature is recorded. Suitable corrections are allowed for, and then knowing the weight of the sample used, the weight of the water about the bomb, the water equivalent of the bomb and the actual rise in temperature, the calories, or British thermal units, in the sample are calculated.

Fig. 2 shows two of the bomb calorimeters used by the technologic branch of the United States Geological Survey. To indicate how these are actually used and to supplement the very brief general description of the calorimeter and its use, we quote at some length from a professional paper of S. S. Voorhees, testing engineer of the technologic branch:

"The apparatus consists of an outer jacket containing water, insulated by a layer of curled hair held in place by an outside leather covering. The water is not changed and assumes the temperature of the room. Its temperature is read by a thermometer graduated to the tenth part of a degree Centigrade. The inner vessel holds the water surrounding the bomb. It is insulated from the outer water jacket by a 2-inch air space and a cork and hard-rubber stand on the bottom. The temperature changes due to combustion are read by a very accurate thermometer, with a range of 12 degrees graduated to the hundredth of a degree Centigrade. With a small telescope readings are readily made to a thousandth part of a degree Centigrade. The bomb itself is made from a special aluminum bronze, heavily plated with gold on the inside and nickel-plated on the outside. It contains 3020 grams of aluminum bronze, 578 brass, 77 gold, 4.5 platinum, 6.5 steel, 2.4 insulating material, making a total of 4500 grams, and having a water equivalent of 478 grams.

"A small pin is connected with a platinum plug extending through and insulated from the bomb by fine asbestos paper. The platinum stand which supports the crucible in which the coal is fired is made in two parts, insulated from each other by a plate of mica. A very fine platinum wire, 0.004 inch in diameter, is formed into a loop in the crucible and bridges the insulation in the support. The circuit is now complete from this insulated binding post on the jacket through this pin to the platinum plug to which the support is connected, through the platinum fuse wire to the bottom of the bomb, and finally through the jacket and out. A small motor drives the stirring device which can be turned in so as to mix the water in the outer jacket, as well as in the bath about the bomb.

"The bomb is held in a clamp while being charged with oxygen, and is closed with a locknut, which presses down the lid on a pure tin gasket. A simple check valve (a brass piston which seats a rubber washer when pressure from the oxygen tank is reduced) prevents any material escape of oxygen until the cap is screwed down. The oxygen is supplied from a cylinder holding 100 gallons under some 1200 pounds pressure. Now, to make the determination the stirrer is started in the outer water jacket and run for some 15 minutes, with a thermometer inserted to determine the temperature of the jacket.

"A little more than 1 gram of the pulverized coal is weighed and compressed into a tablet in the diamond mortar by a hand-power screw press. This tablet is accurately weighed to 0.1 milligram (0.0001 gram) and placed in contact with the platinum fuse wire in the crucible and with the support inserted in the bomb, and the bomb is closed and charged with oxygen until the pressure gage shows about 350 pounds. It is then placed in a jacket and immersed in 1500 grams of water, cooled to a temperature of about 5 degrees Centigrade below that of the outer jacket, so that the final temperature will be within a fraction of a degree of the outer jacket. The stirrer is started and the temperature readings made at half-minute intervals until the change is constant, usually about 0.01 degree per minute.

"The circuit is closed by a switch, an ammeter reading is taken and the initial temperature is recorded. The readings are now taken at ¼-minute intervals, and the rise in temperature is very rapid. By the end of the first minute the temperature is usually within ½ degree of the maximum. The readings are continued for about eight minutes after firing until the temperature changes become constant, showing that the maximum temperature has been recorded."

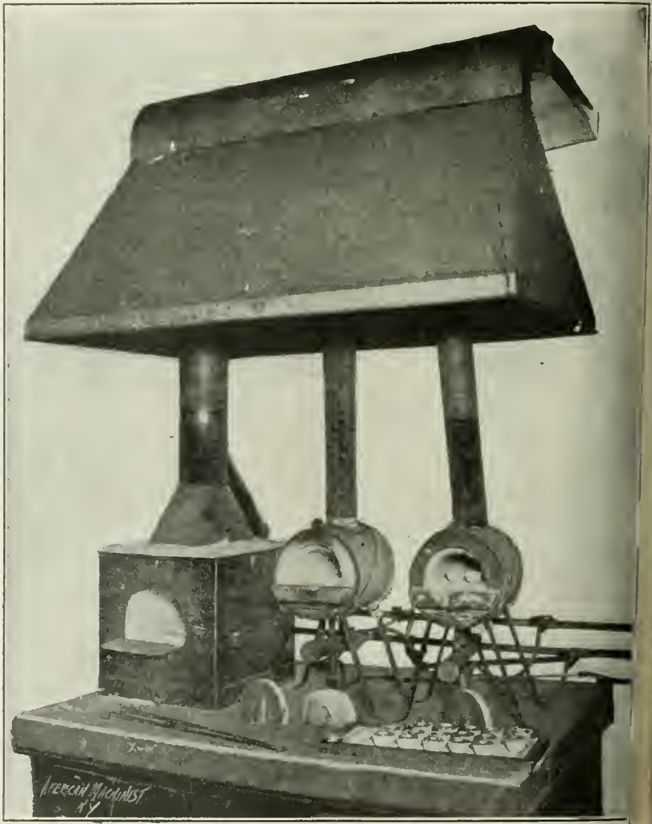

FIG. 1. MUFFLE FURNACES USED TO DETERMINE ASH IN COAL

A sampler similar to the foregoing is used for the quartering or dividing work in the coal-crushing room and laboratory. By the use of this apparatus the personal equation is more or less eliminated in securing the final sample from the gross sample. The essential feature is to procure a sample that shall be representative of the entire lot of coal to which the results of the analysis of the sample are to be applied. As outlined, the procedure is to take a comparatively large sample from the carloads or cargoes as the case be, eliminating as far as possible all tors which will tend to give too rich or lean a sample; then by suitable mi and subdivding a final small sa is obtained, which shall be as repr tative of the large sample as the sample is of the entire amount.

It is necessary that the entire pr of sampling be carried on as rapid as possible to prevent moisture changes to the effect of exposure to the air. is especially important if the co bought on an "as received" basis ost cases there will be a loss in moisture obtaining and preparing a sample for nalysis which will be in favor of the ller. To care for the changes occurring the laboratory the sample as it is re- ived is crushed as rapidly as possible so to pass a ¼-inch mesh sieve. A large mple of this crushed coal is exposed to ospheric conditions in the laboratory til it reaches constant weight. This al is called "air-dried." On account of t. difficulty of handling this large sample is the more general practice to take a smaller sample of this crushed coal and dry in an oven at 105 degrees Centigr to constant weight. This gives a al" and "total moisture."

ther portion of this coarsely crushed sam is sampled down and ground so as t pass a 60-mesh sieve. This finely ground sample is used for the proximate anal is and the determination of heat valu. From these two moisture determinations the proximate analyses and heat values are calculated to the "as received" and "dry coal" basis.

Ather point which should be considered is the change in moisture in the coal due to drying after it is mined, in transit, storage, and the like. We quote: "The coal as it is mined contains a normal amount of moisture which varies from less than 2 per cent. in some of the Eastern coals to as high as 30 to 40 per cent. in some of the Western lignites. This moisture content changes as the coal is exposed to the air, in transit, or in storage, so the ash, volatile matter, fixed carbon, sulphur, and British thermal units are increased as the coal dries out and diminish as the coal takes up moisture. This fact is of especial importance to the user who desires to know the actual value of the coal as it is received. If, however, the sample is taken when the shipment is weighed any increase in moisture content above normal will increase the tonnage to exactly compensate for the diminished heat value of the coal. Therefore, if the coal is bought and paid for on a strictly *pro rata* heat-unit basis the increased weight balances the decreased British thermal units in the coal as received."

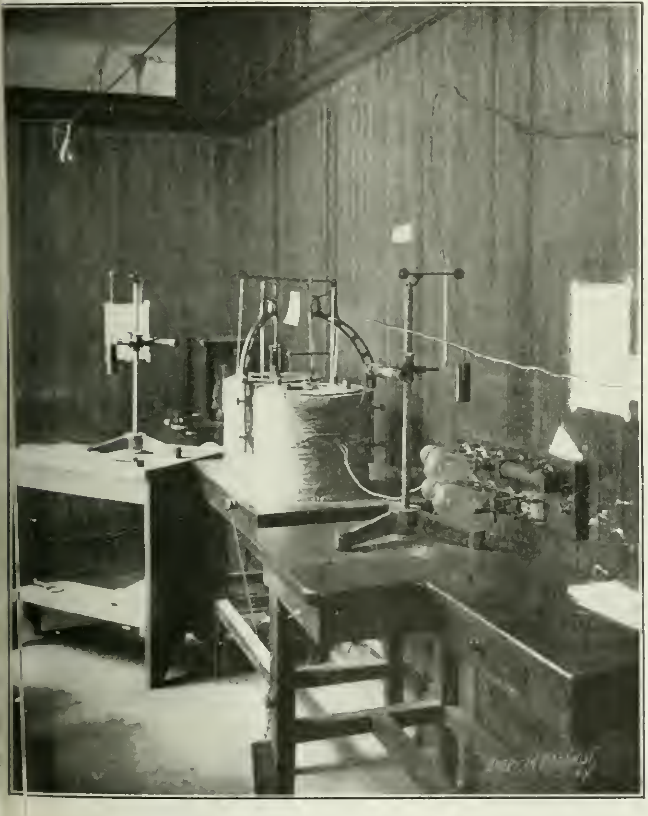

FIG. 2. CALORIMETERS USED IN OBTAINING HEATING VALUE OF COAL

METHODS OF ANALYSIS

The coal analysis, as conducted for the United States Government in connection with the adjustment of price on coal contracts involves a determination of the moisture, ash, volatile matter, sulphur and the heating value in British thermal units. From this analysis the price paid for the coal is adjusted in accordance with the price bid. To the average consumer, however, a much simpler procedure will undoubtedly afford adequate protection. This simpler procedure involves merely a determination of the ash and heat units, on which basis a correction can be made in adjusting payment. For this reason we will only consider the methods used at the technologic branch for determining the percentage of ash and the heating value of the coal.

Turning to the illustrations, Fig. 1 shows a group of muffle furnaces for determining the percentage of ash, and Fig. 2 a pair of bomb calorimeters used for determining the number of British thermal units, or the heating value.

The percentage of ash or mineral residue of a sample of coal is obtained by completely igniting or burning all of the combustible matter in small, gas-fired muffle furnaces, the sample being contained in a desiccating dish; see Fig. 1. As used in Government specifications the percentage of ash is calculated to dry coal; that is, coal from which all moisture has been driven. The moisture is driven off by heating the sample to 105 degrees Centigrade for one hour in a ventilated oven supplied with dry air.

The direct method of determining the heat values of a specimen of coal is based on actual measurement of the heat produced by combustion. With apparatus of proper design, and with suitable precautions and corrections, this method gives the most accurate results that it is possible to attain; in fact, it is used as a standard to determine the accuracy of all other methods. The instrument used is what is known as a bomb calorimeter, a metallic vessel or bomb made from a high-carbon steel and so designed that it can withstand an internal pressure of 300 atmospheres, or, say, 4500 pounds. The inside of this bomb is lined with some metal to prevent corrosion from the resulting gases, and is surrounded by a known weight of water. The vessel containing this water is insulated by an air space, and this air space in turn is surrounded by a jacket of water which is kept at the temperature of the room. The outside of the water jacket is insulated by a layer of felt, or other suitable insulating covering. The temperature measurements are made by a special thermometer, which is very sensitive and accurately graduated to read to the one-hundredth part of a degree Centigrade. The readings are taken by means of a telescope at some distance; 1.0053 grams of sample were used, and the corrected rise in temperature was

4.176 degrees. The water used being 1500 grams plus 474 grams for the water equivalent of the bomb, we have

1974 × 4.176 ÷ 1.0053 = 8202

calories, and multiplying these by 1.8 = 14,764 British thermal units.

Such is the method used to determine the British thermal units in a sample of coal. These determinations are always made in duplicate, and are required to agree within 40 British thermal units, or less than 0.3 of 1 per cent. By this method the heat imparted by a given amount of coal to a given amount of water is actually measured. Thus a British thermal unit becomes a real thing, and when one stops to realize the amount of stored energy in the coal and notes how much heat it yields, he is amazed. Take a single gram of coal. When this burns it raises the temperature of 8202 grams of water 1 degree, or putting it in another way, 1 pound of this coal will raise the temperature of 82 pounds of water from the freezing point to the boiling temperature. Or, in still another way, 1 pound of such a coal will actually develop 1 horsepower for one hour.

### MINIMUM YEARLY TONNAGE TO WHICH SPECIFICATIONS CAN BE APPLIED

The question is sometimes asked—what is the smallest yearly tonnage for which it is economical to prepare specifications on a heat-unit basis and to take the necessary steps to see that such specifications are properly carried out? Such minimum yearly tonnage is a variable amount and depends in part upon the following: The rate at which coal is delivered, the facilities at hand for making heat-value determinations, and the character of the coals which compete in the particular market in question. In cases in which the consumer has not the facilities at hand for making determinations, but has to depend upon a commercial laboratory, the minimum purchase per annum to which it would be economical to apply such specifications is probably in the neighborhood of 1000 tons.

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## The Kempton Park Pumping Station

By FRANK C. PERKINS

The accompanying illustrations show the interior of the Kempton park (England) pumping station and the English vertical triple-expansion engine as constructed at Oakengates by the Lilleshall Company, Limited. This waterworks plant pumps water for the New River company from the staines aqueduct to a reservoir at Portis Green near Nuswell hill. The metropolitan water board was formed for taking over this plant at Kempton park, as well as the new pumping station at Cricklewood, where ther are three pumping sets of the same con struction.

Every twenty-four hours, 15,000,000 gal lons of water is raised, the work bein done in three stages. There are five e gines at the Kempton park plant, the fir lift being performed by two engines, o of which is held in reserve. The capaci of each engine is sufficient to raise t full quantity of 15,000,000 gallons per d against a head of 32 feet from the stain aqueduct to the subsiding reservoir. Fr this reservoir the water flows by grav into filter beds, and from there three gines raise the water for the second l two of which are required for raising amount of water stated every twenty-f hours, the total head being 166 feet the capacity of each engine being 7,500 gallons, one of the three engines be held in reserve.

The water is raised by the latter engi from the filter bed at Kempton park to Cricklewood intercepting reservoir. this point the third lift is accomplis two of the units lifting the 15,000 gallons against a head of 181 feet t service reservoir at Fortis Green, the t engine serving as a spare unit.

The speed of all these engines i revolutions per minute and the strok 4 feet, the engines of the first lift ha high-pressure cylinders 13 inches in d eter and low-pressure cylinders 32 ir

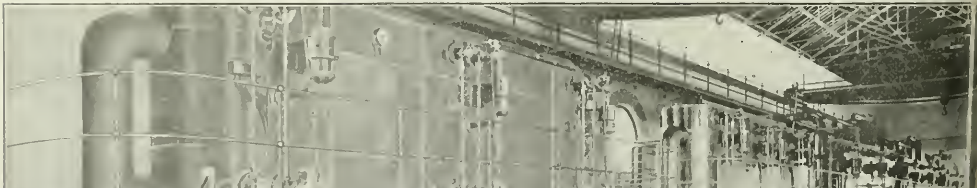
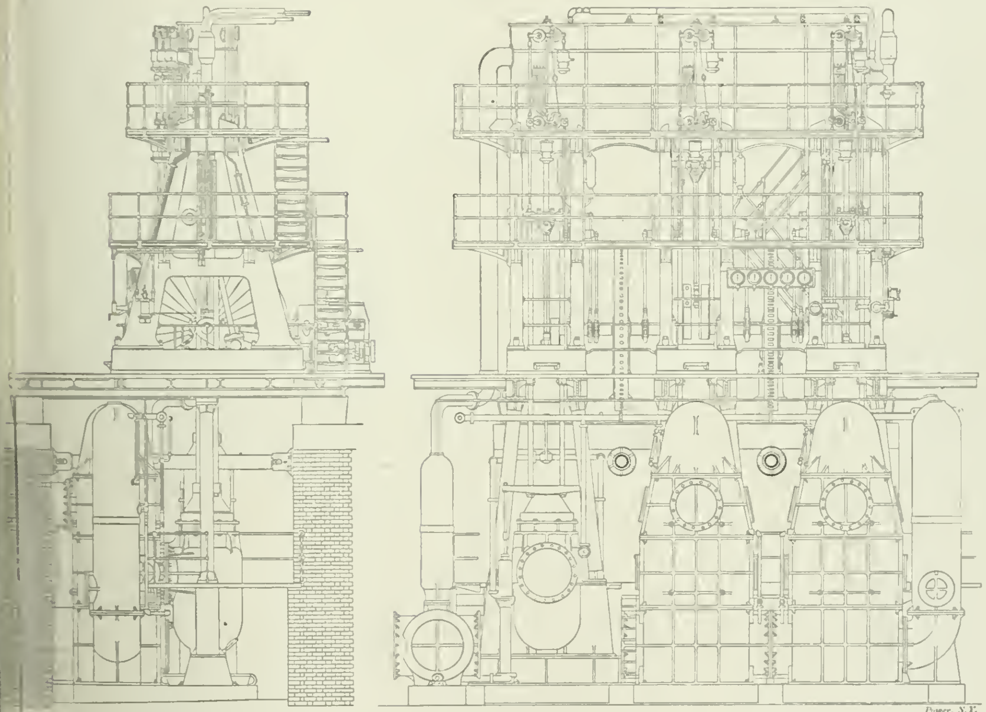


FIG. 1. INTERIOR OF KEMPTON PARK PUMPING STATION

i diameter, the intermediate cylinders m suring 21 inches in diameter.

orliss valves and trip gear worked by a eccentric on the crank shaft are pro- v d on the engines of the second and th d lift, the crank shafts being built up, t shaft for each engine having two parts c pled together in one of the webs of t intermediate-cylinder crank. These e ines have a stroke of 4 feet with high- p ssure cylinders 21 inches in diameter low-pressure cylinders 52 inches in d meter, the intermediate cylinders meas- u g 34 inches. The shaft bearings are ches in diameter and 16 inches long.



Power, N.Y.

FIG. 2. SIDE AND END ELEVATIONS OF ONE OF THE TRIPLE-EXPANSION PUMPING ENGINES AT KEMPTON PARK

T re are two air pumps to each en- n f the single-acting type, each having 4 t stroke with a bore of 6½ inches or first lift engine. The main pumps f e engines are single-acting, with am f 48-inch stroke and 34 inches in iar r.

F the second- and third-lift engines he lungers have the same stroke but a re 24 inches in diameter and are o l to the crosshead by double rods f d steel 5 inches in diameter. The yw els are about 11 feet in diameter, e ms measuring 10x12 inches. The ngi s operate at a steam pressure of 50 unds per square inch.

## Gift to A. I. E. E. Library

The Western Electric Company has presented to the library of the American Institute of Electrical Engineers a valuable addition in the shape of a patent specification library. This gift constitutes the largest accession since the original creation of the library by Dr. S. S. Wheeler with the Latimer-Clark collection.

The patent library which the Institute thus acquires contains no fewer than 461 substantial leather-bound volumes containing approximately 100,000 specifications. These specifications begin with May 30, 1871, and run to December, 1908, thus covering the entire period of activity which includes the telephone, the electric light, electric railways and the electric motor. From May 30, 1871, up to the last day of 1887 the volumes are complete, containing all the specifications issued by the patent department, certified. From July, 1887, up to December 1, 1908, the volumes contain all the electrical specifications which are not certified.

The original set cost over $4000, and duplicates of these specifications, if now purchased from the Government and found, would cost between $1000 and $1500. This library has been accumulated by the Western Electric Company in Chicago, from which city it is now being brought to New York to be added to the collection of technical literature housed in the Engineering Societies building.

## "Clermont" and "Half Moon" on Exhibition

After their official reception on September 25, as the most distinguished attractions in the Hudson-Fulton celebration, the "Clermont" and "Half Moon" will be open to public inspection, remaining anchored in the Hudson opposite One Hundred and Tenth street, New York City, until September 29, when they will voyage under escort up the river which the originals of both vessels traversed in earlier years. Special ceremonies with float parades will occur as follows: October 4, at Poughkeepsie and Yonkers; October 5, Kingston, Hastings, Dobbs Ferry, Irvington, Tarrytown; October 6, Catskill and Nyack; October 7, Hudson, Ossining, Haverstraw; October 8, Albany and Peekskill; October 9, Troy, Cold Spring; October 11, Cohoes.

# Heat Transfer and Future Boiler Practice

## New Type of Boiler Suggested, Carrying into Effect the Principles of Rapid Heat Transference Evolved by Various Authorities

BY ARTHUR H. ALLEN

During the last few years there has been a tendency in the manufacture of steam boilers to standardize designs to the utmost, to regard the matter as though finality had been reached, and it only remained to improve existing patterns in detail, while adhering strictly to the recognized principles in accordance with which they have been evolved. But are those principles correct?

He would have been a bold man who ten years ago would have dared to prophesy that within a decade current views on steam-engine design would have undergone a complete revolution, and that the steam turbine—the despised "steam eater" at the end of the last century—would have triumphed over the low-speed reciprocating type not only on land, but also in that stronghold of tradition and standardization, the ocean steamship. Yet that has come to pass, and within a few short years we have seen the turbine capture position after position, until now it holds the field, and the largest electric generators, as well as the most enormous vessels of peace and war that the world has ever seen, are wholly dependent upon the turbine for their operation and propulsion. The author well remembers seeing at the Glasgow Exhibition of 1888, a little Parsons turbine driving a small dynamo—one of the first of these machines to come before the public eye, and he has watched the gradual evolution of this type of prime mover with constantly increasing interest, from the days when it was regarded rather as a curiosity, a freak in engine practice, than a practical source of power, until he has seen it constructed with blades a foot long and giving an output of 70,000 horsepower in a single ship.

The boilers, however, which supply steam to these huge machines, have not developed at an equal rate either in efficiency or output, so true is this, that one of the most difficult problems in a modern turbine-power station is that of providing sufficient boiler power within a reasonable distance from the turbines. Is it not possible that there is scope for a similar development in boiler design to that which we have seen in the case of the engine? The author believes that it is not only possible, but also probable.

### THE THEORY OF HEAT TRANSFERENCE

The principal foundation for this belief lies in the important lecture which was delivered in January last before the Junior Institution of Engineers, London, Eng., by John T. Nicolson, professor of mechanical engineering in the University of Manchester. Doctor Nicolson took for his subject the laws of heat transmission in steam boilers, and embodied in his address the results of the experiments which he has carried on during the last five years. His conclusions were as striking as they were bold. Reminding his audience that thirty-five years ago Prof. Osborne Reynolds indicated the direction in which to work, and that Dr. T. E. Stanton in 1897 obtained experimental confirmation of Professor Reynolds' views, Doctor Nicolson drew attention to Prof. John Perry's remark, in his book on "The Steam Engine," that "when a good scrubbing action is established on both sides of the metal, there ought to be at least ten times and may be more than 100 times as rapid an evaporation per square foot of heating surface as has yet been obtained in any boiler." This extraordinary statement lay unnoticed by engineers until the fuel-testing department of the United States Geological Survey came upon it, and carried out experiments in 1907 which appeared to corroborate the theory. Doctor Nicolson himself had been interested in Doctor Stanton's experiments in 1897, but had not an opportunity to investigate the matter until 1905.

It is well known that there is an enormous drop in temperature between the hot furnace gases and the boiler plates; there is also a considerable, but comparatively much smaller, drop between the plates and the water, the former being over 1000 degrees Fahrenheit and the latter about 20 degrees Fahrenheit. The substance of the plate offers a trifling resistance to the flow of heat, and it is immaterial whether the plate is made of steel or copper, or whether it is thick or thin—the great obstruction to the rapid transference of heat from gas to water lies between the gas and the plate. What is the nature of this obstruction?

Doctor Nicolson's experiments have led him to the conviction that it is nothing more than an infinitesimally thin film of the gas itself, which is entangled by the microscopical roughnesses of the surface of the plate and is cooled to approximately the same temperature as the plate, while it constitutes an effectual barrier against the flow of heat. Were it not for this—if that is, the fire side of the plate could be raised to a temperature approaching that of the hot gases—the transference of heat from gas to water would take place at a rate somewhere near one hundred times that actually observed. The formula for heat flow is

$$Q = k \frac{T - t}{c}$$

B.t.u. per hour per square foot., where

$T$ = Temperature in degrees Fahrenheit of the furnace side,
$t$ = Temperature in degrees Fahrenheit of the water side,
$k$ = Thermal conductivity of the plate
$c$ = Thickness of the plate in inche

For wrought iron or mild steel $k$ ha the value 450, and with $T$ = 1500 degrees Fahrenheit, $t$ = 350 degrees Fahrenheit and $c$ = ½ inch, we should ha $Q$ = 1,035,000 B.t.u. per hour per squa foot, equivalent to an evaporation of 10 pounds of steam from and at 212 degre Fahrenheit per hour per square foot whereas in practice we only find about or 5 pounds. It is evident, therefore, tl the furnace side of the plate is nowhe near the temperature of the hot gas in the ordinary boiler.

Rankine's formula for the practical ca is

$$Q = \frac{(T - t)^2}{a},$$

where $a$ is a constant, usually taken about 200. Giving $T$ and $t$ the same val as before, we find that $Q$ = 6620 B per hour per square foot, which is in neighborhood of actual results; obviou by taking a suitable value for the cons $a$, we can always make the formula a with the ascertained results—the bea of which remark will be apparent la

The Rankine formula takes no acc whatever of the speed of flow of gases and water over the surfaces of plates; and in this respect it is show Doctor Nicolson to be radically defe—for the speed of flow is a vital ele in the proposition. The theory put ward by the lecturer was essentially same as that of Professor Perry: na that by establishing a powerful scrul action between the gases and the l plate, the protecting film of cooled a could be torn off as rapidly as it a formed and new portions of the hot could be brought into contact with plate, so as constantly to renew the m perature gradient in the metal. We not here go into details of the c ments that were carried out to investigate whether this was the true remedy for the trouble; it will be sufficient to say that Doctor Nicolson's researches point conclusively to the fact that by increasing the speed of flow of the gases, a corresponding increase in the rate of transfer of heat to the water is obtained, and this conclusion is supported by numerous other researches on boilers, which had not previously been discussed from this point of view.

### THE RESULT OF THE RESEARCH

The result of the research is summed up in the following amended formula, the derivation of which was discussed at great length in the lecture.

$$Q = \left[\frac{\phi}{200} + \frac{1}{40}\sqrt{\phi}\left(1 + \frac{1}{m}\right) r u\right]\left(T - \theta\right)$$

where

$Q$ = B.t.u. transferred per hour per square foot of flue surface,

$T$ = Average temperature of gas flowing along the flue, degrees Fahrenheit,

$\theta$ = Temperature of metal wall of flue, degrees Fahrenheit,

$\phi = \frac{1}{2}(T + \theta)$ = Mean film temperature, degrees Fahrenheit,

$r$ = Density of gas, pound per cubic foot,

$u$ = Speed of gas in feet per second,

$A$ = Cross-sectional area of flue in square inches,

$c$ = Perimeter of flue in inches,

$m = A \div c$ = Hydraulic mean depth of flue.

This formula, it will be seen, takes due account of the speed of flow of the hot gases, and has been found by Doctor Nicolson to agree well with practical results. The explanation of the fact that the Rankine formula has hitherto been found sufficiently close to the actual results is simply that where a high speed of flow has been employed, as with forced draft, it has been assumed that the temperature of the hot gases was much higher, and the constant $a$ has been manipulated, a value as low as 120 being recommended by authorities on the subject. Doctor Nicolson's formula, on the other hand, agrees with the results without any such "cooking."

The conclusion is that by employing a high rate of flow—some ten times the ordinary speed—the rate of heat transference can be proportionately increased; that the heating surface for the same output may therefore be reduced to even one-tenth of that now necessary, with a corresponding reduction in the size, cost and floor space required, or with the same heating surface the output may be enormously increased; and that perfect combustion and increased efficiency can be obtained, boiler efficiencies of over 90 per cent. being foreshadowed. On the other hand, the draft will have to be paid for with energy consumed by the fans required to produce it, but Doctor Nicolson finds that the expenditure in this direction only amounts to a small percentage of the total output, by no means comparable with the advantages gained.

It will now be seen that, accepting these results as valid—though, of course, they will need further confirmation before adoption generally—the way is opened for a complete revolution in boiler practice.

### HOW TO APPLY THE NEW PRINCIPLES

The question now arises how to apply these new principles. It is clear that subdivision of the hot gases will be an essential feature of the design. In one of his experiments, Doctor Nicolson nearly filled up the flue of a Cornish boiler with an internal water vessel, leaving only an annular space round the latter 1 inch thick, 40 inches in mean diameter and 10 feet long, through which the whole of the gases were driven, when burning coal on the grate at the rate of 1200 pounds per hour (63 pounds per square foot per hour). The heat flow was 34,450 B.t.u. per square foot of heating surface per hour—some eight times the ordinary rate—and the speed of flow of the gases was about 330 feet per second, thus being also 8 or 10 times the highest ordinary speeds. The fan consumed about 4½ per cent. of the total power. It will be seen that this plan was directly opposed to the method so frequently adopted, of interposing water tubes, etc., at right angles to the flow of gas, so as to break up the gases and hinder their passage.

In accordance with the theory, the flow of gases must take place in such a way as to produce a thorough scouring effect; that is, parallel with the length of the tube or plate, not transversely to it, and through a passage of small cross-section. The nearest approach to these conditions in practice appears to be the locomotive type of multitubular boiler, in which tubes of small diameter are employed, amongst which the current of gas is finely subdivided and a powerful draft is induced by the blast of the exhaust; it is well known that remarkably high efficiencies have been obtained from this type of boiler, in spite of the comparatively small area of heating surface.

Another point put forward by Doctor Nicolson is that the countercurrent system should be adopted; this is already employed in connection with condensers. The steam and water should flow over the metal surfaces in opposite directions, so that the hottest gases meet the hottest water, and the cooler gases are utilized in heating the cooler water. This requirement calls for the continuous flow of the water in one direction, as in the Babcock & Wilcox and Stirling boilers; but for the highest efficiency to be attained the principle should be carried farther. In fact, the boiler should represent an ordinary boiler and economizer together, the feed water entering at the end where the flue gases leave the boiler, while the steam is mostly generated near the furnace end of the boiler. The Serpollet and other "flash" boilers afford an example of this system.

Lastly, the furnace should be lined with refractory material, and form an inclosure in which the highest temperature can be obtained and perfect combustion accomplished.

It will be seen that not one of these features is novel, the only novelty in the matter under consideration is the embodiment of them all in a single boiler; and this is the problem before us. All these points were mentioned in Doctor Nicolson's lecture, but he gave no hint as to the means by which they could be put into practice.

In the first place, it appears to the author that the conditions indicate the use of some arrangement of tubes; large shells and flues are out of the question. To spread out the gases in the form of a thin layer with the aid of tubes necessitates the use of concentric tubes with an annular space between them, through which the gases may flow—as in Doctor Nicolson's experiment, cited herewith. It is true that the innermost tube might be replaced by a core of refractory material, but difficulties arise with regard to the choice of material and the method of supporting such cores. Nevertheless, the device may prove serviceable, at any rate in the case of small boilers.

Confining our attention for the moment to the use of tubes only, we require three concentric tubes in each element; the space between the outer tubes and the interior of the inner tube being filled with water, while the space between the two inner tubes is traversed by the flue gases. The character of the problem will now be manifest. To devise such a system is by no means impracticable, but to devise a successful solution will call for great mechanical ingenuity. It must be borne in mind that the heating surface required for a given output will be reduced in the ratio of ten to one, as compared with an ordinary boiler, and therefore there is considerable margin for increase in the cost of construction, though if this is too freely drawn upon one of the chief advantages of the system will be lost.

### THE AUTHOR'S HEATING ELEMENT OF THE TYPE DESCRIBED

The author has devised a heating element of the type described, but found serious difficulties in elaborating a practical design. One of the first points which strikes one is the impossibility of so arranging the tubes and headers that the heating surfaces can be cleansed of scale and soot. As regards the former objection, it is maintained by some engineers of repute that the interior of the boiler ought not to be utilized as a water purifier; the boiler should be fed with pure water. Indeed, it was recently suggested.

[illegible] Electrical Engineers [illegible] it was stated that it would be wise to supply distilled water for make-up as is done at sea, using evaporators; the whole of the condensed steam is free from oil, and can be returned direct to the boilers, and by the use of suitable evaporators, water can be distilled at a very low cost to make up for the unavoidable wastage. Large installations of water purifying plant are already to be found at many British power houses, and when the condensed steam can be turned direct into the boiler, it seems questionable whether it might not be more economical and advantageous to replace these by evaporators, even where the present type of boiler is employed. In any case, for large turbine stations this does not appear to be a serious difficulty.

It will be borne in mind that if pure water is used, the expense of cleaning the tubes will be done away with, and this saving can be set off against the cost of distilling the make-up water; another item tending in the same direction is the increased efficiency of the boiler through the absence of scale, and we may add the longer life of the tubes as a further gain. Less boiler plant would also be needed, as it would not be necessary to shut down a boiler for scaling. The rapid flow of water through the narrow passages would of itself tend to keep the surfaces clean.

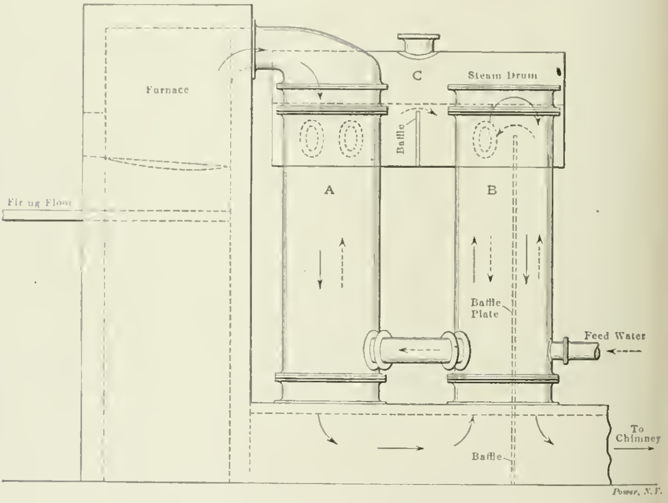
A more serious difficulty, however, is that of cleaning the annular flue between the tubes; it is true that there is less tendency to foul than in an ordinary type of boiler, owing to the hurricane draft, but it is not denied that cleaning would probably be necessary from time to time. This difficulty proved so troublesome that, while not regarding the design as hopeless, the author has preferred to follow a different path toward the goal.

This leads to a type of construction advocated by Prof. John Perry, in which the hot gases are led through a series of small tubes which are surrounded by the water, somewhat as in a boiler of the locomotive type, but still more allied to the condenser in its essential features. It will be admitted that in a surface condenser an enormous amount of heat is transferred from steam to water in an extremely short time; some four-fifths at least of the heat imparted to the steam in the boiler is here removed at an almost equal rate, but in a space of comparatively very small compass, and with a very high degree of efficiency. What we must aim at is to reproduce the action of the condenser in the opposite sense; to impart heat at high speed to water, we should make the boiler resemble the condenser as closely as possible.

With this object in view, the author has devised the arrangement shown roughly in the accompanying sketch. In this design the various elements that make for efficiency—countercurrent, separate combustion chamber, high rate of flow of water and gas, and facility of access have been embodied as far as possible.

The natural tendency of steam bubbles is to rise in water, and to facilitate this they should ascend with the water current; the last portion of the water path, therefore, must be upward. Floor space is valuable but extension in the vertical direction is both convenient and feasible at moderate cost. The indications are therefore in favor of vertical, or nearly vertical, tubes, as in the Nesdrum boiler and some others that have proved successful in practice. The steam-collecting drum is naturally placed at the top part of the boiler; water drums are not necessary unless a large reserve of heat energy is required.

In order to secure the desired counterflow of water and gas, the furnace gases ought to be led in at the top and downward in the opposite direction to the ascending water flow; for this reason the furnace is placed near the top of the boiler, with a combustion chamber above it lined with refractory material.



SOLID ARROWS SHOW DIRECTION OF FLOW OF GASES
DOTTED ARROWS SHOW DIRECTION OF FLOW OF WATER

### Description of the Device

The cylinders *A* and *B* are water vessels, provided with a diaphragm at each end; the interior of each cylinder is filled with small tubes, say one inch in diameter inside, expanded or otherwise secured in the diaphragms or tube plates, as in the construction of a condenser, but with less vacant space around them. The cylinder *B* is further divided vertically near the middle with a diaphragm, to direct the flow of water from the feed pipe on the right hand upward, and down on the left, after which it passes finally upward in cylinder *A*; the smoke box at the bottom of cylinder *B* is similarly divided, so that the hot gases coming from *A* pass up and down through the tubes in *B*.

It will be remembered that heat is being rapidly abstracted from the gases as they pass through the boiler, so that their volume at exit is much less than half as much as at the beginning; in order to maintain the high speed of flow, therefore, cylinder *B* is thus divided into two parts, of which the right-hand portion is of less cross-section than the left. The steam-and-water drum *C* is connected to the top of each drum, so that a continuous circulation can be automatically maintained down the left-hand portion of *B* and up the whole of *A*; this provides a liberal allowance in *A* for the escape of the steam bubbles upward, which also increase the volume of the fluids in *A*. A baffle plate in *C* allows only the hot surface water in the left-hand part of the drum to pass toward the right and down *B*; this circulation cannot take place down the right-hand of *B*, because there is no communication between the two compartments at the bottom. An upward flow in the right-hand compartment is caused by the admission of the feed water at the bottom.

The hot gases, having thus traversed the length of the cylinder three times at high speed, may be further utilized on their exit to heat the exterior of the cylinders at a slower rate of flow, by being guided around them from right to left and back again, passing away to the flue on the right hand; if, however, the boiler is working on load, the gases will be so far cooled by the feed water in the right-hand compartment of *B* that it will be better to lead them straight away to the chimney, as shown in the sketch. The whole of the boiler should be incased in a wall of brickwork, with an air space or other heat-insulating device, to minimize radiation. In a battery of such boilers, all at work, only the end walls, top and front and back of the boilers will radiate heat to waste, and the arrangement is at most no worse in this particular than the ordinary water-tube boiler.

The author believes that while this design cannot be regarded as other than a suggestion, it incorporates all the points set out in the foregoing. An important advantage of the vertical arrangement of the tubes is that dust and soot, carried down *A* at high speed, will tend to pass clear through the tubes and be deposited at the bottom in the enlarged smoke chamber, which is purposely made of considerable volume to allow the gases to flow more slowly there and thus to deposit dust. This chamber is easily accessible for cleaning out.

It will appear at first sight that this type of boiler can only be employed for small output; it should be remembered, however, that we are dealing here with very different conditions from those obtaining in ordinary boilers. Owing to the high speed of flow and the countercurrent, the efficiency of the heating surface is increased tenfold, so that for a given output the heating surface need be only one-tenth as great; moreover, an enormous heating surface is exposed in each cylinder. Thus at least twenty times as much evaporative work can be accomplished in the same volume as that of an ordinary boiler. Floor space will be economized both for this reason and on account of the vertical disposition of the tubes. The cost of a boiler for a given output will be reduced enormously, and the increased output for a given space occupied will obviate the difficulty now met with of providing sufficient boiler power for turbines within a reasonable distance. Forced draft will of course be necessary, but the cost of the forced-draft plant will be partly offset by dispensing with a tall chimney, to say nothing of the reduced cost of the boiler, and the water-purifying or distilling plant will in great measure pay for itself.

No doubt there are many points in the rough design here given which are open to criticism; the whole thing, indeed, depends entirely upon the validity of the views expressed by the various authorities mentioned in this article. The author feels, however, that in view of the enormous advantages that appear to be brought within reach by the possibilities of rapid heat transference, time has not been wasted in the effort to develop a boiler in which the theory can be put into practice.

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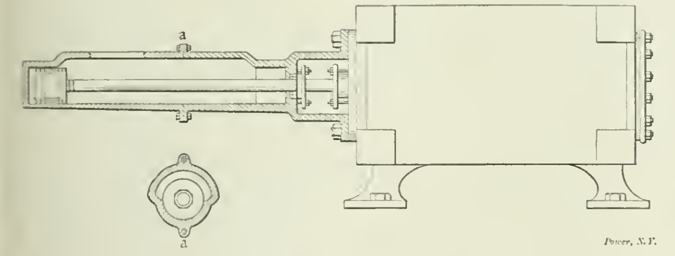
## Compression Outside of the Main Cylinder

By S. Kirlin

Many articles have been written on the subject of compression, both for and against, and most engineers agree that all except very slow-running engines require some compression to counterbalance the inertia of the reciprocating parts as the engine passes its centers, in order to obtain quiet running and to absorb the shocks that would otherwise come directly on the bearings.

All engineers do not agree, however, that compression which is obtained in the usual manner, by closing the exhaust valve when the piston is yet several inches from the end of the stroke, is economical or desirable if the same results could be obtained otherwise.



METHOD BY WHICH INERTIA CAN BE OVERCOME WITHOUT RESORTING TO COMPRESSION

If the exhaust valves were allowed to remain open until the piston had reached the end of stroke, or nearly so, practically all wrecks due to water in the cylinder would be avoided.

Take, for instance, an engine running at 90 revolutions per minute; from the time the exhaust valve closes for compression until the piston has reached the end of its travel is only the fraction of a second, and when one remembers that water is practically incompressible, it is easy to see that something will have to happen in a hurry to relieve the cylinder in case there is much water present.

Most engines are supposed to relieve themselves in a case of this kind by lifting their admission valves, or are equipped with relief valves set to open slightly above the highest boiler pressure; but in either case the pressure in the cylinder will have to rise to a point far above the boiler pressure to discharge the water, and with a large volume to be forced out in the short space of time there is almost certain to be some damage done.

The illustration shows how the inertia of the reciprocating parts can be overcome without resorting to compression in the steam cylinder, the piston rod being extended and carrying a small piston which, sliding in the guide, acts as a tailrod to carry the main piston.

At each end are cup-shaped cylinders into which the small piston enters as it nears the end of the stroke, compressing the air to a point necessary to balance the inertia of the moving parts. An end view of the piston and guide is shown in the section on *aa*, which shows the piston-bearing surface on the guide forming the tailrod.

On account of the area taken up by the rod in the crank-end cylinder, this cylinder would have to be somewhat deeper, or the piston adjusted to compress the air to a smaller volume, in order to get the same cushioning effect on each end.

The amount of power consumed in the compression cylinders would be small, as they would deliver to the piston on the outstroke as much power as was consumed in the compression stroke, minus the slight loss due to leakage and friction and the heat developed in compressing the air which escapes by radiation.

The operation of the compression cylinders would be practically noiseless, and if it was desired to vary the compression while the engine was in operation, it could easily be done by an arrangement of valves in the air cylinders.

No great amount of variation should be necessary, however, unless the speed of the engine was changed, as the inertia of the reciprocating parts would remain constant as long as the speed did not vary.

With the compression obtained in the usual manner in the steam cylinder, it becomes necessary to close the exhaust valve considerably earlier when running condensing, as the density of the steam which remains for compression is much less, and requires a larger volume to be compressed to raise the pressure to a point sufficient to overcome the inertia.

With compression outside of the steam cylinder, the inertia alone is all that is necessary to be considered when adjusting the compression, as it makes no difference whether the engine is operating condensing or noncondensing, as the release takes place early enough to balance the pressure on both sides of the piston as it approaches the ends of the stroke, both exhaust valves being open at this time.

This arrangement would allow the clearance to be reduced to a fraction of the usual amount, as the exhaust valves are open until the piston has almost reached the end of the stroke, which minimizes the liability of damage by water.

As clearance is a large source of loss, any arrangement which would reduce it would result in better economy.

# Lubricators and Lubrication

## Interesting Discussion of These Features of Steam and Gas Engine Work, with Descriptions of Several Leading Types of Lubricator

### BY W. H. WAKEMAN

A lubricator that was designed to supply oil to two cylinders on which the pressure is equal is shown in Fig. 13. It can be located between the two cylinders of a double engine, with the central connection for the condenser attached to the main steam pipe, thereby securing water to float the oil. The right-hand sight feed delivers oil through a suitable pipe to the right-hand cylinder, while the left-hand feed supplies the left hand cylinder. Whether a cylinder is right- or left-hand is determined by standing between them, facing the flywheel.

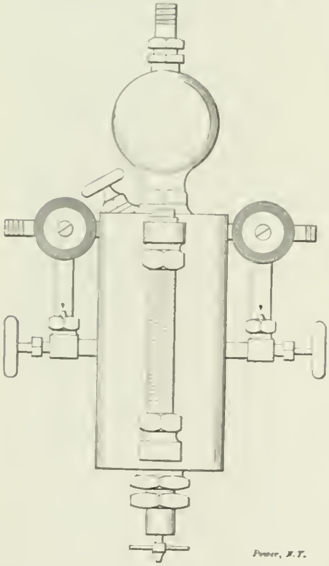

Power, N.Y.

FIG. 13

If the steam which passes through the main pipe of a simple engine is not thoroughly saturated with oil, and there are two steam valves, as in the Corliss or any similar type, one valve may get more than its share of the oil, leaving the other without sufficient lubrication. With a single lubricator in use the only available remedy is to increase the feed in an effort to secure better results, but the lubricator shown in Fig. 13 should be secured as soon as possible and connected so that each sight feed will deliver to a separate valve, thus leaving no doubt of the proper application of the oil.

As a matter of interest in this connection, I will explain that the term "double engine" means one that is fitted with two cylinders, both of which take steam direct from the boilers and exhaust it into a condenser, or to the atmosphere, according to conditions. A simple engine has but one cylinder, provided it is fitted with a double-acting piston.

With Fig. 13 in operation, the same oil is delivered by both sight feeds, hence if equally good results are not secured, it is due to conditions under which the oil is used, rather than to the oil itself. If a certain oil gives satisfaction and the price is reasonable, it is poor policy to discard it for another brand because the latter is a few cents per gallon cheaper, as the small difference in first cost will be quickly overbalanced in case the new oil proves to be inferior, and if the cylinder is damaged thereby it will cost enough to balance the difference on the total quantity required for several years.

For illustration of the possible effects of using inferior cylinder oil the following facts are presented: Fresh animal oil or fat is comparatively pure, but when allowed to stand in a warm room in which the atmosphere is moist, it decomposes rapidly, resulting in the formation of acids that destroy machinery. The natural consequence is that when this fat is mixed with mineral oil and used in a steam cylinder the process of decomposition is hastened by heat and moisture, until the resulting acid becomes dangerous in a short time, not only to cast iron, but to copper and to various metals with which copper is mixed for mechanical purposes.

I. T. Redwood cites a case where two pounds of foreign matter were taken from a small cylinder, and when it was analyzed it gave the following result: Fatty matter, 31 per cent.; moisture, 23 per cent.; iron, 46 per cent. The writer has had a similar experience, but the process was stopped before the damage became so great.

Fig. 14 illustrates a lubricator that will supply two cylinders with oil, although the pressures may vary widely. It may be located between the two cylinders of a cross-compound engine, the high-pressure side of which is operated by steam at 150 pounds gage pressure. If the cutoff takes place at one-third stroke, the low-pressure cylinder will take steam at about 30 pounds, but this lubricator will feed evenly to both of them.

It is possible to find a cylinder oil that will lubricate the high-pressure cylinder perfectly but will not be suitable for the low-pressure valves and piston, because there is not sufficient heat to atomize it, and thus cause it thoroughly to saturate the steam. This point may be illustrated by watching the sight feed of any lubricator. The drops of oil pass upward

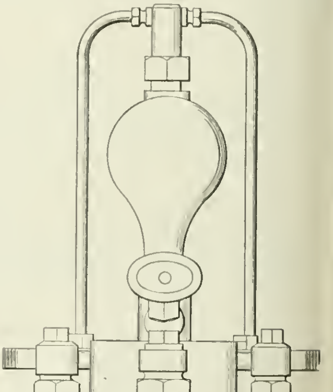

Power, N.Y.

FIG. 14

through the water but this water is not saturated with oil. Because oil passes through steam it does not necessarily follow that it is saturated by the oil. A cross-compound is sometimes erroneously called a "double engine," but the difference is plain from the foregoing descrip tions. The two cylinders of a tandem compound engine may be lubricated in the same way.

It is not always convenient to heat cylinder oil before it is put into a lubricator, but if it is cool when thus used, and the oil is not wanted for an hour or more, care should be taken to provide a vent in order to prevent the accumulation of a high pressure due to expansion of the oil as it gradually absorbs heat from the metal. This does not mean a vent to the atmosphere, as that is not practicable, but if the feed-regulating valve is closed, that will prevent waste of oil, then the condenser valve may be left open one-quarter of a turn. When the oil expands it will simply force a few drops upward without increasing the pressure.

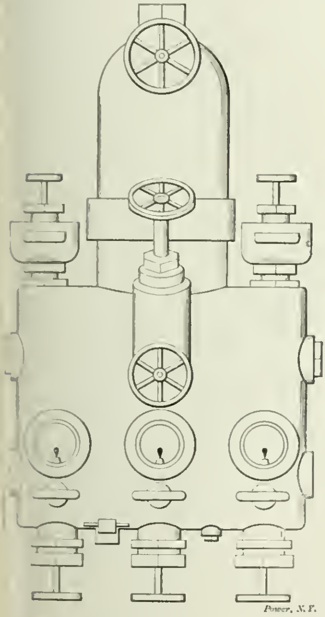

Power, N. Y.

FIG. 15

Fig. 15 is a rough, strong lubricator for hard service and little care in lroad work. It has three separate ls, one for each steam cylinder in h power is developed for driving a tive, and one for the air-brake piston. The sight feeds are obved through glass disks which are one h thick, hence there is no danger of the ncer or fireman being scalded on act of a broken sight-feed glass. There n gage glass on this lubricator, but s cannot be expected here, for if the vice requires such heavy sight-feed sses, it is impracticable to secure a gage s of equal strength.

Fig. 16 illustrates another locomotive bricator with three separate feeds. This especially designed for feeding against equal pressures and all of the changeable conditions found in locomotive service. For illustration, it will feed against full boiler pressure in the steam chests, or, if a compound locomotive is to be lubricated, one feed will deliver into the high-pressure and another into the low-pressure steam chest. Both will work well when going down grade with steam shut off, or when the locomotive is at rest. If it is ever necessary to renew a sight feed glass, or replace a wornout gasket, it can be done under full steam pressure, as valves are provided for this purpose.

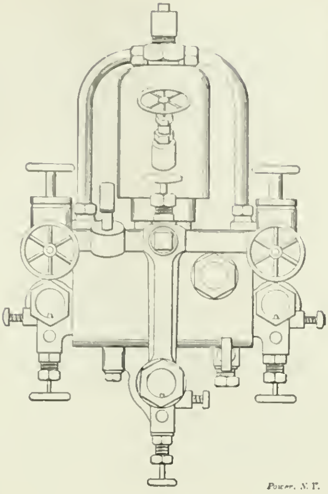

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FIG. 16

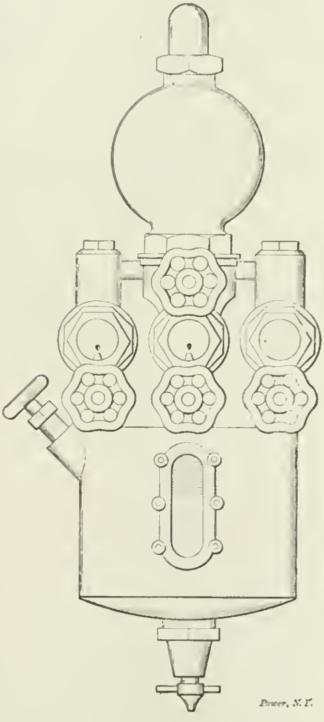
Power, N. Y.

FIG. 17

When the efficient service secured by the use of these lubricators is compared with the wasteful and costly methods adopted in connection with common lubricators, so-called, and tallow cups, the benefits secured will be appreciated. It is not claimed that they will use less oil, because in places where a premium is paid for oil saved, the amount used is much less than good lubrication demands, causing excessive friction of the parts and unnecessary repair bills. As the premiums are paid to men who do not pay the above expenses, these unsatisfactory results are accounted for. If really efficient service is required, taking the whole into consideration, the modern lubricators described in this article will prove far superior to the crude devices used in many cases for the purpose of spreading oil without due regard to right use of the same.

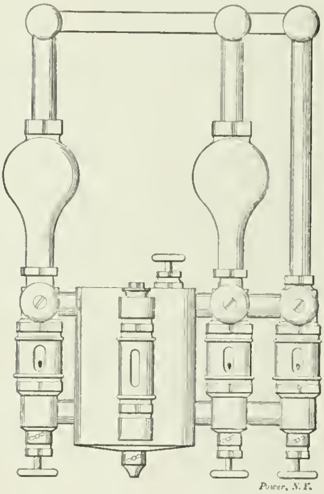
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FIG. 18

Fig. 17 illustrates a triple sight-feed lubricator with a glass disk for each feed, and a special gage glass made of thick flat glass which cannot be easily broken. This is very convenient and removes one objection to the disk or "bull's-eye" sight feed, as it is generally understood that a gage glass will not be used in connection with this style of sight feed. Another cause for this conclusion, in addition to the reason already stated, is that the "bull's-eye" sight feed is frequently (but not always) used where it is not practicable to install glass tubes, as they would not prove durable and the conditions of service will not admit of renewing them at short notice, but this flat gage glass [illegible] and give the engineer a better lubrication than was possible before.

Fig. 18 illustrates another triple sight-feed lubricator, fitted with a gage glass. Glass tubes are used for all of them, but they are well protected by metal shields, therefore it requires a smart blow to break one. This kind is preferred by some engineers, but they are not better than the "bull's-eye" type, as the metal shields obstruct the view, making it difficult to determine the rate of feed unless the light is strong and favorable.

Fig. 19 illustrates a peculiar kind of lubricator that is fitted with three sight feeds. Glass tubes are used for these feeds, therefore the device is not suitable for hard usage, but for stationary engines under normal conditions it will give satisfactory results.

An estimate of the quantity of cylinder oil required to lubricate an engine may be made as follows: Divide 50 by the number of drops used per minute. The quotient represents the time in hours that one quart will last. For illustration, suppose that 2 drops of normal size are used per minute. Then one quart will last 50 ÷ 2 = 25 times. On this basis one gallon will last 25 × 4 = 100 hours, or 10 days of 10 hours each. Of course much depends on the size of the drops, therefore no accurate rule can be given for this purpose, but this will give approximate results.

Reports are occasionally made of engines that are run without cylinder oil, but there seems to be little danger of this practice becoming universal. It is claimed that if a new engine can be run for a few days without oil in the cylinder, it will never need it afterward, but not many engineers have the assurance required to enable them to start a new engine without thoroughly lubricating every part. To a careful engineer who understands the comparatively rough condition in which the cylinder and piston, also the valve seats and valves, come from the machine shop, the idea of putting them into service in a dry condition cannot be reconciled with good practice, but on the contrary he cannot without a strong effort refrain from using much more oil at first than he intends to after the first week.

Even if the engine builder, or his representative, and the purchaser stand by and agree to take the responsibility, in case the cylinder is scored, or the valve seats cut from lack of lubrication, it does not entirely satisfy him, as he is well aware of the fact that when his record as an engineer is reviewed in after years, in order to decide on his qualifications for a responsible situation for which he has applied, the damaged engine will be included in the evidence, without the redeeming feature to which he is justly entitled; therefore, he will probably be blamed for the whole trouble.

Furthermore, although engines have been run without cylinder oil and have not been ruined by the process, there is no evidence at hand to show that friction is less under this condition than it would be if the internal parts were well lubricated.

When it becomes necessary to take off

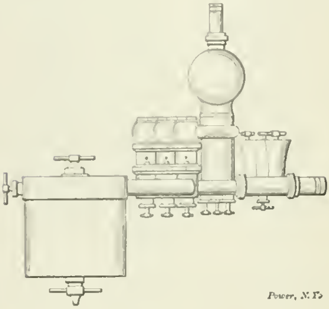
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FIG. 19

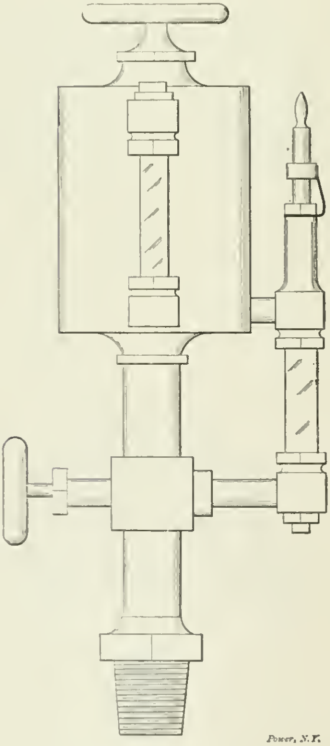

Power, N.Y.

FIG. 20

the steam chest cover, or the cylinder head of an engine, my first idea is to note the condition of the internal parts. Those that are located in my plant are covered with oil that has remained after steam was shut off, thus preventing rust from collecting on the surfaces while the engine is shut down. What would be the result if I discontinued the use of cylinder oil? Would not these parts corrode in a short time, thus greatly increasing the danger of scoring when they are put in motion again?

On the other hand, much more cylinder oil is used in some plants than is actually required. Proof of this fact is sometimes secured in unexpected ways, of which the following incident is a good illustration: A certain small engine was fitted with a lubricator holding not more than a pint of oil. In some plants where power is developed in a high-speed engine this would be used in five hours, while in others it would last two days. If it answered the purpose for three days of ten hours each, it would be considered extraordinary. Through a misunderstanding this lubricator full was not fed out in five weeks, yet there was no evidence to show that the lubrication was defective. The engineer accounted for this record by stating that there was no separator on the exhaust pipe, hence oil that was previously run through the cylinder accumulated in the boiler and floated on the water surface, whence the steam carried this oil to the cylinder and used it many times.

Perhaps this theory is correct, but why does not oil that passes through the high-pressure cylinder of a compound engine lubricate the low-pressure valves and piston? Is it because it is "worn out" by its service under high pressure, or does it settle down to the lowest places, and so pass out with the exhaust steam without being distributed through its entire volume? Why does more of the same oil when fed directly into the low-pressure steam chest, lubricate the parts better than a much larger quantity delivered through the high-pressure cylinder? If the latter assumption were not true, it would only be necessary to have a singl sight-feed lubricator for a compound, o even a triple-expansion engine. Thes questions relate to interesting points o cylinder lubrication, on which there i not as ,much information available a there ought to be for the good of al concerned.

Fig. 20 illustrates a lubricator suitabl for the cylinder of a gas engine. Th filler plug opens a passage leading directl into the body, hence it can be filled quickl even when oil is cold and thick. As thi is not a hydrostatic lubricator, the fee is downward, and it is regulated by th valve directly over the sight-feed glas When the proper feed is secured it ma be entirely shut off by pulling the sna lever down. Raising this restores tl feed without readjustment. The cro valve should be closed when the body to be refilled.

The lubrication of gas- and gasolen engine cylinders becomes a serious pro lem in some cases, owing to the gre heat developed by combustion directly the cylinder. This not only makes it necessary to use an oil with a high fire test to lubricate the highly heated parts, but there must be a minimum of sediment left in the cylinder to be disposed of by the scavenger process. A certain portion of this sediment bakes onto the piston, etc., but the percentage is greater with some oils than with others, hence when experience has demonstrated which kind is best for known conditions, it is a good idea to buy that kind and repudiate all others.

When a new gas engine is started, care should be taken to know that the cylinder is thoroughly lubricated, because lack of

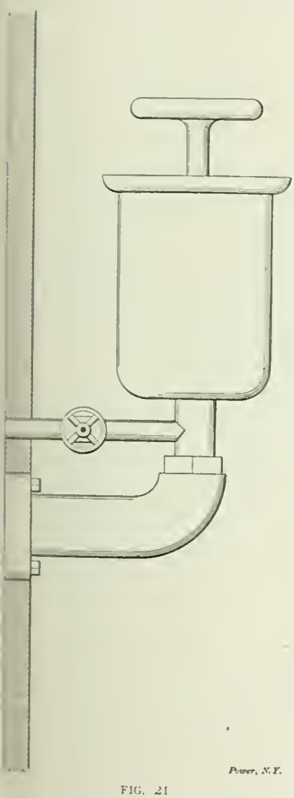


FIG. 21

rication will usually damage the cyl- r f an internal-combustion engine h sooner than in the case of a cyl- der in which steam is used. This is e to the high temperature secured and k f moisture found in steam.

Fig. 21 illustrates the best hand pump r oiling a steam cylinder, that I ever sed. It was formerly supplied with every rliss engine built by a certain firm, t as competition became stronger, this mp was omitted from the list of trimmings belonging to the engine. It rested a strong cast-iron bracket, which gave a firm foundation, hence when the discharge valve was opened and the piston forced downward in the process of sending oil into the cylinder, there was neither spring nor vibration felt in connection with the action, and this is in strong contrast with some of the hand pumps that we find in service today

A hand pump of some kind should be installed on every engine, not to be depended on for regular service, because it takes too much time to oil the valves and piston of an engine in this way, but to be kept in reserve as a spare device for this purpose; then if the regular lubricator fails to work, or the engineer neglects to fill it at the right time, causing the valves to "grunt" or the piston to "chatter," because they have not been properly lubricated, he can quickly send a dose of oil where it will restore normal conditions, then refill the lubricator at his leisure. It is useless to argue that an engineer should always refill his lubricator at the right time, which is just as soon as the last drop of oil has gone out of it, as other important work may claim his attention at that particular time, making it impracticable to stand and watch the lubricator.

I am aware of the fact that as a general rule an engine will run for a considerable time without receiving oil into the cylinder, as it is demonstrated in my own practice, but this proves that it has been receiving more oil than was necessary, for if oil has been sent into the steam pipe at the rate of two drops per minute, and it is possible to shut off the supply for 30 minutes without having any perceptible effect on the engine, the regular supply ought to be reduced to one drop per minute and maintained there until it is proved insufficient for the desired service.

If the regular feed is reduced to the lowest practicable point in everyday service, as described, a small quantity ought to be pumped in just before steam is shut off, when the engine is to remain idle for one or more days, in order to insure copious lubrication and cover all of the internal surfaces with oil at this time, thus preventing them from rusting while not in use. A hand pump is very convenient for this purpose

About twenty-five years ago, the National Association of Stationary Engineers, of which I was a member, occupied rooms that were adorned with engineering appliances of many kinds. Among these was a force feed oil pump, which is illustrated in Fig. 22. We always regarded it as a curiosity, and although it seemed to be designed on principles that were mechanically correct, none of them was put into service on our engines. It operated as follows: The connecting rod *A* was attached to some part of the valve gear that gave it a horizontal movement of 2 or 3 inches. This caused the vertical lever *B* to swing accordingly, and operate the pawl *C* which engaged the rack just below it. In the illustration this rack is moving toward the left-hand, but when the end of its travel in this direction is reached, the pawl is changed and the rack moves in the opposite direction. The right-hand end of this rack forms a plunger which works in a small cylinder as shown, thus forcing oil that has accumulated in front of it out through two check valves into the steam pipe. The feed is increased by raising the clamp *D* and decreased by lowering it.

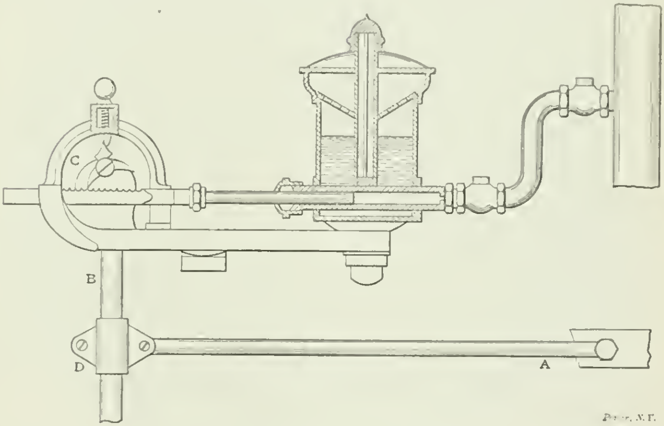


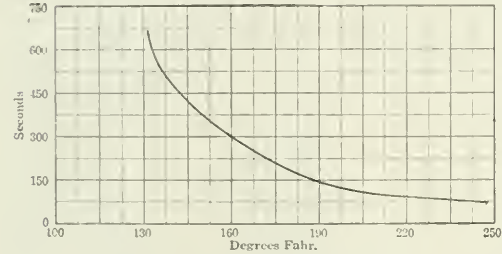
FIG. 22

Why did the force-feed oil pump fail to receive recognition as a practical device for so many years, and then suddenly come into favor so rapidly that several firms were kept busily at work filling orders for them? Why did not engineers appreciate its value when it was first put on the market? Is its value overestimated at the present time? Is there any good reason so far as the mechanical operation of both is concerned, why oil should be fed faster through a good hydrostatic lubricator than it is forced into a steam [illegible] by an oil pump? If one drop per minute is sufficient to lubricate an engine when an oil pump is in use, is there a good reason why the same engine should receive four drops per minute by means of a hydrostatic lubricator? These questions are submitted to engineers and steam users, trusting that they will receive whatever consideration they may deserve, and prove interesting accordingly.

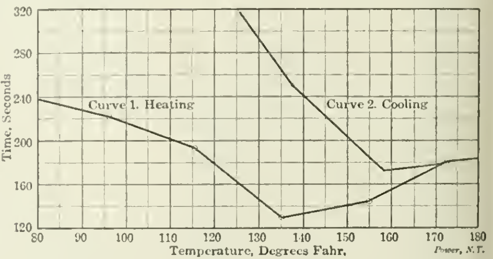
## Testing Lubricating Oils

By P. H. White

No modern power plant is complete without some means of testing the oils which it uses for lubricating purposes. Any engineer can make a few simple tests in a very short time, and thus determine the kind of oil best suited to his plant.

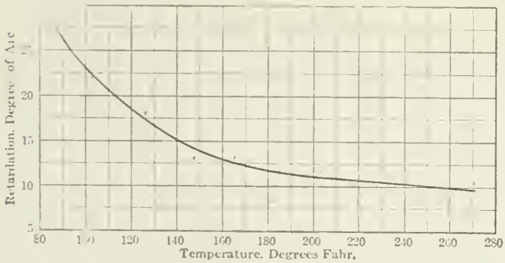


TIME-TEMPERATURE CURVE FOR CYLINDER OIL, PENN. R. R. VISCOSIMETER

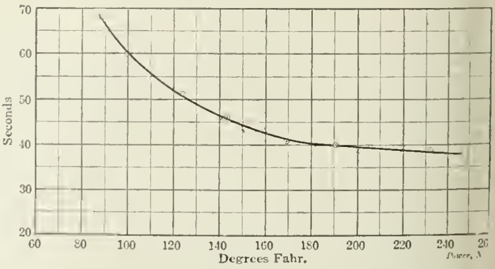


TIME-TEMPERATURE CURVES FOR CASTOR OIL, SCOTT VISCOSIMETER

The apparatus may be quite simple and inexpensive, or it may be more elaborate; but in general, the simpler apparatus is much easier to use and gives results sufficiently accurate for practical power-plant purposes. A good thermometer capable of recording at least as high as 700 degrees Fahrenheit, a small iron crucible four or five inches in diameter, a few small porcelain crucibles, an alcohol or a bunsen lamp, and some form of a viscosimeter are all the apparatus that are necessary.



RETARDATION-TEMPERATURE CURVE FOR OIL, DOOLITTLE VISCOSIMETER



TIME-TEMPERATURE CURVE FOR MACHINE OIL, PENN. R.R. VISCOSIMETER

The viscosimeter is the part of the apparatus which, for the most part, determines the cost of the outfit, but with one of the simpler forms, the cost will be insignificant. The simplest form of this instrument is found in the "Pennsylvania Railroad Company's viscosimeter." It consists simply of a small glass tube with a large bulge in the middle which forms a reservoir for the oil. On each side of this bulge the stem is marked, and the space between these two marks will hold exactly 100 cubic centimeters of oil when at a temperature of 100 degrees Fahrenheit. One end of the stem is drawn down to a jet, so that the oil will not run out too fast.

In using this viscosimeter, it is clamped in a vertical position with the jet end of the stem down. A small rubber tube is slipped over the upper end of the stem, and after the temperature of the oil has been taken, it is drawn up into the glass by sucking on the rubber tube. The stem should be filled a little above the upper mark, and the rubber tube removed. As soon as the surface of the oil reaches the mark on the stem, the number of seconds must be counted until it reaches the lower mark. After the oil has run out its temperature is again taken, and if this differs from its first temperature, the two are averaged. The sample is now heated up about 20 degrees, and the process is repeated. A large number of readings should be taken, increasing the temperature about 20 degrees each time. After quite a high temperature is reached, readings should be taken at differences of about 20 degrees as the oil cools. Any good oil will show no appreciable variation in the time required to discharge 100 cubic centimeters of oil at a certain temperature; but some impure oils, after being heated to a high temperature, will give widely varying results. For more accurate determinations, a second complete test should be run after the oil has stood for several hours.

Another quite simple apparatus is the Scott viscosimeter. It consists of a small copper vessel capable of holding about 200 cubic centimeters of oil, and a copper vessel surrounding this and forming a water jacket. In the bottom of the oil reservoir is a valve which controls the flow of oil. The sample is poured into the oil reservoir, and the jacket is filled with water. A glass graduate is placed under the oil outlet, and a thermometer is immersed in the oil in the reservoir. After the temperature has been read, the valve is opened, and the oil is allowed to flow out into the graduate. As soon as the stream of oil strikes the bottom of the graduate, seconds are counted until 5 cubic centimeters have run out. This i poured back into the reservoir, and tl temperature of the oil is raised by heati the water bath. The principal advanta of this over the Pennsylvania Railro Company's viscosimeter is that the wat bath prevents considerable radiation heat from the oil reservoir. The resu obtained by using the two instruments a however, practically the same.

A much more expensive apparatus, a

ne which works on an entirely different rinciple, is the Doolittle torsion vis- smeter. A small brass cylinder sus- ended by a fine wire is immersed in the essel of oil. Above this cylinder, and onnected to it by a stiff brass rod, is a rge disk, graduated in degrees. The spending wire is fastened at the top of pair of uprights to a torsion head, so t the wire can be twisted any desired nt. When there is no torsion in the ire, the pointer above the graduated disk als at zero.

In using this instrument, the tempera- e is read as before, and while the disk eld stationary at the zero mark, the n head is given one complete turn. disk is now released, and the torsion the suspending wire causes it to re- ve against the frictional resistance of il surrounding the brass cylinder. the disk stops at the end of its swing, the reading of the pointer is led. The backward swing is disre- but upon the third swing, when disk is moving in the same direction rst, another reading is taken when es the end of its swing. The dif- between these two readings is the n in degrees, due to the fric- f the oil against the brass cylinder. rrect for any errors in reading, the k is stopped at the zero mark, and the n head is turned in the opposite tion. When the retardation is again , the two are averaged. The oil is as before, and a set of readings taken for about every 20 degrees ge of temperature. This instrument, iffering greatly from the two pre- ly described, shows practically the results when curves are plotted from readings.

e accompanying curves show some of results obtained in actual tests. With ils, the curves are all quite regular; e curves for the castor-oil sample w what may be expected from impure

flash and burning points are very determined for any sample of oil. all porcelain crucible is filled with mple, and this is placed in an iron ible and packed around with sand. rmometer is suspended above the le, so that the mercury bulb is im- l in the oil. Heat is now applied iron crucible by means of a bunsen r or an alcohol lamp. When the ature becomes quite high, a lighted r is held about half an inch above urface of the oil from time to time. the vapor given off by the oil s up and burns for an instant, the perature is read and recorded as the point. The heating is continued until flame spreads over the whole surface, the vapor continues to burn after the ted splinter is withdrawn. The tem- ature is now read and recorded as the ing point.

A few simple tests such as here outlined will give the engineer an idea of the purity of the oils he is using, and will aid him in determining the value of any new sample of oil which is brought to his attention.

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## Wooden Water Pipe and Gate Valve

In 1774 work was begun upon a water-supply system for the City of New York, the reservoir being built on the east side of Broadway between Pearl and White streets, and the water pumped from a pond where Center and Leonard streets are now located, and upon the site now occupied by the Tombs prison. The pumping station was located on Pearl street near Elm street. As a means of conducting the water, wooden pipes were placed under the streets, and the residents of the city in the vicinity of Wall street and lower Broadway were thus supplied.

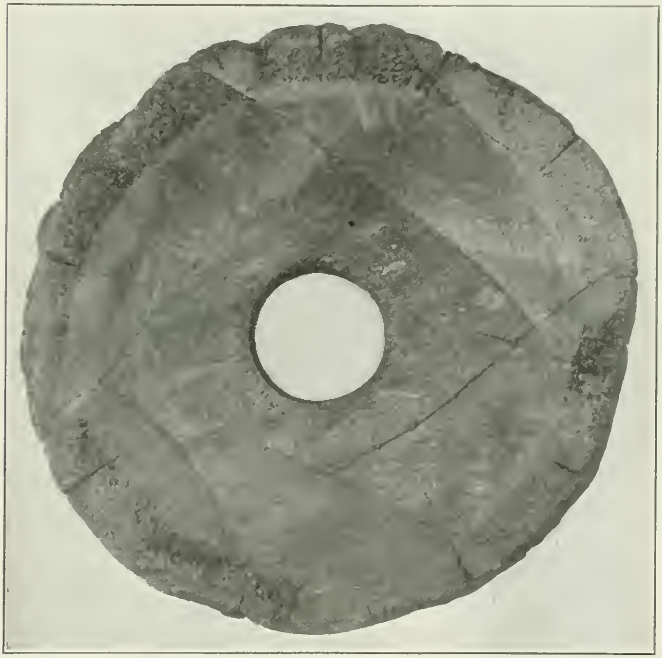

FIG. 1. SECTION OF OLD WOODEN WATER PIPE

Fig. 1 shows a section of wooden water pipe taken from the corner of Pearl and Park streets, October 21, 1906, after having been underground more than 130 years. This particular piece of pipe formed part of the water system constructed by Christopher Golles for the city during 1774 and 1776. The pipes were made of white-pine logs, the hole being bored and varying from 2 to 6 inches in diameter. The piece of log shown in Fig. 1 is 11 inches outside diameter, having a 2½-inch hole. It will be noticed that for a depth of about one inch the wood slightly shows the effect of its long interment, while the rest of the section is as solid as when it was cut. The fiber of the wood surrounding the bore does not appear to have suffered from the flow of water through it.

A solid wedge gate valve of 1779 design, and probably about the first constructed, is shown in Fig. 2. It was taken from Park row, New York City, during the subway excavation in 1900. The valve body was made from a white-pine log and the wedge from a piece of sheet iron, which was lowered through a close-fitting slot in the body of the valve.

Wooden pipes were used up to 1815, when iron pipes were introduced, and it is said that some of these iron pipes are still in use and in a perfect state of preservation.

Every branch of industry has advanced so vastly over the original practice that it seems almost incredible that the crude methods used by our forefathers were ever put to practical and successful use. This also applies to gate valves and piping, for today one can purchase a gate valve 96 inches in diameter and weighing approximately 18 tons, which may be opened and closed by simply pressing a button instead of digging it out and prying it open with a bar as in the case of the primitive valve here shown. The limit of size does not seem to have been reached, as the Chapman Valve Manufacturing Company is designing a valve 108 inches in diameter, to be capable of withstanding 100 feet head, for a Niagara Falls plant.

We are indebted to the C. T. Hungerford Brass and Copper Company and Mr. Frank Barry, New York manager of the Chapman Valve Manufacturing Company, for data pertaining to the wooden pipe and gate valve, respectively.

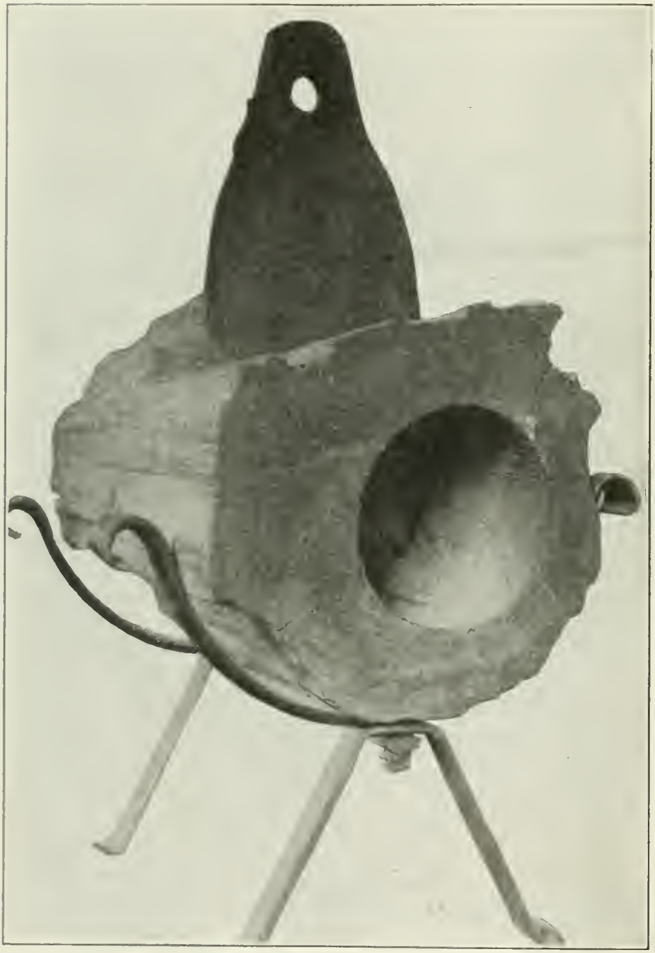

FIG. 2 OLD-TIME SOLID-WEDGE GATE VALVE

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More than 12,000,000 tons of coal were produced in India in 1908, against 11,000,000 tons the previous year, Bengal heading the list with 11,500,000 tons, or 95 per cent. of the whole.

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# Probing Storage Batteries

By M. C. Saeger

When storage batteries are provided with lead-lined tanks, it is impossible to see the condition of the bottom of a cell by natural light, it is necessary to have a lamp submerged while making an inspection. Foreign matter, such as soluble substances and metals other than lead, should not be submerged in the electrolyte.

Fig. 1 illustrates a method of arranging a lamp for inspection purposes. No. 16 B. & S. gage weatherproof wire is threaded through the stick as indicated; a weatherproof socket is strapped to the block *K* with a small strip of lead. Where the lamp and wires enter the socket they should be covered with rubber tape followed by friction tape and finally coated thoroughly with hot paraffin. The stick should also be covered with paraffin, bu not necessarily taped.

Fig. 2 shows a gage stick to measur the hight of the sediment which accumu lates at the bottom of the cells. scale is marked on one side of the stic and small holes are bored opposite eac scale mark. When the stick is thru down into the sediment the holes tha enter the sediment are filled with it an retain it when the stick is drawn out. plain stick dipped down will show n mark as the sediment is washed off the stick is drawn through the electrolyt

In recovering iron or steel which l accident may drop in a cell, a permane magnet secured to a stick, as in Fig. 3, very convenient. The magnet and sti should both be dipped in hot paraffin a protection against the action of t acid. A small strap of lead should be us to fasten the magnet to the stick. Electr magnets are not satisfactory in prol for metal because the acid soon w into the winding of the coil and dest it.

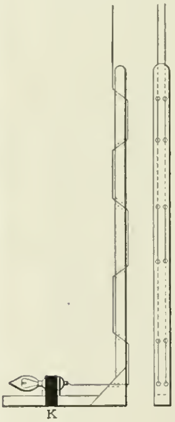


FIG. 1

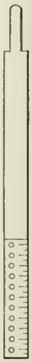
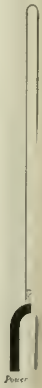


FIG. 2



FI

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The meetings committee of the Amer Society of Mechanical Engineers has clined a petition for a National Cong on the subject of Smoke Abatement, the council in approving of this a suggests to the meetings committee it may arrange for a monthly meetin the near future on the subject of sr abatement on strictly engineering line

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A new steamship will be built b Cunard line. It will not be quit large as the "Mauretania" and "Lusita but will be able to serve instead of e at times of repair or overhauling. bids will contain alternate prices on bines, reciprocating engines and com tion machinery, and the type of e will be decided later.

# Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think,
Know or Want to Know About Your Work, and Help Each Other

## WE PAY FOR USEFUL IDEAS

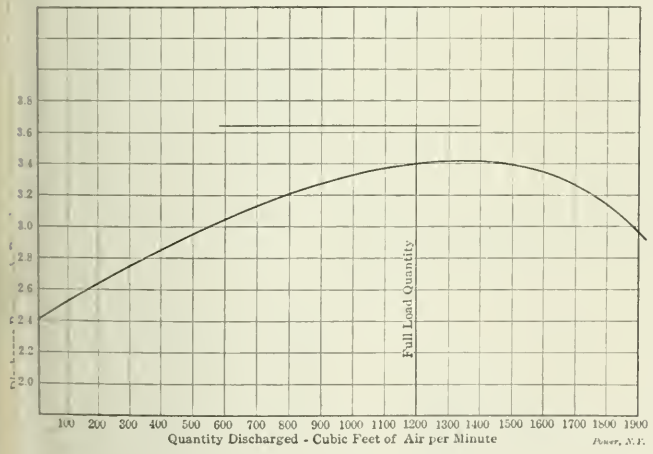
### haracteristics of Centrifugal Air Compressors

Centrifugal air compressors differ very materially in their operating characteristics from the standard types of positive-pressure blowers, and as they are just making their appearance in commercial installations, engineers not familiar with their different characteristics are likely to try to operate them as they would a positive-pressure blower.

The positive-pressure blower operates at constant volume and variable pressure, when the speed is held constant. That is, with every stroke of a reciprocating compressor or every revolution of the cycloidal type, a certain definite volume of air is taken into the compressor and discharged, the pressure of the air depending on the size of the orifice through which it is forced. Positive-pressure blowers are usually equipped with safety valves to prevent excessive pressure rise when delivering small quantities, and this leads to waste of power when operating at light loads.

The centrifugal compressor requires no safety valve and is thus much more efficient at light loads than the positive-pressure machine. The main characteristic of the centrifugal compressor is just the reverse of what it is in the positive-pressure blower. The pressure is nearly constant at constant speed, while the volume can be varied through a wide limit. The accompanying curve shows how the pressure varies in a centrifugal compressor from no-load quantity to load and a half.

By automatically varying the speed of a positive-pressure blower it can be made to work as a constant-pressure machine through a limited range, while by varying the speed of a centrifugal compressor it can be made to work as a constant-volume machine through a limited range.



CHARACTERISTIC CURVE OF CENTRIFUGAL AIR COMPRESSOR

In the centrifugal compressor this change of speed is obtained automatically by having a floating air governor attached to the inlet pipe of the compressor. This governor consists of a sheet-iron cone inside of which is a circular disk supported by the current of inflowing air. The hight at which this disk floats depends on the quantity of air flowing. The disk is connected by levers, with the speed-controlling device of the driver, so as to change the speed with any change in the quantity of air flowing and thus hold the quantity constant at the volume at which the air governor is set to operate.

When starting a centrifugal compressor the blast gate should be closed until the machine has been brought up to speed and then it should be gradually opened. All openings closed gives light load on this type of compressor. This is the hardest thing about the machine for operating engineers to grasp, as it is directly opposed to positive-pressure-blower practice. The machine should never be run with the piping wide open to the air. Under these conditions it will deliver several times the full-load volume and since the pressure does not drop off a great deal at heavy overloads, as can be seen from the curve, the driver will be heavily overloaded, and if the compressor is motor-driven, the motor armature will be very likely to be burned out. With a turbine-driven machine no particular damage would be done.

It might be well to state for the benefit of those not familiar with this type of compressor that, due to the high speed at which they run, they are always direct-connected to the driver and the drivers are either high-speed motors or steam turbines.

The one great fault with this type of compressor is the liability of the impeller wheel to vibrate. The inherent characteristic of the machine requires very high wheel speeds. A common practice is to run a 30-inch wheel at 4000 revolutions per minute. This gives a peripheral velocity at the rim of 31,400 feet per minute. While this is not a high value for turbine practice, it is for wheels constructed as are impeller wheels and it requires the most careful balancing of the wheels to prevent excessive vibration at this speed. Excessive vibration may cause the impeller blades to break off, due to fatigue, and is almost certain to put the driver out of commission.

When two centrifugal compressors are used to pump into the same main header, a check valve should be placed between each machine and the header. If this is not done and it is attempted to run much under full-load quantity for both machines, one or the other of the machines will take all of the load and thus run at a heavy overload, while the other machine will be running light. The reason for this is that centrifugal compressors have a rising-pressure characteristic from no load up to nearly full load; that is to say, an increase in quantity of air delivered by the compressor gives an increase in pressure. This can be readily seen from an inspection of the curve. When two compressors are pumping into the same header there is a slight pulsation of pressure in each machine and as one compressor happens to reach momentarily a slightly higher pressure than the other, the slight increase in pressure will increase the quantity supplied by this machine, and the increased quantity will give a still higher pressure, due to the rising characteristic, and this in turn a larger quantity. This building-up process will continue until one machine is carrying nearly all the load. This tendency can be overcome by having the speed of the driver drop off as the load increases, thus neutralizing the effect of the rising-pressure characteristic.

This change in speed can be obtained in turbine-driven machines by a simple adjustment of the governor for falling speed, and in direct-current motors by having them heavily compounded.

HOWARD M. NICHOLS.

Kenyon, R. I.

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## Painting Power Plant Stacks

A short time ago we got tackle and material ready to paint the stacks of the power plant; but when we came to hoist the tackle by means of the small cables (Fig. 1) with which each stack was equipped, they were found to be broken and useless.

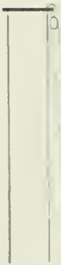

FIG. 1

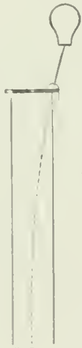

FIG. 2

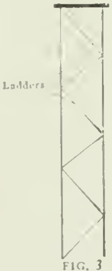

FIG. 3

Power, N.Y.

We procured some paper balloons and sent them up inside the stack (Fig. 2) with a cord attached, intending to pull up a small rope, and then a wire cable. Everything worked nicely until we began pulling the string. It caught on a ragged edge on the top and refused to go farther. Several attempts were made, but always with the same result. The string method was a failure.

The stacks are 116 feet high and 5 feet in diameter. We were not in a mood to give up, and the job was shortly accomplished by building nineteen ladders each 8 feet long, the longest we could take in at the base of the stack. These ladders were built to fit together at the proper angle, and set up inside the stack, as shown in Fig. 3. New cables were placed in the sheaves at the top and the painting was soon in progress.

C. D. ELDREDGE.

Fairport Harbor, O.

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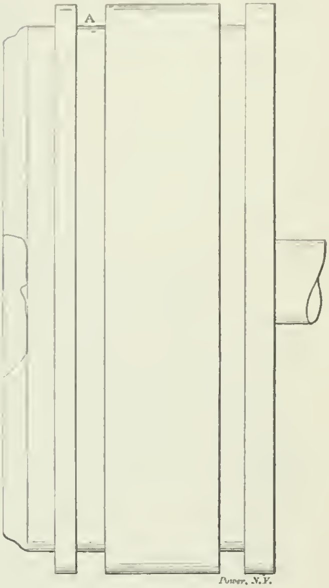
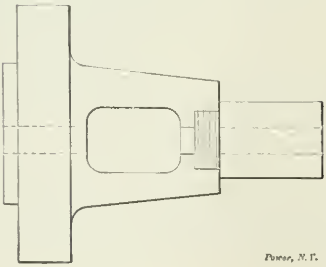
## Two Repair Jobs

In the engine room a quick solution and repair often make a great saving. We had a piston (shown in Fig. 1) in which the rod gave way. In taking the piston out, we broke the ring groove, as shown. We had to make a new piston rod, and scheme some way to repair the piston so that the engine could be used at once.



Power, N.Y.

FIG. 1



Power, N.Y.

FIG. 2

We cut a temporary ring groove back from the broken one as shown at *A*. A new ring was made, and when the engine was started it ran very smoothly, and continued to do so until we could get a new piston.

In Fig. 2 is shown another rush job, that of repairing a Corliss-engine bonnet that had been broken off. We bored out the end, made a new supporting collar and threaded it into the broken piece, and the bonnet was as good as new. We heated the base of the bonnet slightly and screwed in the extended collar; in cooling it shrunk on the collar and made a good solid job.

C. R. McGAHEY.

Richmond, Va.

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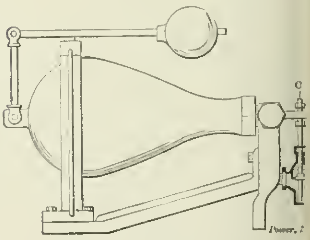
## Adjusting Bundy Steam Traps

In instances where Bundy return trap are used for draining oil from the separators of condensing engines there ma be some trouble in their operation, whe used with a vacuum, due to sticking o the center.

The object of this letter is to sho how this trap can be adjusted so that it operation will be uniform, no matte whether it is draining headers under hig steam pressure, or oil separators under vacuum.

Anyone familiar with the Bundy tra knows that when the steam valve is op the air valve must be closed and *vi*



ADJUSTING BUNDY STEAM TRAPS

*versa;* also, that the higher the lift of steam valve the less lost motion there v be between the collar and the locknuts the steam-valve stem, wherein lies cause of all the trouble, as I have found With small lost motion the action the trap will be as follows: The trap b will fill with water and oil and slo start to descend, the collar *A*, striking top locknuts *B* on the steam-valve sten and tending to open the valve, upon wl there is full steam pressure. This p sure, in addition to the friction of trunnion packing, counterbalances weight of the water in the trap bowl the descending motion is arrested, lea the bowl hanging in midposition.

To overcome this condition, the bowl must drop far enough to gain s cient momentum to overcome the pres on top of the steam valve and the fric n of the trunnion packing. To do thi it must have sufficient lost motion betw n the collar *A* and the locknuts *B* an *C* on the steam-valve stem *T*. To do is, depress the trap bowl to within 1/16 in of the bottom of the frame, in the m n-time having screwed the locknut *I* up and the lower locknut *D* down, and make a mark on the valve stem in line with the top of the stuffing-box nut. Then screw the nut *B* down until the steam-valve disk is raised 1/16 inch.

Next, try to screw up the air-valve disk until it seats itself, which you will be nable to do, because the threads on the air-valve stem are not cut up far enough. Mark the hight to which the threads should come and take out the stem and cut the threads up to this point, at the same ime sawing off enough of the stem to al w the use of the cap locknut for holding e air-valve disk in position.

Then repeat the foregoing adjustment, d when the steam valve has a 1/16-inch and the air-valve disk is against its seat, lock the nut *B* in that position. Then se the trap bowl to within 1/16 inch f the top of the frame, and screw up e lower nuts and lock in position. The p will then be in perfect working order. If the trap is draining a vessel below mospheric pressure, a slight leakage at e steam valve will allow the bowl to ll with vapor, which will hold the inlet eck valves closed, thus keeping out the er. To test for this, close all the lves but the steam valve leading to the p and unscrew the cap from the inlet eck valve. If there is any leakage, one ll be liable to see it. To remedy, take valve out and put in a seat of good rd babbitt and the trouble will be over.

Frank G. Engle.

yton, O.

## Water Power for Steam Pumps

I have been surprised to learn that few ineers seem to realize that the or- ary duplex steam pump can be run on ter pressure from city or other mains. ere are a great many places where h a pump can be used to advantage, re conditions or location prevent the f steam.

me time ago I was in charge of a ing station operated by oil engines. ecame desirable to pump the fuel oil m the barrels in the storage shed to tanks on the engines. After studying us schemes, I decided to use a water- n pump. I tried to locate a suitable ndhand one, but every engineer and nery dealer that I outlined my plan ndemned it as impossible. Not dis- aged, I purchased a new pump and it done its work faithfully. The water re varies from 40 to 60 pounds, t this has never given any trouble. Of rse, it should be remembered that the ns will not travel as fast as with am, so a larger pump will be required do the same amount of work. The mp that I put in was a 2 and 3 by 2-inch plex and had a capacity of about five llons per minute.

H. K. Wilson.

dgartown, Mass.

## Air in the Air Chamber

A chief engineer in a cotton mill in Massachusetts, holding a first-class license, had the top of the air chambers on all his pumps drilled and tapped and pet cocks put in so he could "let out the foul air" whenever it accumulated. In starting a pump he would always open the pet cock and let it remain open until a solid stream of water came out. Then he would close it, and wonder what made the pipes and pump jar so. With the best of arrangement, very few air chambers are performing their full duties, unless some method is used to fill them full of air. We usually expect that the air chamber will fill with air from the water, but I think we would be surprised to find that very few air chambers are even half filled with air when under pressure.

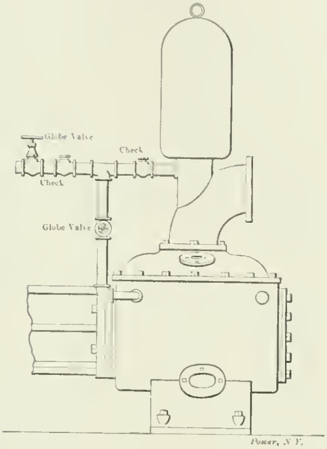


FIG. 1

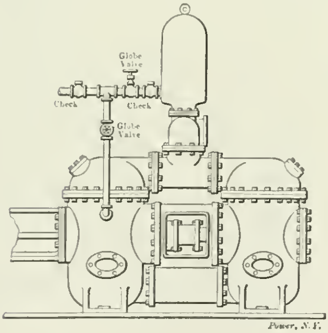


FIG. 2

While a small amount of air will sometimes be sufficient to prevent the pump from jarring badly, nine times in ten, if the air chamber were full of air when in operation, things would go much smoother, and fewer pump valves and studs would be broken, from apparently no known cause.

A very simple method of filling the air chamber with air is shown in Figs. 1 and 2. It works well and can easily be applied to any pump by the engineer. Drill into the pump at any place in the suction chamber *between* the two sets of valves, preferably in the highest place available, and tap for a ½-inch pipe. Then enter the air chamber near the bottom and connect as shown.

At each suction stroke of the piston on that end a small amount of air will enter the pipe, and upon the return stroke part of this air will be forced into the air chamber. In a very few minutes the chamber will be filled, when the valve should be closed until the chamber has again become filled with water. It will be much better if a glass gage is put on the air chamber so the amount of water and air in the chamber can be seen.

H. W. Grafton.

Lawrence, Mass.

## Kerosene in Boilers

I have been taking a silent interest in the controversy in regard to kerosene in boilers, and will give my experience with kerosene long before I saw anything written about it.

About three years ago, when I took charge of the plant which I am now operating, in going over the boilers I found cold water feeding into them. This plant is fitted with two National closed heaters, one from each engine, and making inquiry of the fireman as to why he was feeding cold water, the answer was that "the heater is checked." I at once set about to ascertain the cause. I disconnected the outlet and found the coils closed to ¼ of an inch. The outlet being at the bottom, I plugged it up and, disconnecting it at the top, filled the coils with kerosene and let it stand forty-eight hours. Then I made steam connection direct from the boiler into the top, took the plug from the bottom and turned on the steam at 125 pounds pressure. It worked.

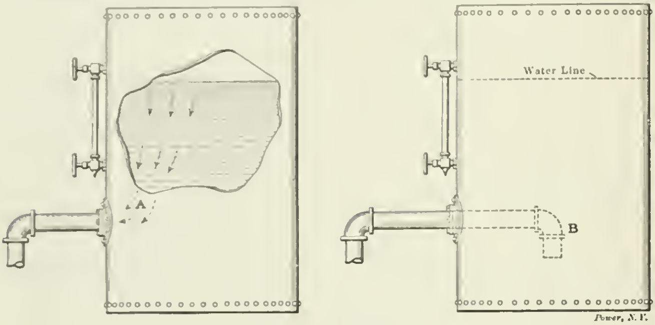
This scale was not of a solid formation but made up of thousands of particles that had formed from time to time and been released, and then formed into one porous mass. I find kerosene in boilers very beneficial when used in the right way and at the right time. I have never got any material benefit beyond the heaters and feed lines by using it while the boiler is under steam. I find the proper time (if the boiler is scaled) is after cleaning. As kerosene is not a solvent of lime formation, it only does its work by penetrating to the sheets and there forming a body which causes the relaxation to take place.

J. R. Boyd.

Rogers, Ark.

## A Troublesome Pressure Tank

The accompanying sketch illustrates a tank in a hydraulic-elevator installation which gave considerable trouble. Ordinarily the water was carried at about two-thirds the hight of the tank, leaving the remaining space for air.



A TROUBLESOME PRESSURE TANK

Difficulty was experienced in maintaining the desired pressure without the air going out under the plunger with the water. This brought about unsteady motion of the cars, an almost continuous application of the air pump, etc.

The engineer in charge conceived the idea that there was a sort of swirl formed, as at *A*, above the mouth of the discharge pipe from the tank to the cylinder, such as one sees form in a vessel of water which has an opening in the bottom.

He tried an experiment, as illustrated at *B*, extending the pipe inside the shell and extending it down to within 3 inches of the bottom. This entirely overcame the trouble.

EDWARD T. BINNS.

Philadelphia, Penn.

## Poor Engineering

While visiting the power house of a large manufacturing concern recently, I saw a new way of installing pipe work and other apparatus.

The plant consisted of two direct-current generators direct-connected to cross-compound condensing Corliss engines, and three water-tube boilers of a new design. Upon first stepping into the engine room I did not know whether to stay or not, as steam and hot water were issuing from nearly every point in the plant, and the engines were running about as smoothly as a boiler shop. The "chief engineer," who had previously run a 50-horsepower slide-valve engine in a grist mill, told me that the engines were no good and that he had told his employer so. The engines had not seen a piece of waste for two weeks, judging from the amount of oil and dirt on the frame, and the space under the generators contained at least three barrels of oil that had dripped from the bearings and eccentrics.

The 12-inch header was divided into two parts by a gate valve, but no provision was made for operating the feed pumps or condenser from both parts. While I was there they connected up the third boiler, which made it necessary to cut a section out of the header to insert a tee. The part removed was taken to the machine shop to be cut off and threaded according to the dimensions given by the engineer. When the pipe was returned and put into position it was found to be ⅞ inch too long. Instead of cutting it off the engineer put wedge between a steam pipe to one of th engines and a column in the wall an sprung the piping apart by driving th wedge in with a sledge. Then he procee ed to "cuss" the fittings and the packin and machine shop because the join leaked.

The engineer in trying to show off son of his authority told one of the firem to keep the coal in a pile and not to scatt it all over the boiler-room floor, and th functionary promptly told him to where they don't wear overcoats.

I have since heard that it was nece sary to shut down this plant for twel days to put it in running shape, and n an engineer, in order to get a job in tl plant, has to have a pedigree a mile lo

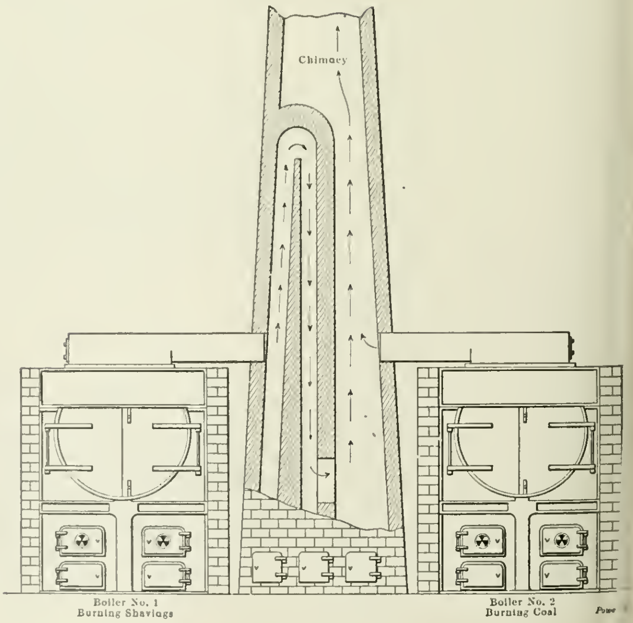
LOUIS B. CARL

Marshfield, Wis.

## Peculiarly Designed Chimney

The illustration represents a chim that has been doing duty for the past years and is apparently good for as any more. The object of this type of flue is that where shavings are burn the sparks travel a greater distance anc a better chance to die out and n set fire to the surrounding property.

There being no shavings burnt the diving-flue section has recently been



CHIMNEY OF ODD DESIGN

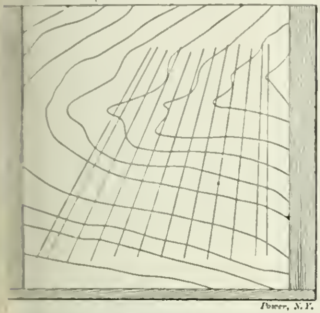
ut, making an ordinary direct-flue himney.

S. BUELL.

Lynn, Mass.

## inding the Mean Effective Pressure of Indicator Diagrams

There are two methods of obtaining the ean effective pressure of indicator diarams. The planimeter and the ordinate thod, which can be worked out with a mmon rule.



Power, N.Y.

FIND MEAN EFFECTIVE PRESSURE OF INDICATOR DIAGRAM

When using the ordinate method it is cessary to divide the length of the diam into equal spaces and then draw an nate through the center of each. This l give equal spaces with a half space ach end of the diagram. To space a gram requires considerable time and re, but by the use of the board shown the illustration it can be quickly and rately done.

The board is made of hardwood, ⅜ thick and 8 inches square, on each e of which is a cleat 1 inch wide, to d the board in shape. Across the bot is a strip of wood raised above the face of the hoard sufficiently to guide edge of a triangle. With the triangle this guide, draw a perpendicular ear the right-hand side of the board. the bottom of this line measure th left five inches and divide the into equal spaces with a half space ch end. Near the top draw a line inches long and similarly divide it and, a sharp-pointed instrument, draw from the bottom dots to the cornding top ones.

divide a diagram place it against guide and with the triangle draw a ppendicular line across it at each end s as to just touch the ends. The distice included between the perpendiculars w define its length. Move the diagram un the board until the ends of the perpdicular at the bottom coincides with t extreme lines on the board, and with a harp pencil dot the bottom of the per opposite each line. Move the paper dn against the guide and with the triangle erect a perpendicular from each dot and the diagram will be properly divided by ordinates.

The board laid out as shown will have a range of from 2½ to 5 inches. To assist in working up a diagram, a table of circle areas from the diameter of the smallest rod to that of the largest cylinder, also a steam table, can be attached to the back of the board for ready reference.

Considerable duplicate work can be avoided by computing a constant for each cylinder in the plant. This may be determined by multiplying the total area of each side of the piston, after deducting the area of the rod, by the stroke in feet and dividing by 33,000. The quotient will be a decimal which multiplied by the mean effective pressure and by the revolutions per minute will give the horsepower at that particular speed and pressure.

LEWIS C. REYNOLDS.

Willard, N. Y.

## Designing a Vacuum Tank

George P. Pierce tells an interesting story in the August 31 number, about an "engineer" who did not have a copy of my "Pocketbook" and had to borrow one at 1 a.m.; but he gives it a rather melancholy ending, like that of the modern short story in the magazines. He also leaves the end hanging in the air, so that the reader wonders if the tank ever was built, and if so, how thick it was made. The end of the story is merely: "He fell in the boss' estimation from a promising engineer to a raving theoretician." Served him right, of course, but Mr. Pierce might have told us what he would have done if he had been in the engineer's place.

Many morals might be drawn from Mr. Pierce's storiette. The most obvious one of course is that he should have had a "Pocketbook" of his own. If he had owned one and were familiar with its use he would have known better than to think "he could look up about that tank and figure it out in less than an hour," and he would have "got onto the job" of figuring it before reading his evening paper. In less than an hour, probably, he would have found that the "Pocketbook" did not contain a word on the subject of vacuum tanks 12 feet in diameter by 20 feet long, and an idea might have crept into his "think-tank" that he was mistaken in supposing that "surely a long boiler flue is under the same conditions as a tank."

The next moral is, that having found that the boilermakers were "in doubt about the correct thickness that would be safe," and that all the books were silent on the subject, he should next morning have confessed his ignorance and recommended to the boss that he either employ a consulting engineer to design the tank, or else write to half a dozen of the leading tank builders of the country and ask them, if they had ever built a vacuum tank of such dimensions, what thickness they would advise, how they calculated it, and if they would guarantee the tank. The boss then would have still considered him a "promising engineer" and not a "raving theoretician."

WILLIAM KENT.

Sandusky, O.

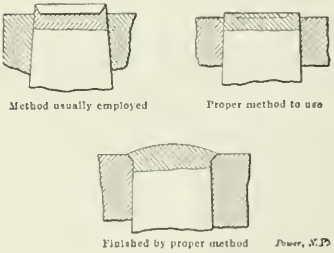
## To Rivet a Crank Pin or Piston Rod

A large number of crank pins that are fitted with a taper hole in the crank web and riveted to the web, work loose after a short time and cause a lot of trouble.

The method generally used is to cup out the end of the pin or piston rod (as the trouble is the same for piston rods as for crank pins), and rivet over the edge of this cup. This is not a very strong way, as this thin edge will soon break off and cause the pin or rod to work loose.

The proper way to rivet a crank pin or piston rod is to use a taper on the pin or rod of about ¼ inch to the foot. This taper in itself has a tendency to hold the pin or rod more than the taper usually employed, which is generally about ¾ inch to the foot. This in itself should appeal to the practical man, for it is a fact that the nearer straight a taper is the harder it will hold.

Instead of cupping out the end of the pin or piston rod, a groove should be cut on the end about ¼ inch deep and about 7/16 inch from the edge, according to the size of the pin or piston rod. A ball-set should be used to rivet it up with by spreading the metal on each side of the groove until the countersink in the web or piston is filled. In this way the rod or pin will never come loose, as there is no thin edge to break off.



Method usually employed

Proper method to use

Finished by proper method

Power, N.Y.

METHODS OF RIVETING

The accompanying sketches will show how this is done and also the way that is exclusively used and how the job will look when done in the way described.

H. C. WILLIAMSON.

Portsmouth, Va.

## How Shift Changes Waste Money

Every manufacturer who operates a steam-power plant for twenty-four hours per day, or for more than one turn or watch per day, should be interested in the following:

There is a great loss in fuel when the day turn is replaced by the night turn. This loss is caused by the desire of the day turn to get away the moment the night turn shows its face. The same trouble occurs when the night turn is replaced by the day turn. The men are tired with their long hours of labor, and prepare for a speedy departure, long before the relief appears.

It is customary for the men on duty to coal very heavily about half an hour before the relief appears. By so doing, in a plant of, say, 1000 horsepower, they will charge the furnaces with about 3 tons of coal one-half hour early. This coal acts as a wet blanket and smothers the fire. From the heat beneath, gases of the fresh coal are distilled and wasted. These are exceedingly valuable parts of the coal and, in the East, represent from 18 to 22 per cent. of its weight. From a thermic standpoint they represent from 30 to 40 per cent. of the value of the coal. It is needless to say that the gases of this great blanket of fresh coal are distilled and wasted, resulting in a loss to the owner.

These firemen, about to retire from their labors, pay little or no attention to the fires during their last half hour. They spend this time in washing and changing their clothes. After having washed and changed their clothes they do not care to soil their good clothes or their hands in firing. The result is that the fires become honeycombed, full of large openings through which cold air can pass, and economies are impossible.

As stated, as soon as the relief appears the old fireman skips. The new gang exchange greetings among themselves, change their clothes, and will sometimes consume twenty-five minutes in their preparations, so that there is often an interval of from thirty to forty-five minutes between the extra-heavy coaling and the new gang's taking hold of the fires. By this time the fires have burned exceedingly low, spots and openings occur on the grate and economy is destroyed. The new gang, in order to boost up the steam, level off the fires and throw on another dose of, say, 2 or 3 tons of coal.

From long experience and observation I am convinced that such a method of changing from day to night gang, or from night to day gang, results in a loss to the owner of at least 2 tons of coal per day in a 1000-horsepower plant.

The remedy is to permit no fireman to wash up and change his clothes until his relief has got into firing togs and is in a position for duty and work.

The foregoing is a copy of a paper which I have sent to numerous clients.

J. M. WHITHAM.

Philadelphia, Penn.

## Why the Eccentric Slipped

The following is a rather peculiar accident that happened to a pneumatic air-compressor which is a simple direct-connected engine, with the rocker arm set back of the flywheel shaft. The eccentric is fastened to the flywheel shaft by a collar in which are two set screws on each side of the cam. These screws became loosened and allowed the eccentric to slip just enough to allow one of the screws to get into another hole, and there it held fast. Not having run an engine very long, I was at a loss to locate the trouble, and did not stop the machine for perhaps two minutes, first working a light and then a heavy throttle.

After I once stopped, I could not start up again, and then, of course, it was easy to find the trouble. It is the little things that sometimes cause the most trouble.

ROY S. WOODS.

Ashland, Ore.

## How Should the Boilers be Run?

Several years ago I ran a plant consisting of two horizontal-flue boilers, 54 inches by 24 feet, connected across the top with a large steam drum, and a mud drum across the bottom, and a 10x20-inch slide-valve engine, with a very light load, and steam was only used for the engine. This plant was leased for six months and it was decided to run the plant as found, as no other expense was to be incurred. The boilers were set over one furnace, and I bricked off all but about one-third of the grate sur face under each boiler and kept th damper nearly closed. A friend of m employer told him that he could run wit one boiler, without altering anything, an save half the fuel, but he failed to tel him how this was to be done. Was it pos sible to fire one of these boilers an allow the other to act as a steam reservoi and effect a saving, or would it have bee more wasteful?

MILTON HEGLIN.

Cincinnati, Ohio.

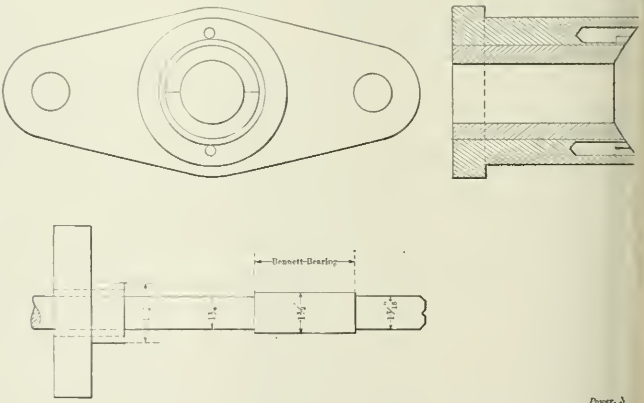
## Worn Corliss Valve Stem

Following is how a worn Corliss val stem was repaired after being worn inch deep, due to the friction of the pac ing.

It would have been better to have put new stems, but I did not want to d until I could have the valve ports rebo when we will get new stems and valv

In turning the worn valve stems, I gan on the inside edge of the bo bearing and turned up to the botto the stuffing box, the rest of the metal thickness of the bottom of the st box, being left to preserve a fit and a shoulder for the packing to buil against. I then took the gland and l out for a bushing, counterboring packing side of the gland so that the ing would not slip through when p pressure on the packing. The bu was then turned to a sliding fit o gland.

Next I drilled two small pin hole one in the upper and one in the lower h of the bushing. This being a split bu ng. the holes were drilled from the p ing side of the gland so the pins could in- serted after the valve stem had been ced



METHOD OF REPAIRING VALVE STEM AND BUSHING through the bonnet. The pins are for the purpose of keeping the split bushing from oscillating with the stem.

P. J. Walters.

Pelham, N. Y.

## Heating and Ventilating Buildings

The steam from the boilers enters the heating chambers, after being reduced to the proper pressure, by means of a reducing valve. After condensing, the water flows into the pump, and is pumped back into the boiler, at a temperature of about 200 degrees Fahrenheit.

The pump is controlled by means of a pump governor, which not only serves to keep the system from flooding, but also acts as a seal for the returns. The air ducts leading to the several rooms are connected directly to the heating chamber, and the air is drawn from outdoors, through and around the coils in the chamber, by means of a fan blower, and from there it passes to the several rooms in the building.

When the fan blower is driven by a steam engine, the exhaust is also connected to the coils, so that either steam direct from the boiler, or exhaust steam, or both, may be introduced into the coils. As the air passes between the coils it is heated to about 68 degrees Fahrenheit, and at that temperature enters the room near the ceiling, circulates around the room and passes out through an opening near the floor, and is finally discharged above the roof of the building, in this way expelling all impure air from the rooms, and keeping up a constant circulation of pure air at a temperature of 68 degrees Fahrenheit.

All windows, doors, etc., must be kept tightly closed, so that the circulation of air is not broken. If windows and doors are kept open the efficiency of the system is greatly reduced; in fact, it is practically useless, besides burning considerable more coal than is necessary. On the other hand, if the system is properly run, it will prove economical, and the ventilation perfect. When this system of heating is in operation, the direct steam to radiators may be shut off entirely. The proper temperature of the air in the ducts is maintained, usually by means of a thermostat, set into the ducts, which opens or closes the steam valve, as the case may be, thereby insuring constant temperature. In mild weather the exhaust from the engine is generally sufficient for heating the entire building.

When the thermostat shuts off the exhaust from the engine, the resulting back pressure is sufficient to open the regular back-pressure valve, and allow the steam to escape to the atmosphere. By this system practically all of the water is returned to the boiler, the air to the rooms is pure, and the chilling of rooms by opening windows is done away with, such as would be the case where direct steam alone was used.

Charles T. Mellen

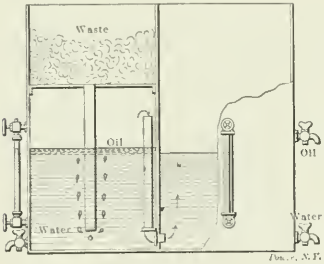
New York City.

## An Oil Filter

The accompanying sketch shows the construction of an oil filter which is giving excellent satisfaction. The body consists of two compartments, 15 inches in diameter and 30 inches deep, connected by means of a pipe through the bottom of the partition, running up 17 inches on one side.

It is fitted with a gage glass to each compartment faucet to draw the water off. One compartment has a faucet about 14 inches from the bottom to draw the oil off after the filtering process.

A box, 14½ inches square and 12 inches deep, with a pipe 16 inches long connected to the bottom, is so constructed that it will fit inside of one of the compartments in such manner that the pipe covers within 2 inches of the bottom when in place. The box rests on cleats soldered on the sides of the compartment. Inside the box are cleats on which to lay a frame covered with wire screen so that it will rest about 2 inches above the bottom of the box.



OIL FILTER

The operation is as follows: After putting about 12 inches of clean water in each division of the filter, the box, with the pipe extending from the bottom, is placed into one side of the filter, as shown, and the screen placed in the box. The box is then filled with waste, after which the filter is ready to work. By pouring oil on the waste it filters through the screen, runs down the pipe to the bottom of the compartment and comes up through the water, until the level is higher than the pipe on the side, when it overflows, runs down through the connecting pipe and rises up through the water in the opposite chamber of the filter.

This process has taken some time, and as a large amount of dirt is taken out of the oil in passing through the waste, and more by standing in the first chamber, the dirt that gets through the waste naturally settles to the bottom of the tank, and by the time the oil has passed through the second water it is like new oil.

R. E. Dillion.

Arlington, O.

## Will a Centrifugal Pump Do the Work?

A direct-acting pump under my supervision has been in operation for several years, taking muddy water from a river 300 feet distant, and delivering into a tank against a total head of about 115 feet. The suction, at times of extreme low water, may be as great as 24 inches of mercury at the pump.

On account of the gritty water the cylinder becomes cut and the valve seats badly pitted, requiring repair every few months. We know, however, when the pump is getting in bad shape, and taking advantage of a time when a smaller quantity of water than usual is being drawn from the tanks, smaller pumps can be run in emergency until repairs are made.

Although there is considerable slip, and decrease in efficiency after much wear, the pump is always dependable and can be relied upon to deliver water at any and all times. This fact is of the greatest importance. Water is constantly being drawn from the tank into which the pump delivers, and it is very important that the supply shall never fail.

It is now proposed to replace the reciprocating pumps by a 10-inch centrifugal turbine pump. It can hardly be denied that the centrifugal pump, if well built and with ring oiling bearings outside the pump casing, will be of cheaper and more satisfactory operation from a mechanical standpoint. Such a pump should require little attention and absolutely no repair for a long time; and would be an ideal pump for this service if the suction lift were not so great. But I am of the opinion that 26 feet is too high a suction lift to expect of a centrifugal pump through such a long suction line in which there is the possibility of a good deal of air leakage.

Centrifugal-pump salesmen assert that the centrifugal pump is good for just as great suction lift as the reciprocating pump, but I should like to hear from the readers of Power on this subject. The old pump, though expensive in operation, can always be depended upon to deliver some amount of water; while small air leaks might cause the centrifugal pump to lose its water entirely just at the time when it was most needed. I have heard the opinion expressed also, that if the centrifugal pump was made in two stages, it could take care of a higher suction lift than a pump with a single runner. I have no reliable information on this point, however.

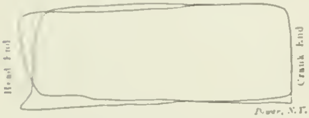
L. Corwin.

Newburgh, N. Y.

## Pump Indicator Diagram

I submit the following diagrams, taken from a Holly triple-expansion vertical pumping engine.

The diagrams were taken from the high pressure cylinder, the pump working against 50 pounds water pressure, with 25 pounds pressure in the intermediate receiver. The speed was 15 revolutions per minute, with a steam pressure of 100 pounds per square inch, 22 inches of vacuum being carried on the exhaust. The pump was lifting water 16 feet. A 60 spring was used on the indicator.



PUMP INDICATOR DIAGRAMS

If any reader has taken similar diagrams I should like to hear from him.

George W. Caryl.

Angola, Ind.

## Difference in License Examinations

The station load had decreased to such an extent that only one engine was running, and after looking over the engines that had been running, and finding everything in good order, I sat down to eat my midnight lunch. Just then the oiler startled me by abruptly saying:

"I'm going to throw up this job and see if I can't strike something out Pittsfield way."

"Why?" I asked. "Got something in view out there?"

"No," he replied, "but you know I have tried twice to get a license and failed, so I've been culling some facts and figures and putting them together, and I've come to the conclusion that if I expect to get a license my chance is just 33.5 per cent. better in that district than in Salem. Oh! You needn't smile," he went on, "I've got the figures down in black and white and you have often told me in our discussions that figures don't lie."

"That's getting it down pretty fine," said I. "I've often wondered at the fact that men who have tried for a license in this district and failed would migrate to some other part of the State and after a while return with a 'gold seal,' but I never knew that the solution could be found in figures, so I guess it's up to you."

He went to his closet and returned with a book and several papers. Handing me the book, he said:

"Now this book is the report of the chief of the district police of Massachusetts for 1908, and on page 132 you will find the general summary of examinations. These figures," handing me a paper, "are taken from it."

Looking at the paper I saw the following

| District. | Applications Received. | Licenses Granted. | Applications Rejected. | Per Cent. Granted. |
|---|---|---|---|---|
| 1 | 952 | 286 | 310 | 48.3 |
| 8 | 6.1 | 532 | 177 | 81.8 |

After comparing his figures with the report, I remarked that "the men out that way must be better posted than in our district."

"Don't believe it," he replied. "It's the examiners. Some of them ask their questions in much the same manner that the cheerful idiot propounds conundrums at a party, and they exhibit the same idiotic glee when they find you've been fooled as to what the question really was; while others ask plain questions and if you don't quite understand they explain until you do."

"Well, admitting that there is a personal element that enters into the examinations, what plan can you suggest that will improve the system now in vogue?"

"By having the questions in writing and approved and the answers marked by someone not concerned in the examination. Then and not until then will a man in one district be examined on the same plane as one in another part of the State. Just think of it, here's an examiner in the Suffolk district, who only passed 22 per cent. of the men he examined, while the examiner in the Berkshire district, passed 90 per cent. If you had to be examined which one of these examiners would you prefer to go before?"

I replied that I "guessed I would be inclined to favor the 90 per cent. man."

"That's why I'm going to give my notice in the morning," he remarked, as he replaced his book and papers in the closet.

F. C. Almador.

Salem, Mass.

## What Caused the Air Pressure?

A three-stage centrifugal pump, driven by a three-phase induction motor, was opened up a few days ago to note the condition of the runners and casing. After the pump was assembled it was filled with water through a 1 inch pipe which was tapped into the discharge and suction pipes. After the pump was started, the ammeters showed that the pump was not pumping water. It was shut down and the priming valve opened to fill the pump and suction pipe again, as far back as the check valve. When started again the ammeters registered the same as before, and the vacuum-gage pointer was hard against the stop.

I then removed the gage and air came out of the suction pipe, and judging from the sound of the escaping air, I should say that there was about five pounds pressure. The next time the pump was started everything went nicely.

I should like to have the opinion of others as to what caused this air pressure in the suction pipe when the pump was running.

Louis B. Carl.

Marshfield, Wis.

## Limitations of Pump Lift

Thirty years ago I was employed by a mining company as engineer. When I took charge they had a Blake pump, fitted with single cup-leather packing, pumping water from the bottom of the mine. The suction pipe was 28 feet in a vertical position and the pump kept the water out without any trouble. We could stop any length of time to put in new leather, and start right up as though the pump had not been stopped; the suction pipe had no foot valve, at that.

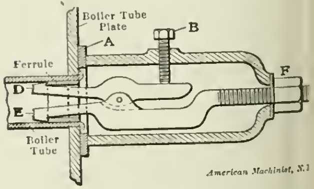
Soon after this one of the steam boilers gave out, and we could not get enough steam to keep the water out of the mine, the water rising until we were compelled to raise the pump to a platform 28 feet above where it first stood. I left the air chamber of the suction pipe and after repairing the boiler, steam was got up and for the first three or four days we lowered the water on an average 4 feet per 24 hours, after this we could not lower it so fast, and the pump began to knock. When we reached 22 feet we could not lower the water any more. I fished up the vacuum chamber and put it in place and 30 hours after putting on the chamber, the platform, 28 feet below us was dry. We then lowered the pump to its old position and had no trouble with a 28-foot suction. This is the way I learned the value of an air chamber.

William Mellen.

New York City.

## A Good Ferrule Extractor

The boiler-tube ferrule extractor illus trated herewith is being used in a numbe of locomotive shops and has the advantag over many of being cheaper and easier t construct; of being "huskier," to stan



BOILER-TUBE FERRULE EXTRACTOR

more abuse and having the advantage being capable of some adjustment for u in various sizes of boiler tubes.

In using the ferrule extractor shown the sketch, a hard-steel washer *A* is fi placed against the tube plate, the screw *B* being slackened to allow the ja *D E* to enter. When all are in positic the set screw *B* is advanced far enou to press the jaws of the extractor tig against the sides of the boiler tube; the nut *F* is then turned with a wrench and the ferrule gradually drawn out.

R. P. Messer.

Poughkeepsie, N. Y.

## To Increase Speed of a Corliss Engine

To increase the speed of a Corliss engine, all the change needed is a larger pulley on the governor shaft. The governor will revolve at the same rate of speed, but the number of revolutions per minute made by the crank shaft will be greater.

The method of finding the size of pulley required will be easily understood from the example. A Corliss engine is running at 60 revolutions per minute; the size of the pulley on the main shaft is 12 inches and on the governor spindle, 8 inches. To speed the engine up to 80 revolutions per minute, find the size of pulley needed on the governor.

The speed made by the governor shaft is,

$$\frac{12 \times 60}{8} = 90 \ r.p.m.$$

Size of pulley required is,

$$\frac{12 \times 80}{90} = 10.66 \ inches.$$

Leonard Vallillee.

Gabriels, N. Y.

## Corliss Engines versus Steam Turbines

I note with considerable regret that on ge 331 of the August 24 issue, under e above caption, you are opening your lumns to what appears to me to be an gether useless and wholly undignified ntroversy.

Without wishing to cast any reflection n the good faith of the reason given for e departure from your usual policy, elieve that on more mature consideran, you will be of the opinion that e important engineering question inlved" dwindles into utter insignificance mparison with the question of the priety of sundry modern advertising thods.

By referring to page 112 of the adrtising section of the same issue, the nnection between the advertisement and "open letter" is plainly seen. It is e evident that the advertisement and letter were intended to appear simultasly, and that by a trick that is more rewd than commendable two columns your editorial pages have been made to pplement a page of paid advertising.

The advertisement of the Corliss engine fers to an advertisement of a steam rbine, and both are bad examples.

The advertisement of the steam turbine so unspeakably silly that it could misad no one who makes any pretensions to being an engineer. The statement that the steam consumption of a reciprocating engine increases over 50 per cent. after three months' service is so preposterous that it would immediately be recognized as being born of crass ignorance, rather than a deliberate desire to deceive.

However, when one realizes that under modern business conditions the advertising of a large concern is conducted as a distinct department, just as is the engineering, the construction or the accounting, an advertisement of this sort will be recognized as an unfortunate incident rather than an evidence of bad faith.

With the utmost care, a large manufacturing establishment with a complicated organization will occasionally get an incompetent engineer who will turn out a faulty design, or a careless mechanic who will slight some detail of his work, or an accountant who will make an annoying mistake. Is it, therefore, any more surprising that there might be an incompetent employee in the advertising department who should turn out a faulty advertisement that is no more representative of the policy of the company than is faulty design, workmanship or bookkeeping?

It is, indeed, surprising that this sort of thing does not occur oftener in these days when advertising is claimed to be taught as a special science, quite independent of a technical knowledge of the thing advertised, but based on psychological principles equally applicable to liver pills, mining stocks and locomotives.

The advertisement of the Corliss-engine builder is equally reckless. Without entering into any discussion as to comparative economies, the facts are at least sufficiently well established that no intelligent person will seriously consider the intimation that a steam turbine cannot be made to give economic results within 25 per cent. of the best obtainable with any type of reciprocating engine whatsoever.

Furthermore, the advertisement is in decidedly bad taste, and I believe that if many of your clients were to submit copy of this sort, you would not be overly well pleased, and would probably place some restriction on the class of advertising matter that you would admit.

If there be any one who is so constituted that the steam-turbine advertisement mentioned awakens within him a feeling of honest indignation instead of pity or amusement, he would be entirely justified in registering a dignified protest against the publication of such irresponsible statements even in your advertising pages. The protest that has been made in this case hardly comes under the class which could be called dignified.

I venture to suggest that it might not be outside the province of the management of an engineering journal to exclude from its advertising pages, just as rigidly as from its reading columns, any matter that is palpably untrue. The inauguration of such a practice would, undoubtedly, work to the benefit of both the advertiser and the general public.

As to the little engineering question involved, the comparative merits of the steam engine and the steam turbine are no more likely to be determined by discussion than the time-honored question about the relative mightiness of the pen and the sword, that rural debating societies struggled with for years.

There are situations in which steam turbines are most desirable, and there are situations in which it would be folly to install them; just as there are situations in which it would be folly to install a compound steam engine instead of a simple one. Even the old, simple, slide-valve throttling steam engine still has its place in the engineering world, and instead of being driven to the wall by what we call progress, its builders, without any flourish of trumpets, are enjoying a volume of trade that would be surprising to those of us whose vision is restricted to the consideration of modern developments in power-plant equipment.

There are situations in which gas power is preferable to steam power, but the prospects of its universal adoption are as yet not particularly alarming to those who build or use steam power-plant equipment.

It is safe to assume that the engineering public buys intelligently, and that the fact that steam turbines, steam engines and gas engines are bought and sold year after year is more convincing evidence that each has its merits, than any amount of wordy argument.

A discussion of the relative merits of the several types of prime mover, apart from the conditions of service, is wasted effort.

The engineer must consider the question in connection with the local conditions that confront him, and make his decision accordingly. And, in general, he does not regard all advertising statements as strictly scientific facts.

There is too much talk about what power-plant apparatus *will accomplish* in the way of economical results, instead of what *can be done with it*.

Economical results are obtained not from the machinery alone, but from the combination of a man and machinery. A good workman may turn out excellent work with an indifferent tool, and an incompetent workman will probably turn out a botched job with the best tool in the world.

The fact that the overall economy of a certain power plant with one kind of equipment is better than that of another plant with a different type of equipment is no conclusive evidence as to the relative merits of the respective equipments in themselves. No manufacturer of power-plant apparatus has yet reached the point where he can afford to ignore the intelligent and thoughtful engineer as a factor in establishing and maintaining the commercial success of his product.

As to the length of the period over which the original economy of any prime mover may be maintained, whether it be a steam turbine, steam engine or gas engine, no one dare set a limit when the machine has the quality of care and attention that many men are capable of giving it.

The Westinghouse Machine Company,
H. E. Longwell
Consulting Engineer.
East Pittsburg, Penn.

## Reheating Tubes in Receiver

Among other engines in a power plant of about 1500-horsepower capacity was a 300-horsepower cross-compound Corliss condensing unit, the receiver of which contained a nest of tubes for the passage of live steam for reheating purposes.

The economy of this arrangement had caused some little discussion, and one first-class engineer contended that the economy would not be impaired in the least by cutting out the live steam from the receiver and using it in the ordinary way through the throttle. This engineer, who I knew could design, build, and operate simple or compound engines, and who had not forgotten his training in thermodynamics, eventually came to have charge of the plant in question.

The first thing he did was to cut out the reheating system. Now the point that arose in my mind at the time was this: The engine was the product of a first-class firm, which has a reputation of knowing its business, and, similarly, the engineer who was up in *his* business condemned and removed this portion of the company's design.

A discussion on this point of reheating, not from a theoretical standpoint alone, but also from a practical point of view, should prove interesting and profitable to engineers in these days of speculation as to how long it will take the gas engine and turbine to put the reciprocating engine on the scrap heap.

J. A. Carruthers.
Bankhead, Alberta.

## Engine Repairs

At the time of assuming responsibilities in a plant of considerable capacity, trouble was experienced with piston packing in a 20x22 railway engine. Upon inspection, it was found that there was considerably more clearance than necessary between the piston rod and the back of the stuffing box. A metallic backing-up ring for packing was used, and had become broken and allowed to churn around, cutting the bottom of the stuffing box in a disgraceful manner. After thinking matters over, the following method of repairs was adopted:

The piston and rod were removed. A solid cardboard disk was fitted in the stuffing box from the front, and backed up by a piece of shafting. A piece of 1-inch pipe was put in from the back end of the cylinder and backed up with clay. Then the space was filled with babbitt, after which the babbitt was removed and a hole for the rod was cut and faced off. This made a half moon of very irregular and peculiar shape. This was put in place and, with a lead washer over the entire face of the bottom of the stuffing box, made quite a respectable piece of work, in appearance.

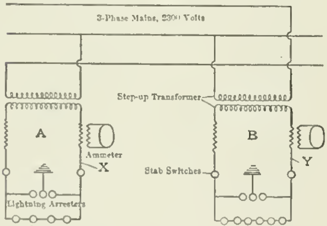
A standard metallic packing was also used, instead of soft fibrous packing, and there has not been a cent's worth of repairs or packing used on the rod in the past year.

Incidentally, it has been the writer's experience that by the use of metallic packing this expense account has been reduced more than one-half, and while it is hard at times to induce plant managers to purchase metallic packing, the first cost is no consideration at all when ultimate saving is considered.

George A. Eyler.
Cumberland, Md.

## What Caused the Lights to Go Out?

While making some changes in the line work in front of a light plant, it was necessary to cut the four wires of two arc circuits. When connecting up again the leads $X$ and $Y$ (see sketch) were interchanged by mistake. When the lights were put on that night the ammeter on circuit $A$ only registered 2 amperes, but as soon as the stab switches on circuit $B$ were inserted, both ammeters registered 4.5 amperes. The lights on both circuits would light up and go out and quite a few grounds showed up that never gave trouble before.



WIRING DIAGRAM

One of the electricians in this plant claims that none of the lights ought to burn, as the circuit was open, while the other one claims that as both circuits were connected to different phases of a three-phase circuit, the circuit is closed through the other phase. What I should like to know is what caused the lights to light up and go out; also, what caused the grounds to show up. If the circuit should be open on this same system, what causes the lightning arresters to flash when the stab switches are inserted?

Louis B. Carl.
Marshfield, Wis.

## About Electrical Grounds

We have a mining plant with two boilers, two stacks 50 feet high and two pumps to drain the mines. We do the drilling with compressed air. The hose through which air is conveyed from the supply pipe to the drilling machines is wire-covered, and it is a common thing during an electric storm for the men to get shocked. The hoisting cable is iron, but the hoisting tower is only about 35 feet high. The electrician at the local electric-light plant told the "boss" to solder a copper wire to the receiver of the air compressor and drive an iron into the ground and ground the air pipe.

I contended that it would not be grounded any more than it is now. The mine is 100 feet deep, and wet, with a 4-inch air pipe going from the receiver down to the bottom, where they connect the hose to the machines. One pump is connected to a 10-inch pipe, the other to a 3-inch pipe, and a centrifugal pump with a 4-inch suction pipe is connected to the pond about 400 feet away. Notwithstanding these grounds, with a heavy charge of electricity some goes down in the mines. How can this trouble be overcome?

E. McKoy.
Linden, Wis.

## Homemade Packing

Our packing expense used to be quit an item and we tried to cut it down t no avail, until one day I happened to b looking through our scrap and the ide occurred to me to make a packing fro scrap-babbitt metal.

I procured a wooden box, two 5-poun lard cans, two 1-inch round irons wit centers on each end and hot sand enoug to fill the wooden box. I got my babbi together and put it in the ladle over common plumber's furnace and whi that was getting hot I prepared my bo I placed the two cans in the box a surrounded them with hot sand, th placed the round irons, standing, in t center of each can and secured them that position. Having the box thus pr pared, I was ready to pour the met which should be good and hot. This w poured into the pails.

The object in heating the sand was prevent blowholes in the babbitt after had cooled.

When cold I stripped the tin off, the metal in a lathe and cut threads ab the thickness of light twine and 3 or feet long. I put enough threads toget to fit that particular box and not scr up too tight. After a few days it in working order and it has proved good a packing as any on the market up to 100 pounds pressure, except on machinery, brine pumps and the wa end of feed pumps.

Edgar G. Schindle
Roxbury, Mass.

# Inquiries

***Questions are not answered unless they are of general interest and are accompanied by the name and address of the inquirer.***

---

*Direct-current Lighting Feeder*

What size of wire should be used to supply 50 incandescent lamps in a building 650 feet from the one containing the dynamo? The dynamo gives direct current at 110 volts.

L. D. H.

It depends almost entirely on the loss you can allow in the wire. The following table gives the drop in voltage for each standard size of wire carrying one amperes a distance of one foot:

| Wire Number. | Circ. Mils. Section. | Drop per Ampere per Foot. |
|---|---|---|
| 0000 | 211,600 | 0.00010 |
| 000 | 168,700 | 0.00013 |
| 00 | 133,079 | 0.00016 |
| 0 | 105,560 | 0.00020 |
| 1 | 83,694 | 0.00026 |
| 2 | 66,370 | 0.00032 |
| 3 | 52,630 | 0.00041 |
| 4 | 41,743 | 0.00051 |
| 5 | 33,102 | 0.00064 |
| 6 | 26,250 | 0.00081 |
| 8 | 16,510 | 0.00130 |
| 10 | 10,382 | 0.00204 |
| 12 | 6,530 | 0.00324 |
| 14 | 4,107 | 0.00515 |

With a drop of 3 volts, 107-volt lamps would be used and the current would be 26 amperes. The distance being 650 feet, the drop per ampere per foot is

$$\frac{3}{26 \times 650} = 0.0001775$$

ft. No. 00 gives less drop than this and No. 0 more. Using No. 0, the drop would be 0.0002 volt per ampere-foot, or

$$650 \times 0.0002 = 0.13$$

volt per ampere. Therefore, to get 3 = volts drop, the current must be 3 ÷ 0.13 = 23 amperes, which would not be enough for 50 lamps. It would probably be best, however, to use 107-volt lamps and No. wire, because the drop would be very little beyond 3 volts with all lamps burning and it would be just 3 volts with 44 lamps burning.

*Dynamo and Motor*

How can a shunt-wound direct-current dynamo be changed to run as a motor, the voltage being the same in both cases?

R. H. L.

No change is necessary in the machine. It is only necessary to put a rheostat in series with the field winding and leave the starting box in the armature circuit.

The speed as a dynamo must be 10 to 20 per cent. faster than it ran as a motor, according to the size of the machine.

*Resistance in Armature Circuit*

Will a motor rated at 750 revolutions per minute operate satisfactorily with resistance in series with the armature to bring the speed down to 460 revolutions per minute?

E. G. H.

Yes, provided the load is constant or very nearly so. If the load varies, the speed will vary badly, increasing when the load decreases and decreasing when the load increases. There will be a large loss in the dead resistance, but the motor will operate satisfactorily except as to speed regulation, as explained.

*Impedance of a Magnet Coil*

If a coil wound on an iron core has a resistance of 5 ohms and an inductance of 1/20 henry, what current will flow when an electromotive force of 100 volts at 30 cycles per second is applied to the terminals?

J. S.

The inductance being 1/20 henry and the frequency 30 cycles, the reactance would be

$$2 \pi 30 \times 0.05 = 9.425$$

ohms. The impedance, therefore, would be

$$\sqrt{(9.425)^2 + 5^2} = 10.67$$

ohms, and the current would be

$$100 \div 10.67 = 9.37$$

amperes.

*Transformer Ratio*

If a transformer having 1500 turns of wire in its primary winding is supplied with primary current at 1000 volts, how many turns must the secondary winding contain to deliver 104 volts at no load?

If the primary wire is No. 10 gage, what size should the wire in the secondary winding be?

J. S.

The secondary winding must contain

$$\frac{104}{1000} \times 1500 = 156$$

turns of wire. The size of the wire should be not less than

$$\frac{1000}{104} \times 10{,}382 = 99{,}827$$

circular mils, but there is no such standard size in copper. The nearest size is No. 0, with 105,560 circular mils, and this should be used, if the wire is to be round. Flat strip or ribbon would probably be used commercially, and the cross-section should be at least

$$99{,}830 \times 0.7854 = 78{,}406$$

square mils, or practically 0.08 square inch.

*Heat Required to Convert Ice into Steam.*

Assume a block of ice weighing ten pounds at a temperature of 18 degrees Fahrenheit. Compute the amount of heat required to convert it into steam having an absolute pressure of 30 pounds.

T. L. W.

The specific heat of ice is 0.504. Therefore, the amount of heat required to raise the temperature of 10 pounds of ice from 18 degrees Fahrenheit to 32 degrees without melting it is

$$10 \times 0.504 \times 14 = 70.5$$

B.t.u. The latent heat of liquefaction of ice is 142.65, so that multiplying this quantity of heat by 10 gives 1426.5 B.t.u. required to melt the ice without raising its temperature. Consulting a steam table you will find that the total heat in steam at 30 pounds absolute pressure (this heat, of course, being measured above 32 degrees Fahrenheit), is 1158.3. Multiplying this figure by 10 to give the quantity for 10 pounds of steam, gives 11,583 B.t.u. Adding these quantities we have a total of 13,080 B.t.u. required to raise the 10 pounds of ice from 18 degrees Fahrenheit to the melting point; then raise the temperature to the boiling point and evaporate it at 30 pounds absolute pressure.

*Entropy and the Temperature-entropy Diagram.*

Please give a definition and explanation of entropy and the temperature-entropy diagram. I have the definition in "Webster's International Dictionary," but I cannot clearly connect the use of the word with the Greek derivation, nor fully understand the quotation with which he closes his definition: "The Entropy of the universe tends towards a maximum."

S. A. D.

In the pressure-volume diagram, of which the steam-engine indicator diagram is an example, vertical distances or ordinates represent pressures and horizontal distances or abscissas represent volume, and the area of the diagram, which is the product of the length and hight, that is, of the increase of volume by the average or mean effective pressure, is the energy.

If you will make a diagram such as was shown on page 226 of our issue of February 2, 1900, in which vertical distances represent absolute temperatures and the area still represents energy as it does in the indicator diagram, the horizontal dimensions or the abscissas will represent entropy. You will find in the article referred to a good illustration of the use of the temperature-entropy diagram and from it should be able to get a good idea of what is meant by that term.

*Proper Distance in Belt Drives*

Is there any formula for determining the proper distance, or maximum or minimum distance, for designing belt drives for any size of belt?

W. M.

We do not know of any positive rule. If the distance between the pulley centers is too short the arc of contact on the smaller pulley will be too small, owing to the greater angularity of the belt and the sacrifice of the sag of the longer belt. If the distance between the pulley centers is too great the belt is apt to flap.

When narrow belts are to be run over small pulleys 15 feet center to center is a good average, the belt having a sag of from 1½ to 2 inches. For larger belts working on larger pulleys from 20 to 25 feet does well, with a sag of 2½ to 4 inches. For main belts working on very large pulleys the distance should be 25 to 30 feet, the belts working with a sag of 4 to 5 inches.

# POWER AND THE ENGINEER

DEVOTED TO THE GENERATION AND TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

John A. Hill, Pres. and Treas. Robert M. Kean, Sec'y.

505 Pearl street, New York.
355 Dearborn street, Chicago.
6 Bouverie street, London, E. C.

Correspondence suitable for the columns of Power solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "Powpub," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During 1908 we printed and circulated 1,836,000 copies of* Power.

*Our circulation for August 1909, was (weekly and monthly)* 174,000.

| | |
|---|---|
| *September 7* | 42,000 |
| *September 14* | 33,000 |
| *September 21* | 33,000 |

*This paper reaches 42,000 separate readers each month and 33,000 each week.*

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*

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## Lubricating Engine Cylinders

Do you know how much cylinder oil you use?

Would it be an awful task to write on a postal card the size and speed of your engine and the amount and kind of oil which it uses and mail it to the editor of Power?

Out of our forty-odd thousand subscribers probably three quarters could give us interesting and valuable information along this line. We have asked for it a number of times but the responses do not come.

We know that our readers are not disobliging, we know that they have this information, and we need it. Won't they send it in?

## The Effect of Vacuum on Engine Efficiency

A correspondent asks for information as to what allowance should be made for failure on the part of the purchaser to produce the vacuum called for in a contract. Suppose an engine is guaranteed to produce an indicated horsepower-hour on 16 pounds of dry steam at 110 pounds pressure with a 26-inch vacuum, but that only 23 inches of vacuum can be maintained. What must be the performance of the engine to comply with the terms of the contract?

The engine builder takes the ground that he is entitled to the 1.5 pounds of mean effective pressure sacrificed by the failure to produce the vacuum through no failure of his. If an engine at a given cutoff produces 26.5 pounds mean effective pressure, referred to the low pressure cylinder, with a vacuum of 23 inches, it would at the same cutoff and hence with no more steam produce a mean effective pressure of 28 pounds with the 26-inch vacuum. The horsepower would be increased in the same proportion, and he claims that the total amount of steam used should be divided by this larger horsepower that he would have produced if the stipulated vacuum had been provided, in determining his steam used per horsepower on test; or that the contract allowance should be increased in the inverse proportion, in this case in the proportion of 28 to 26.5 so that instead of 16 he should be allowed $28 \times 16 \div 26.5 = 16.9$ pounds.

This is simple and is right if the efficiency of the engine is not affected by the change in back pressure, and if it can make a one hundred per cent. return for the vacuum furnished. Is it so affected, and if so in what direction?

The engines at the power plant of the West Point Military Academy developed an indicated horsepower-hour on 18.33 pounds of steam, with a back pressure above the atmosphere of 1.1 pounds* with a mean effective pressure referred to the low-pressure cylinder of 33.6.

Is it to be assumed that with a 28-inch vacuum the engine would have developed its horsepower-hour on

$$\frac{18.33 \times 33.6}{33.6 + 1.1 + 14} = 12.6$$

pounds?

The internal losses of the engine would be increased by the wider range of temperature, there would be more cylinder condensation because of the cooler exhaust, but, on the other hand, the engine would cut off later to carry the same load with the diminished vacuum which would tend to lessen cylinder condensation but would probably carry the engine away from its most efficient condition.

The best way of making the correction would seem to be from efficiency curves of similar engines with different vacua, but these are not always available for the same type of engine, initial pressure quality of steam jacket and reheater conditions as the case in point.

It is a pretty subject for discussion and we should be glad to have our correspondents, especially those who hav had to deal with the question, expres their views of it.

## Load Factor and Power Factor

The above expressions are so simila that they are frequently confused by op erating engineers. Load factor is ap plicable to any machine, apparatus or se of machinery which carries a "load"- that is, does work of any sort. In powe plant operation it can be applied to a com plete station or to any boiler, engine, gen erator, pump, transformer or other pie of the station equipment. It means mere the proportion of the total capacity th is carried as an average. For examp if the average load carried by a five hu dred-horsepower engine is three hundr horsepower, then its "load factor" w be sixty per cent., because the avera load is sixty per cent. of the full rat load. Again, if a transformer rated at t kilowatts carries an average load of ei kilowatts, its "load factor" is eighty cent.

Power factor is less easily explained simple language. It is applied only alternating-current circuits and apparat Any circuit when carrying an alternat current develops what is known as "s induction" and this throws the curr out of step with the pressure. Cor quently, the combination of pressure a current produces less power than it wo if the two were exactly in step dur their alternations. When they are step, if you multiply the volts by t amperes the result will be the power watts; when they are out of step, t product of volts × amperes is not watts but *apparent watts* or volt-amperes. Now, if the pressure and current are out of step to such an extent that the real watts are only eighty per cent. of the volt-amperes, then the "power factor" is eighty per cent., that means that that pressure and that current can do only eighty per cent. of the work that they would do if they were in step.

---

*Power, April 27, 1909, page 754.

The self induction of an incandescent lamp is so small that it is insignificant, and the power factor of an incandescent lighting circuit is so high that it is considered one hundred per cent. But an induction motor has a great deal of self-induction, and the power factor of a circuit carrying current to such motors is therefore relatively low. Moreover, the power factor of an induction motor is lower at partial loads than at full load. A circuit supplying several underloaded induction motors may easily have a power factor as low as sixty or sixty-five per cent., which means that only sixty or sixty-five per cent of the current is doing useful work; the other thirty-five to forty per cent. is merely heating the armature winding of the generator and knocking out its voltage regulation.

A low load factor is a serious disadvantage to a power plant but a low power factor is worse because it forces the generators to run at low load factor and also upsets the pressure regulation.

## Why Live Steam Does Not Burn

There is a belief in the minds of many that dry steam will not burn or scald or, in fact, give up much of its sensible heat until it has parted with so much of its latent heat that it becomes wet. In proof of this belief it is said that the bare hand may be safely held in a jet of dry steam issuing from the trycock on the water column of a boiler making dry or superheated steam, while it would be the hight of folly to place the same unprotected hand in the steam blowing from the exhaust pipe of a steam engine or pump.

Things are not always what they seem, and a jet of dry or superheated steam issuing from a boiler would cook a hand or any other part of the human anatomy just as effectively as exhaust steam, if the two were of the same size. In the case of the little stream of steam from the trycock the small total amount of heat is distributed over a comparatively large surface and is so mixed with and cooled by the air carried along with it that it has no harmful effect.

In situations where it is impossible for the steam jet to pick up and carry along with itself a stream of air, the full effect of the heat in the steam may be felt, as attempts to calk small leaks under the flanges of nozzles where the issuing jet is protected from the air on nearly all sides will prove. It will be found, if tried, that the hand that holds the calking tool must be protected from the jet of steam by means of a glove or by the use of a tool long enough to keep the hand out of the direct path of the clear steam. If the hand in a jet of steam which does not scald also holds a thermometer it will show at once that scalding does not take place because the temperature is below the scalding point.

Any fluid, wet or dry, will give up its heat to a body cooler than itself at a rate proportional to the difference in temperature, and dry steam or dry air if hot enough will just as surely burn the flesh as wet steam or water.

## Effect of Receiver Pressure

To what extent are the steam consumption per horsepower-hour and the total horsepower of a compound engine affected or controlled by the receiver pressure? In a pumping station where the receiver pressure carried was several pounds higher than that ordinarily maintained in similar plants, the reason given for the high receiver pressure was that if the pressure were reduced the engine would run away.

Lowering the receiver pressure by lengthening the cutoff on the low-pressure cylinder reduces the back pressure on the high-pressure piston and increases the work done in that cylinder. At the same time it also decreases the amount of work done in the low-pressure cylinder and the proportion of the total work of the engine performed by the low-pressure cylinder.

With the higher receiver pressure compression will be carried higher than with a lower pressure, for the steam caught by the closure of the exhaust valve will be more dense and less steam will be taken from the boiler to fill the clearance at initial pressure than when the same volume of less dense steam of a lower receiver pressure is compressd.

Though the cutoff takes place at the same point in the stroke in both cases, a much larger volume may be taken into the cylinder in the case where the low receiver pressure is carried than when the receiver pressure is high, and the cutoff on the high-pressure cylinder is not the measure of the steam used that it appears to be.

With the drop in the high pressure diagram to receiver pressure, brought about by lengthening the low pressure cutoff and by a reduction of the compression, the work done in the high pressure cylinder was in one instance increased twenty-three per cent. for a fixed cutoff. The work done in the low-pressure cylinder at the same time was decreased twenty-one and a half per cent., while the total output of both cylinders increased eight per cent.

Unfortunately it was not possible to weigh the condensation from the engine and whether the pounds of steam used per horsepower hour were more in one case than in the other is unknown.

It is to be regretted that so far as is known no results of tests of this kind, if any have been made, have ever been published. It would appear that more steam must be used per stroke of the high-pressure piston in the case of the lower receiver pressure, but was the gain of eight per cent. in the total power of the engine offset by an increased rate of steam consumption?

## The Hoisting Engineer

In the busy walks of life only the great things attract attention. People stop to watch the flight of the "Twentieth Century Limited," but fail to notice the humble sectionman who makes its flight safe. The great transoceanic steamer holds the attention of thousands as it steams into the harbor, but few think of the fireman who toiled to bring about the accomplishment. Thousands have gazed in astonishment at the skyscraper structures in the great cities, but how many have given a thought to the men whose skill and toil made it possible to elevate the material necessary for the construction of these buildings?

The hoisting engineer is found on steam and sailing ships—on the one to hoist the cargo, on the other to handle the cargo and hoist the sails; he is found on docks and in railroad yards; at mines, where thousands of lives are intrusted to his care daily, to say nothing of the wealth of coal and minerals; in the great forests, manipulating the machinery which coils the thousands of feet of rope to the ends of which are attached the fallen monarchs which are to be drawn to the point of lading.

Wherever work on canals, aqueducts and dams is in progress, the hoisting engineer is found operating his small, busy engine, lifting a load, swinging it here and there, raising and lowering it to its designated position—all at a given signal. He is always on the alert; he must be, otherwise fearful loss of life, or extensive damage to the work and the machinery in his care might ensue.

In thinking of the hoisting engineer, one is apt to associate him with the small hoisting engine and upright boiler, losing sight of the fact that many hoisting engineers handle complicated and costly engines developing several thousands of horsepower. No little skill is required to handle an engine such as is used at all large mines, with the weight of hundreds of feet of heavy wire cable hanging from the winding drums. To be sure the drums are made conical to relieve the engines from the strain of starting with a load at the bottom of the shaft, but mechanical perfection cannot prevent accident if the man at the throttle and reversing gear is not competent.

# Engine and Boiler of the New "Clermont"

Following is a description of the engine and boiler now installed in the replica of Fulton's "Clermont."

The engine has a single cylinder, runs condensing, is of the side-rod design, and runs with a steam pressure of 20 pounds per square inch.

The engine drives a pair of paddlewheels which are 15 feet in diameter, overall, and 2 feet wide, the arms, rims and paddles are of oak, the center being of cast iron and keyed to the shaft. The main paddle-wheel shafts are geared to a jackshaft on which are mounted two flywheels; but they are hung outside the hull. The jack-shaft is driven by means of gears on the paddle shaft which are twice the size of those on the jackshaft, the larger gears forming the main crank. This is brought out on a large scale in Fig. 1.

The steam cylinder is mounted vertically on a cylindrical condenser, which is connected to the air pump by a channel-way of cast iron, which also forms the bedplate of the engine. The air pump is of the vertical, single-acting bucket type, and is worked by links from the side levers of the engine, and an open hotwell is placed on top of the pump. The feed and bilge pumps are arranged alongside the air pump, and are connected to and worked by the crosshead.

The valves are of the poppet type and are arranged at each end of the cylinder, being worked by a rockshaft fitted with wiper toes and lifting rod. The rockshaft is worked by a single side eccentric rod fitted with a hook and shipping gear. These features are brought out in Fig. 3, which shows the starting deck of the engine room. There are also a tripshaft and starting bar as shown.

The cylinder is made of cast iron and is 24 inches inside diameter, having a stroke of 4 feet. The steam chests are arranged at each end of the cylinder.

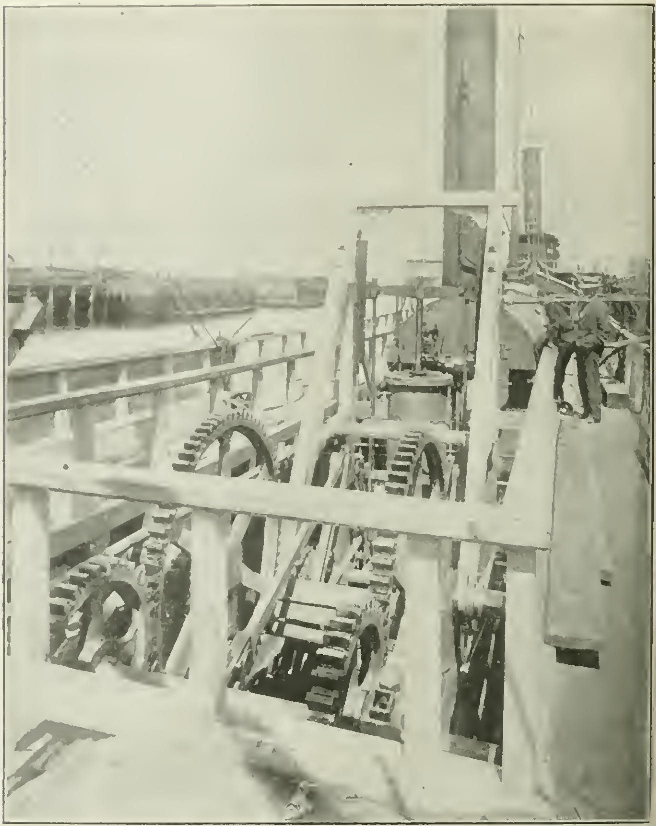


FIG. 1. SHOWING CRANK AND GEAR-WHEEL CONNECTIONS

The side levers for connecting-rod connectors are of cast iron, mounted on a wrought-iron center shaft and supporte by pillow blocks. The ends of the si levers are forked and fitted with wrough iron pins, the connecting rods fitting

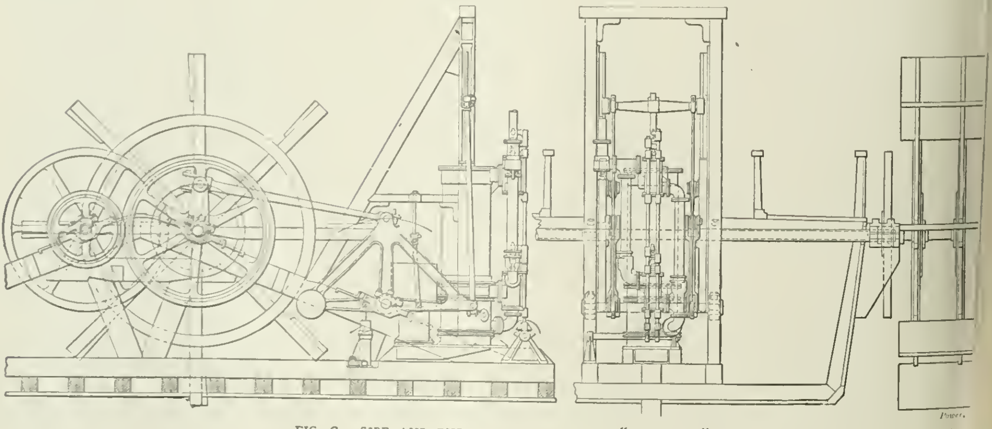


FIG. 2. SIDE AND END ELEVATION OF THE "CLERMONT" ENGINE

as shown in Figs. 1 and 2. The connecting rods are made of wrought iron and fitted with adjusting brass. Fig. 2 shows a sectional view of the engine; a plan view is shown in Fig. 4.

The boiler is shown in the rear of the engine in Fig. 1. It is of the single, cylindrical, return-tubular type, set in brickwork and fitted with the necessary fittings, such as safety valves, feed and blowoff valves, water gages, steam gage, whistle, etc. It is made of marine steel, is 5 feet 6 inches in diameter and 16 feet long. The plates have a thickness of 1/4 nch, while the heads are 5/16 inch thick nd are braced for a working pressure of 5 pounds per square inch. The boiler ntains forty-six 4-inch tubes, and is tted with the usual manhole, safety plugs, tc. The boiler is also fitted with four teel lugs, from which it is supported by ron pillars which are bolted to the keel- n and braced. Over the boiler is a asing of No. 12 B. & W. gage sheet teel, having courses 24 inches wide, iveted together. The stack is 38 inches diameter and 24 feet high.

## Hudson-Fulton Exhibits

Early in September there was placed in one of the rooms of the American Society of Mechanical Engineers in the Engineering building, New York, an exhibit of objects relating to the early history of steam navigation. This exhibit, made possible by an offer from the historical exhibit committee of the Hudson-Fulton Celebration Commission, is open every week day from nine to five. The following material, belonging to the society itself, is included: Oil portrait of Robert Fulton, by himself; original drawing of the "Clermont," by Robert Fulton and signed by him March 1, 1813; solid mahogany table formerly belonging to Robert Fulton; autograph brush drawing by Robert Fulton, 1797, illustrating an aqueduct for a high-level canal; reproduction in bronze of the Fulton drawing of the steamer "Potomac," 1820, prepared by the society; letters of Fulton's workmen concerning the first steamboat; photograph of the West portrait of Fulton; portraits of naval and marine engineers, as Haswell, Loring, Thurston, Melville, See, Worthington, Ericsson, Watt, Holley, Stillman and others.

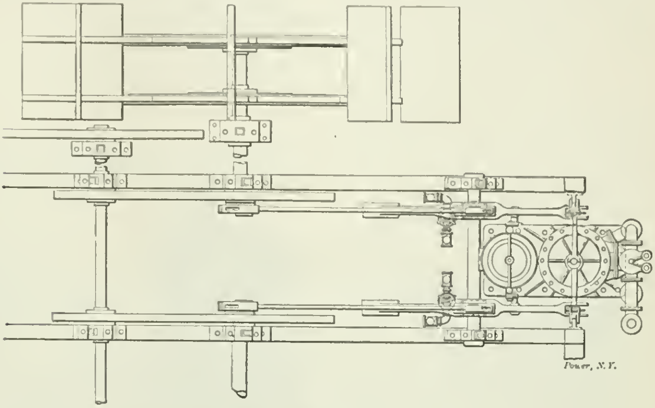


FIG. 4. PLAN OF ENGINE AND PADDLEWHEEL

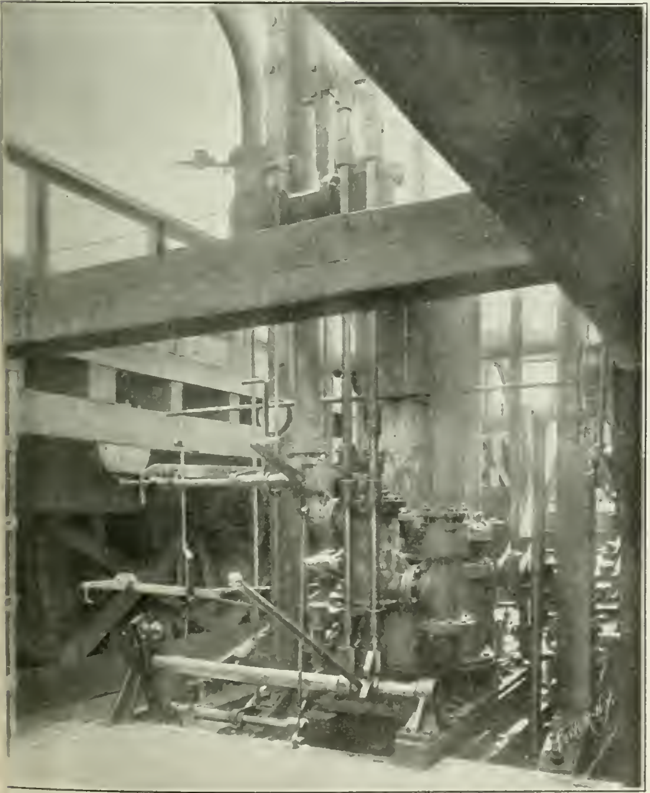


FIG. 3. SHOWING VALVE GEAR AND STARTING BAR

The society has secured for the exhibit, from the United Engineering Society, the Ericsson models; and from the Smithsonian Institution, the models of Fulton's "Clermont," John Fitch's steamboat and John Stevens' "Phœnix."

## American Society of Refrigerating Engineers

At a meeting of the council of the American Society of Refrigerating Engineers on June 22, a resolution was passed authorizing a meeting of the society in Chicago, Ill., beginning October 18. It is the intention to hold a two or three-day meeting at that time and then a one-day meeting in New York City on December 6. At the Chicago meeting it is expected that a number of interesting and instructive papers will be presented. The program committee in charge of the program for the Chicago meeting includes Karl Vesterdal, chairman, W. C. Reid and N. H. Fuller.

## More Michigan Power Companies Incorporated

Other power companies, with a total capitalization of $700,000, have filed articles of incorporation in the office of the secretary of State, in Lansing, Mich., making a total of nearly $4,000,000 represented in what is believed to be a combine for gaining control of Michigan's waterways. The companies were all incorporated at the last moment so as to escape the State control made possible under an act passed by the last legislature. Under the new law the railroad commission supervises the construction of lines and also regulates rates.

The latest companies to file articles were the Little Muskegon Water Power Company, Montcalm Electrical Company and Western Hydro-Electrical Company, all of Grand Rapids, with Bruce Goodfellow, of Detroit, as trustee, holding the larger share of the stock. Associated with him are Orrin T. Bolt, of Muskegon, Jay Reach and Robert T. Hughes, of Grand Rapids.

The Iosco Land Company, Detroit, has also filed articles of incorporation, with Henry F. Loud, Edward F. Loud, and H. Kimball Loud, of Au Sable, as trustees, the principal stockholders. It is stated this company is formed to purchase, to hold, and to deal in real estate, but as the incorporators are those interested in a number of power companies which filed articles recently, it is believed this concern is allied with them.

All Michigan has been interested in the extraordinary water power of the Au Sable river, and its possibilities have been the subject of frequent discussion. A number of years ago surveys of the district were made and shortly after their completion the Eastern Michigan Power Company, which had in possession, apparently, all information and data accumulated, as well as valuable rights and options, went farther and procured franchises in a large number of cities and municipalities in a large group of counties. About this time the propostion began to grow until it assumed, in public opinion, a proposed monopoly to control the State waterways. The result was that the last legislature took steps to prevent any such occurrence.

The American Society of Mechanical Engineers has accepted an invitation from the Institution of Mechanical Engineers to hold its spring meeting for 1910 in England, at such time and place as may be selected by the Institution.

## Oldest Trade Organization in America

There are people who think that the head of every youngster should be examined by a phrenologist, to assist in deciding upon the young person's future career, and these people are probably right in the main; but circumstances, and those curious mixtures of ability which often occur in one human mind, sometimes make an early choice of vocation impossible, and it is only by knocking about in the world for a short or long time that the right occupation is found. For such cases there is in New York City one institution which does much more good than many other organizations which are much better known.

The General Society of Mechanics and Tradesmen of the City of New York, the oldest trade organization in America, was begun in 1785 as a benevolent association. Quarterly pensions and donations are still given to indigent members and to the widows and orphans of members, but its chief work has gradually become the teaching, through a school called the Mechanics' Institute, of technical knowledge at night to young men who work by day and who for various reasons have had to begin the search for the almighty dollar ahead of any preparation for certain lines of work for which they may have special aptitude.

MECHANICS' INSTITUTE, NEW YORK CITY

Andrew Carnegie, a member of t society, a few years ago presented to $300,000, saying that the young men w were its beneficiaries and who studied night, after working hard all day, form the most desirable element in the dustrial life of the country; in fact, said they were "the salt of the eart Through Mr. Carnegie's generosity t stories were added to the Institute bui ing, thus providing additional class roor

The plan of the society is simple. A

erchant or mechanic in good standing ay become a life member by paying $100. nyone may donate funds for the enlargeent of its work. Any young mechanic of d character, over sixteen years of age, y enjoy its free tuition and, together h the general public, have recourse to e biggest technical library in New York ty. The student may also compete for free scholarship in the New York Trade hool. The library now comprises about 0,000 books, and while statistics show at the readers, being human, prefer tion to technical books in the ratio of rly 4 to 1, a large percentage of all books in the library are consulted ry year. In 1908 nearly 4000 books re presented to other libraries.

THE LIBRARY OF THE MECHANICS' INSTITUTE

next series of evening classes beg S ptember 27, and prospective pupils w considered in the order in which t applications are filed with Louis R n, director of instruction, whose is in the Institute building at 20 W orty-fourth street. The courses incl thirty-eight separate subjects and c r science, mathematics, drawing and cl modeling. There are twenty-nine cl ses so far, and last year there were m e than 2000 students. Practically all classes meet two evenings a week, 7 to 9:15 p.m., beginning the last week in September and ending early in Aprl. Puils who have the time and capacity may enter two classes and attend four evenings a week. A few words will describe the value of these evening studies to young men who are earning money, but who would earn more and do better work if they could have technical education.

Course A, architectural drafting, covers three years and ranges from elementary drawing to plans, elevations and details of apartment-house construction. Advanced courses instruct students in intricate plan-reading and estimating methods.

Course B, mechanical drafting, is also a three-year course and is very thorough, with various separate courses for cornice and sheet-metal work, electrical industries, patent-office drafting, yacht and shop work, topographical drafting, mechanism, lettering and carriage and automobile drafting.

Course C, free-hand drawing, runs three years. Work is done from the antique two years and from life the third year.

Course D, clay modeling, comprises both figure and mechanical work, and is especially useful to those interested in architectural ornamentation.

Course E, mathematics, covers various branches, including arithmetic, elementary algebra, geometry and trigonometry, as well as workshop mathematics and applied mechanics.

Course F, science, includes elementary and laboratory physics, industrial electricity and wireless telegraphy. "Physics" is a mysterious word to many, but its study means learning the simple "why" of mechanics, light, heat and electricity; the laws which govern work, motion, energy. A knowledge of physics means knowing the natural laws by which anything material is accomplished, and which every intelligent person will be expected to know as teaching becomes more advanced. Physics teaches the laws of electric currents and electric measurements, the determination of specific gravity, the pressure and density of fluids, and the operation of the steam engine.

All of the instructors are men of high standing. Among them are Charles C. Sleffel, who conducts the first-year course in mechanical drafting; John N. Anderson, who conducts the second-year course, machine details; and Warren Atkinson, in charge of the third-year course, machine design, as well as mechanism, electrical and yacht and ship drafting. George W. Kittredge teaches drafting for cornicemakers and sheet-metal workers, as well as boiler work. Charles W. Reinhart instructs in patent-office and topographical work and lettering. Physics is taught by Charles Forbes, of Columbia University.

The society's diploma is awarded when examination on any course is passed.

# Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

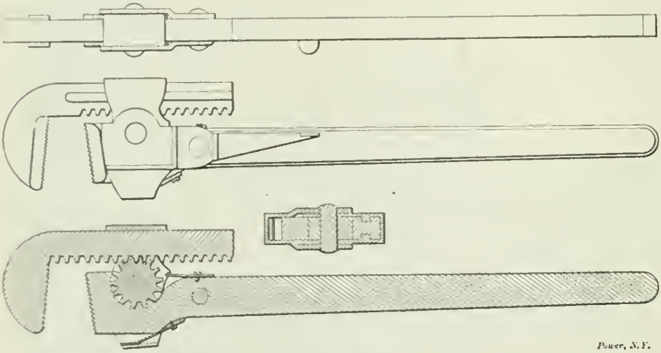
## A New Pipe Wrench

The pipe wrench herewith illustrated and described is quite different from the ordinary tool of this kind. By referring to the illustration it will be seen that it shows a side view of the wrench, a top view, a longitudinal sectional view and a vertical sectional view.

The wrench is made up of a stock or handle having a stationary jaw and a toothed cavity on its end; movable jaw parts are so arranged that the wheel, or gear and a hinged housing. These parts are so arranged that the wheel which is interposed between the movable shank and the stock and carried by the hinged housing, is always in mesh with the teeth of the movable shank. It is in mesh with the teeth of the circular cavity, also, when the wrench is in its locked position as shown.

The housing is made up of two parts, held together by a pin upon which is also mounted the toothed wheel or gear. The upper part of the housing is pivoted, thus allowing the movable jaw and shank more than enough rocking motion to compensate for the distance between two teeth. The lower housing is pivotally mounted on the stock by a pin. One of its sides is extended, forming a small lever, working in the recess in the side of the handle. This lever serves to unlock the wrench. A spring holds the teeth of the gear and stock together normally. Another spring keeps the movable jaw tilted in its forward position, thus enabling the wrench to grip the pipe very readily. The shank of the movable jaw is graduated.

The operation is as follows: The thumb of the hand holding the handle is placed upon the small lever on its side, depressing it, and thus raising the housing gear until the teeth of the gear and stock are disengaged. The movable jaw is then moved to the desired position and, the lever being released, the spring brings the teeth of the gear and stock back into engagement, locking the wrench. This adjustment is made very easily and quickly. The wrench is patented by V. J. Coughenour, Carlton, Ohio.

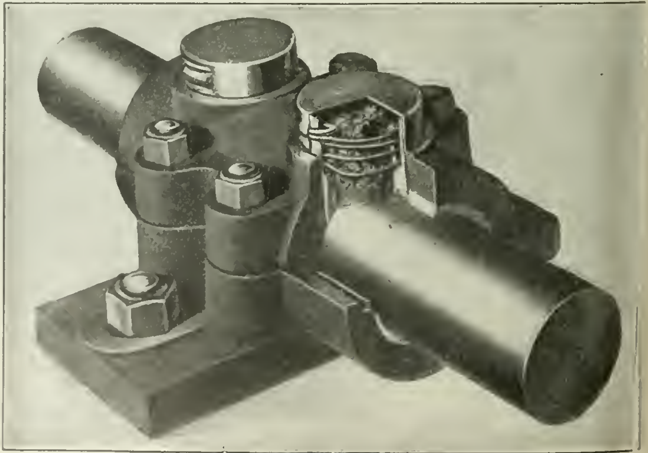

Power, N.Y.

A NEW PIPE WRENCH

## The Van Doren Lubricator

The Van Doren bearing lubricator embodies principles which are said to be entirely new, and is designed to apply th lubricant to the bearings of shafting evenly, in minute quantities, furnishing jus enough to give a perfect film between th two metals. As the lubricant lies upo the moving shaft, all excess grease i wiped off by the felt insert in the woode gland which rides on the shaft due t the tension of the coil spring, as show in the illustration.

This device consists of four parts, barrel, spring, wood gland and cap. Tl main feature is the wood gland, whic rests directly upon the shaft, conformir exactly to its contour. This gland is to l completely filled with grease, which li on the shaft. In the bottom of the glar is a ring of felt packing which presents smooth surface to the shaft and is i tended to prevent the generation of a surplus friction from the wood and keep the shaft always wiped clean, leavi just enough grease to give good lubr tion. The gland is held in place aga the shaft by a light pressure from spring, the top of the spring being fast in slots in the barrel, which is ened to the bearing cap.


VAN DOREN LUBRICATOR APPLIED TO A BEARING

On ordinary bearings under 4 inche

diameter and not over 12 inches in length, two lubricators are necessary. For larger sizes, or for extra-heavy duty, more may be necessary, according to size and conditions.

The only work necessary for installing this lubricator is the drilling of holes in the bearing cap in which to fit the lubricator, which takes but a few minutes. It is manufactured by the C. J. Van Doren Company, 5 West Madison street, Chicago, Ill.

## Forced Feed Automatic Plunger

This lubricating device is particularly adapted to the plunger elevator in providing lubrication to the wearing surface of the plunger with sufficient constancy so that the power used for operation will be reduced. It saves the time of a man smearing the grease on the plunger with his hands, also decreases the amount of grease used, on account of more efficient and uniform use and prevents the rapid destructive abrasion and flaking that take place when the plunger is exposed to the air in a dry condition, it is claimed.

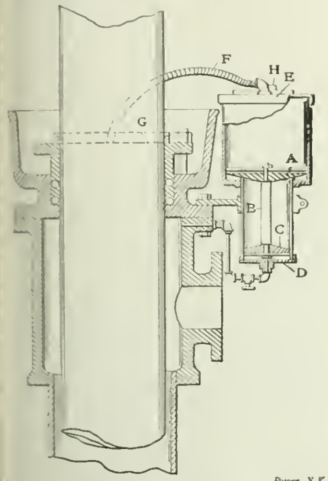


FIG. 1. SECTION OF GREASE HOLDER

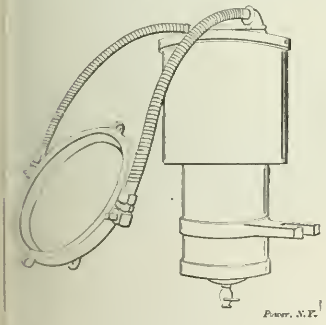


FIG. 2. GREASE CUP AND ATTACHMENT

It is said that one filling of about 4 pounds of grease will last from three to six months, and that after the first adjustment, which can be done in a few minutes, it will need no further attention until the cup is to be filled again. The lubricator is attached to the cylinder head of the elevator by means of a bracket.

Fig. 1 represents the container or holder for grease. Within this holder is mounted a piston *A* having a piston rod *B*, at the lower end of which is a smaller piston *C*, which works in a smaller cylinder *D*, so as to bring less pressure per square inch to bear on the grease than that in the elevator cylinder.

The bottom of the small cylinder is connected with the elevator cylinder by a pipe having a valve for opening and closing it. See Fig. 2.

The top *E*, of the holder is adapted to screw on and is provided with two flexible metallic tubes *F*, for conducting the grease to a split hollow ring *G*, which has perforations in its inner side for directing the grease against the surface of the plunger. A screw at each entrance of the ring regulates the feed. In the top *E* is a cap *H*, through which the filling is done.

This device was designed by A. R. Klingloff, 28 Kittredge street, Roslindale, Mass.

## "Type A N" Condenser

Experience has shown that the best results can be obtained from engines when each engine is provided with its own condenser, and for this service the apparatus shown in the accompanying illustrations, known as the "Type A N" condenser, has been designed and developed by R. D. Tomlinson, condenser expert of the Allis-Chalmers Company, Milwaukee, Wis.

The operation is as follows: Steam enters the condenser at the top and water enters at the side and flows around and over the serrated top, Fig. 1, and down into the steam-and-water combining chamber where the steam is condensed and is then carried with the injection water down through the contracted tube and tail pipe to the hotwell. The top of the steam-and-water combining chamber is serrated in order to corrugate the surface of the water and in this way present a much greater surface to receive the steam.

The water-and-air combining chamber is provided with slots in the side which communicate with a chamber surrounding it, and to this chamber is attached an overflow pipe, the end of which is sealed in the hotwell. This portion of the condenser is designed to take care of a possible flooding.

No dry-air pump is required, and 28 inches of vacuum can be produced when the condensing system is maintained air-tight. The air is forced out of the condenser partially by the energy of the steam which is flowing in at a high velocity and partially by the tendency of the air to cling to the side of the falling water; therefore, a high vacuum can be produced if the condensing apparatus is properly connected to the engine and the system made tight. In order to prevent the air which comes down the center tail pipe from returning through the overflow pipe to the condenser, the hotwell has a partition between the center tail pipe and the overflow pipe. Fig. 2 shows the condenser piped to an engine. The features of this condenser are protected by patents.

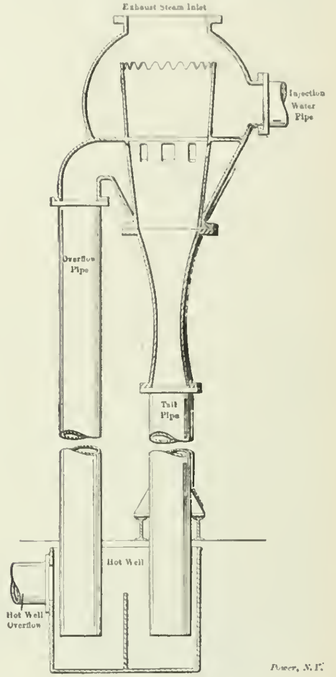


FIG. 1. SHOWING THE SERRATED TOP

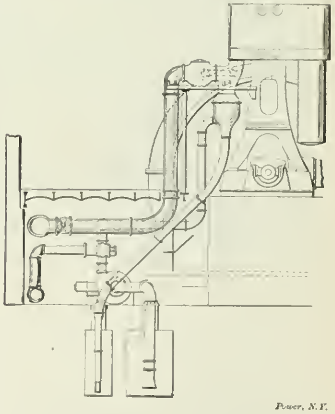


FIG. 2. CONDENSER PIPED TO AN ENGINE

## Business Items

The [illegible] Lumber Company, of Portland, Ore., has installed two [illegible]-kilowatt Westinghouse steam turbines in its mill at Stockdale. One [illegible] will be employed to drive 2300-volt, three-phase, 60-cycle alternating-current generators supplying the local lighting and power load.

The Western Electric Company announces that it is now in position to furnish "Sunbeam" tungsten lamps in voltages between 200 and 250. The lamps are made in four sizes at present, namely [illegible], 70, 112 and 180 watts. They are said to have given thus far, the same satisfaction as tungsten lamps for 110 volts.

The Smooth-On Manufacturing Company, Jersey City, N. J., has just issued the 8th edition of its instruction book. This edition is larger than the others and is fully illustrated, showing many different ways in which the Smooth-On cements have been used in power-plant practice. A copy will be sent to any engineer on application.

[illegible] M. Morse, Chicago district manager for the Harrisburg Foundry and Machine Works, reports nine recent sales of Fleming-Harrisburg engines for direct-connected electric generating sets. One of these engines is for Thomas B. Jefferys & Co., Kenosha, Wis., and is of the Harrisburg improved Corliss-valve nonreleasing-gear type, and will drive a 360-kilowatt alternator at 150 r.p.m. and having the exciter as well as the alternator directly connected to the engine shaft.

The sheet and tinplate mill of the new Aliquippa works of the Jones & Laughlin Steel Company, on the Ohio river below Pittsburg, will be served with power to operate a number of direct-current motors, through a rotary converter, from a 500-kilowatt, 6600-volt, three-phase, 25-cycle Westinghouse turbo-alternator. The fuel used in the boiler plant will be coke-oven gas and the turbine will operate on a steam pressure of 150 pounds, exhausting into a vacuum of 23 inches.

## New Equipment

The Hotel Foeste, Sheboygan, Wis., will install a power plant.

The waterworks plant at Onalaska, Wis., was destroyed by fire.

The city of Mt. Olive, Miss., will issue $8000 electric-light bonds.

The Westfield (Mass.) Power Company is building a new engine room.

The Athern Hotel Company, Oshkosh, Wis., will install a lighting plant.

The Richardson Paper Company, Lockland, Ohio, is building a large warehouse.

The Mandt Wagon Company, Stoughton, Wis., will build a foundry, power house, etc.

The Alpena (Mich.) Power and Electric Light Company, is building a new power plant.

The municipal electric-light and power plant at Hastings, Neb., will be enlarged this fall.

The Mitchell Motor Company, Racine, Wis., has completed plans for a new power house.

The Orwigsburg (Penn.) Knitting Mill will erect a new building and install a new engine.

The Queen City Printing Ink Company, Cincinnati, Ohio, has built an addition to its engine room.

Citizens of Christiansburg, Va., will vote on the issuance of bonds for the construction of waterworks.

The Lewisburg, Milton & Watsontown Railway Company will erect a new power house at Milton.

Rohrer & Co., Orwigsburg, Penn., will erect an addition to its plant and install a new engine and boiler.

Citizens of Johnson City, Tenn., will vote on the issuance of $375,000 bonds for construction of waterworks.

The Monitor Stove and Range Company, Cincinnati, Ohio, will increase the capacity of its power plant.

The Reliable Shoe Company, Orwigsburg, Penn., has remodeled its building and will install motor power.

The National Wire Cloth Company, Miles, Mich., has erected a plant and is installing new engines and machinery.

The Worcester (Mass.) Cold Storage and Warehouse Company will erect an additional building to cost $15,000.

W. H. Williams & Sons, Kalamazoo, Mich., will erect a three-story building for the manufacture of ice cream, etc.

Henry L. Lea, The Rookery, Chicago, Ill., is preparing plans for a coal-gas plant for the city of Raton, New Mexico.

Dickinson & Co., Eureka, Ill., will erect a new canning factory with 200-horsepower boiler capacity and 60-horsepower engine.

Catalogs and quotations on canvas belting and packing are wanted by Gilchrist & Co., Reconquista 484, Buenos Aires, Argentina.

The White Packing and Cold Storage Company, Clinton, Okla., contemplates the establishment of an ice factory and packing plant.

The Watsontown (Penn.) Electric Light and Power Company is in the market for a water-tube boiler with fittings. L. R. Gross, superintendent.

The Memphis (Tenn.) Street Railway Company has awarded a contract for the construction of a three-story addition to its power plant on Broadway.

The Middlecreek Electric Company, Sunbury, Penn., has completed a new power house. Installed part of equipment. Will need more motors and engines.

A new candy factory is being erected at Schuylkill Haven, Penn., to be known as Lauterbacher's candy factory. A new engine and boiler will be installed.

Dickinson & Co., Eureka, Ill., will erect a new factory with 200-horsepower boiler capacity and 60-horsepower engine. The firm is figuring on a motor-drive with direct-connected generators.

## Help Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

WANTED—Good mechanical designers and detail draftsmen for machinery manufacturer located in Wisconsin. Box 98, Power.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," Power.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

AGENTS WANTED to sell Burgmann celebrated engine packings in territories not yet covered. See our advertisement on page 71.

WANTED—Manager, who can obtain some capital, for modern machine works, running day and night, located in Ohio. "Engineers," Box 20, Power.

WANTED Feed water heater designer and draftsman. One who has had experience in designing successful open-type cast iron heaters. Advise age, experience, education and compensation desired. Box 97, Power.

WANTED An engineer experienced in design and application of electric controlling devices for industrial installations. Must thoroughly understand latest commercial systems and apparatus. No application will be given consideration except from engineers of established reputation and experience. In reply, give references, experience and salary expected. Box 8, Power.

## Situations Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

ENGINEER, 12 years' experience, stationary and locomotive engines, desires position. Have good references. Box 18, Power.

POSITION as engineer in electric-light plant. Have had (10) years' experience with different types of engines. Reference furnished. Box 21, Power.

WANTED Position as engineer in electric or manufacturing plant. Experienced with Corliss and automatic engines, fire and water-tube boilers. Box 12, Power.

SITUATION WANTED by steam and electrical engineer. Understands high and low speed engines, condensers and pumps. Would prefer to go South or West. Box 26, Power.

MANAGER, sales manager, department or agency. Commercial engineer, 20 years' experience electrical and mechanical lines. Now traveling, desire change. Harwood, 20 Howard Place, Jersey City, N. J.

ENGINEER wants position; age 37, married; strictly sober; experienced with water-tube boilers, Corliss engines, steam turbines, large direct-current and alternating current generators and high tension. Box 24, Power.

ENGINEER, turbine expert of high standard and good character, who understands economy, desires change from continuous night work; carries first-class licenses; power plant or office; 26 years old, 10 years' experience. Box 27, Power.

POSITION WANTED—Engineer, practical machinist, first-class New York license, best of references, take charge of steam plant, ice machines, Corliss engines, dynamos, factory, brewery, repairing, ammonia and steam fitting, city or country. Box 22, Power.

ENGINEER of several years' experience, stationary and locomotive, who is also A No. 1 fireman, understands boilers, all general repair work and has no objection going where there is run-down machinery, wishes to join a firm of will appreciate good service. Address "J. C.," 127 E. Penn St., Carlisle, Pa.

POSITION WANTED the year round as assistant engineer in 50 or 75-ton ice-making plant. Fifteen years' experience as engineer in charge of ice making plants. Graduate of M. E. and R. E. courses of I. C. S. Have charge at present of 15-ton compression machine. Am not employed by the year and desire a change. Can come immediately. Age 30; married. Box 14, Power.

OPEN FOR POSITION of responsibility capable and energetic young man (married), experienced in operation and installation of electrical and steam machinery. Several years spent on boiler and furnace work, piping, engines, and general central station design and construction. Also testing and general line of electrical power, light and railway experience. Over four years with present employers on variety of responsible undertakings. Best of references. Graduate in M.E., E.E at Cornell University. Please state company, location, nature of position, prospects and salary. Box 23, Power.

## Miscellaneous

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

PATENTS secured. C. L. Parker, Solicitor of Patents, 4 McGill Bldg., Washington, D. C.

WANTED—Firm to make boilers with combined water and fire tubes after four new patents on royalty. The boilers have many advantages, are simple and can be made very cheaply. Box 25, Power.

NEED the part-time services of draftsmen and designers? Years of experience on steam and power pumps, gasolene engines, hoists, etc., at your command at reasonable prices. S. S. Engr. Co., Elgin, Ill.

ANY FIRM or engineer in charge of a steam plant that is troubled with scale in the boilers can get absolutely free, the best indicator and reducing wheel made, with velvet-lined mahogany case. For particulars address Great Lakes Chemical Works, Manitowoc, Wis.

## For Sale

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

FOR SALE—250-horsepower Lane & Bodley Corliss engine, 18x42 cylinder; engine too small for our work and will be replaced soon with one of greater power. Wm. A. Coombs Milling Co., Coldwater, Mich.

# Vernon, Vt., Hydroelectric Development

## Large Water Power Plant with Three-rotor Vertical Turbines Designed for 30-foot Head and Operation under Extremes of Water Level

### BY C. E. BASCOM

The development of the Connecticut River Power Company, Vernon, Vt., comrising an installation of vertical turbines vith three turbines on each shaft, is a ew departure and presents a novel methd of taking care of extremely high-flood vater. With the nominal and minimum w the two lower wheels or rotors develop all the power generated by the unit. he upper turbine has a separate draft be opening above, into the top of the raft tube for the lower rotors. During xtremely high floods, when the water in e tail race rises high enough to seal t draft tube to the top rotor, water is ted to the top wheel by a hand . the lower pair of wheels only being r the control of the governor.

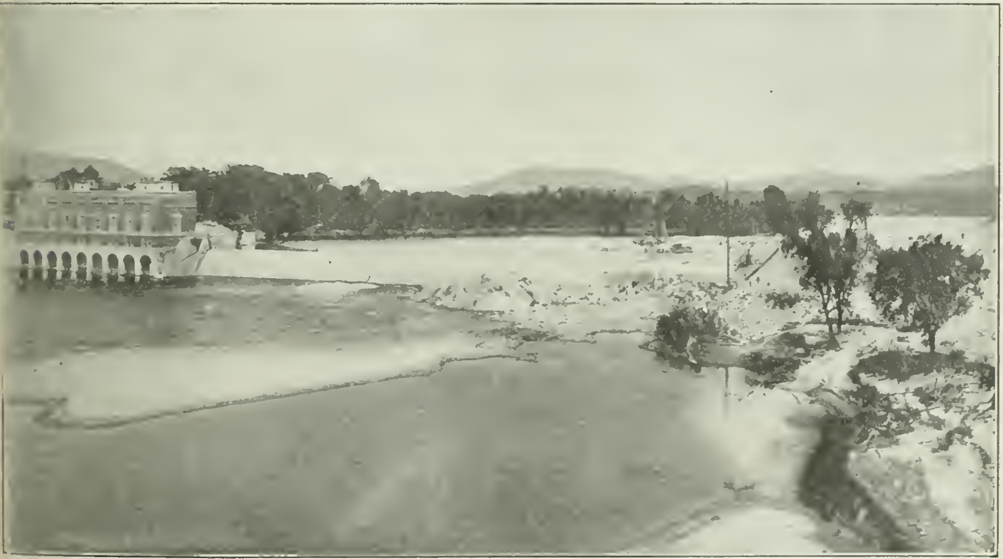


FIG. 1. WATER-POWER DEVELOPMENT AT VERNON, VT.

### E of Plant and Dam Construction

rk on the dam began in May, 1907, al a working force of from 350 to 600 nn was employed in its construction. T plant is located on the west bank of th Connecticut river, on the State line between New Hampshire and Vermont a 5 miles north of the Massachusetts State line. This location is 6 miles south of Brattleboro, Vt., and 2 miles west of Hinsdale, N. H. As a developed water power, the plant ranks fifth in size in New England, and electrically is the largest of this type of plant, about 15,000 horsepower being available.

Near the site of the plant the river makes a loop around a high bluff, returning on itself in a flow of one mile to within 500 feet of the beginning of the loop. It is on one side of this loop that the dam is built, and just above is a rocky island which separates the flow into two channels. The main channel of the river at the location of the dam was 300 feet wide and 18 feet deep. A bluff on the New Hampshire side rose 75 feet above the water. The upper 75 feet was composed of sand marl and clay formation, while the lower 25 feet was rock. This bluff had to be removed, the excavation extending 300 feet back from the river and 6 feet below the river bed. The total rock excavation amounted to 34,000 cubic yards, and it was necessary to excavate 241,500 cubic yards of earth, nearly all of which was removed by sluicing. Two duplex Dean steam pumps, 18 and 10.5 by 12-inch, were used to pump the water from the river through 6-inch pipes to the Eastman 2-inch brass nozzles. Nine steam drills and two baby steam drills were used on the rock excavation. In the construction of the cofferdams 1,600,000 feet of logs were used, and 42,000 cubic yards of concrete were required for the permanent dam, the spillway being 640 feet long by 28 feet high without flashboards, and with flashboards a maximum head of 32 feet is obtained.

The water backs up for a distance of 16 miles, with an average width of over 400 feet. To take care of extreme floods the dam contains 10 flood gates, each 7x9 feet. At present these gates are operated by hand from a tunnel in the dam directly over the gates and extending about two-thirds of the length of the dam, from the power-house end, although provision has been made to operate these gates by power from the station. Figs. 1 and 2 give a general view of the dam and station, and in Fig. 1 the log chute between the station wall and the end of the dam can be seen. The construction of the dam and the concrete work of the

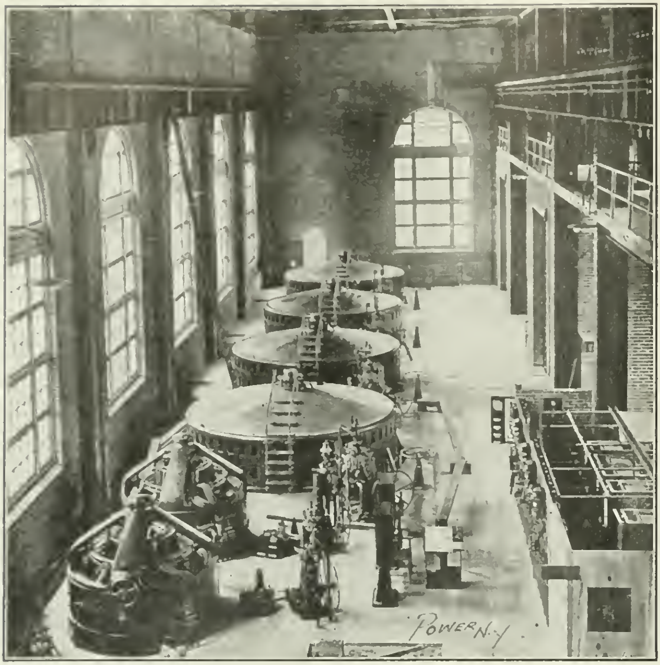


FIG. 4. GENERATOR ROOM

power house and draft tubes was executed by J. G. White & Co., of New York City.

### The Power Plant

The building is of concrete and brick construction, 220 feet long by 51 feet wide and 102 feet from the bottom of the wheel pits to the top of parapet. Fig. 3 is an end elevation through plant, in which *B* indicates one of the main gates. These are 15 feet square and made up of I-beams covered with sheet steel. Bronze hinges secure the gates. In operation the filler gate *L* is first opened to fill the wheel pit, after which the main gate is lowered. The main gate can be closed by the crane *C*, for which purpose cable connections have been made. The location of the high-tension gallery is indicated by *D*. *E* is the transformers alcove, *F* the low-tension gallery, *G* the thrust-bearing room, *H* the generator room and *I* the upper turbine used only during periods of high water. This turbine is 57 inches in diameter and the two lower, or twin wheels *J*, are 60 inches in diameter. When the water rises in the tail race *K* to *A*, the operator opens a hand gate (not shown) to the upper wheel *I*.

The equipment consists of five generating units. The turbines were furnished by the S. Morgan Smith Company, of York, Penn. A feature of this turbine is the thrust bearing which carries the entire weight of the moving parts, 54 tons, on a thin film of oil supplied by a triplex Gould pump, 3x6 inches, under a pressure of from 200 to 300 pounds per square inch. The oil is forced under a disk mounted on the vertical nickel-steel shaft, and is admitted through two 1$\frac{1}{2}$-inch pipes into a chamber of the thrust bearing under the shaft disk. The only escape for the oil from this chamber is by raising the entire weight of the revolving parts of the unit about 0.12 inch. This is easily accomplished as the area of the disk is large enough, with a pressure of 200 pounds per square inch, to lift the 54 tons, and as the pump runs continuously, the weight is always supported on this film of oil.

Besides the five main generators the plant contains two exciters, which are independently driven by vertical turbines equipped with roller-thrust bearings. The generators, exciters, transformers and the entire electrical installation were furnished by the General Electrical Company. The plant has been completed with the exception of the fifth unit, and one more transformer is to be installed soon. The generators are alternating-current machines of the revolving-field type with 54 poles each. At full load they generate 627 amperes at 2300 volts and run at a speed of 133 revolutions per minute. The exciters are 125-volt machines with a speed of 190 revolutions per minute. The station is to be equipped with four 5000-kilowatt transformers, three of which are now installed, to step the 2300 volts from th generators up to 66,000 volts.

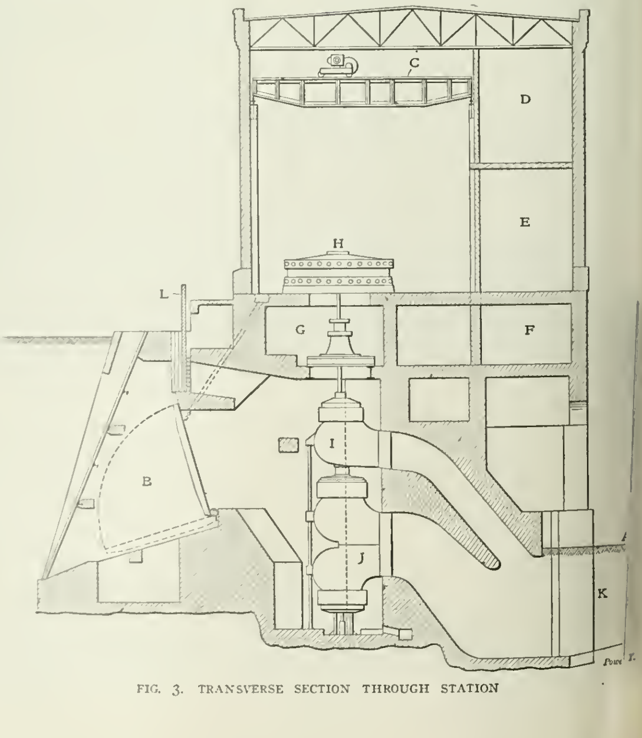


FIG. 3. TRANSVERSE SECTION THROUGH STATION

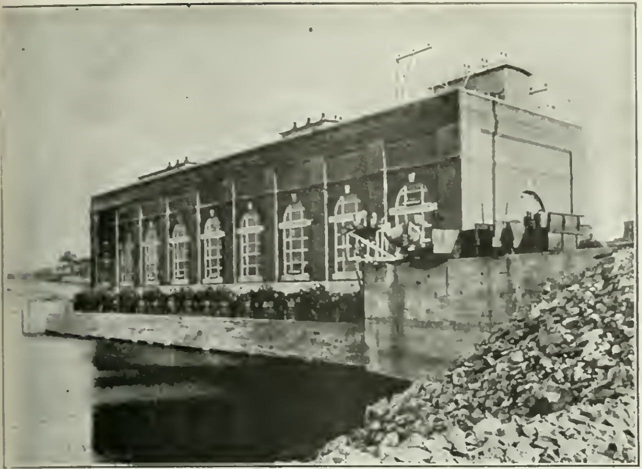


FIG. 2. FOREBAY SIDE OF PLANT

ʻhe company has substations at Clint and Fitchburg, Mass., and substations a to be built at Worcester, Mass., and I ttleboro, Vt. A smaller transformer i be used to step the voltage up to 29,o volts for the Brattleboro, Vt., lines. I h transformer is set upon a four-wheel t k and can be moved along a track as r ired.

g. 4 gives an idea of the generator r , the four generators and two exc rs being shown, also the Lambard w r-wheel governors and the switchb d of 11 panels. Beyond the switchb l are the alcoves in which the transf ers are located. The rails upon which tl rest may be seen projecting out nearl the generators. Above and to the ri t is the high-tension gallery. The fe rs pass to the steel towers on the rcf and then to the substations.

n the door below the generators are th rust bearings, Fig. 5, the oil pumps fc ese bearings, also the Dean triplex ch oil pumps for the Lambard water-wheel governor. To the right under the transformers is the low-tension gallery, Fig. 6. The oil switch compartments are plainly visible, and in the background the oil tank holding oil for the transformers. Fig. 7 shows the switchboard, behind which can be seen the spiral stairway leading from the low- to the high-tension gallery.

An electric crane furnished by the Northern Crane Company is installed in the generator room. The hoist and bridge motors are rated at 25 horsepower each, and the carrying motor at 6 horsepower. The crane has a carrying capacity of 60,000 pounds and a standing lift capacity of 140,000 pounds.

Fig. 8 illustrates the type of steel tower used for supporting the feeders, also the kind of insulations used. The tower supports the ends of two 1700-foot spans.

To avoid flowing some valuable land belonging to the Brattleboro hospital, it was necessary to build a dike in Brattle-

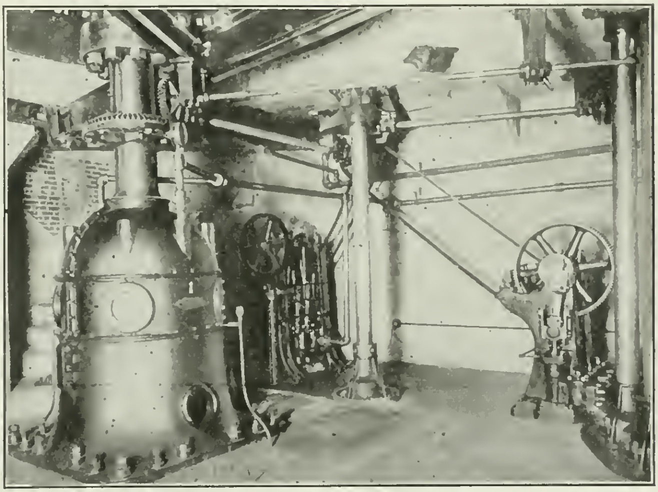


FIG. 5. THRUST BEARING AND OIL PUMPS

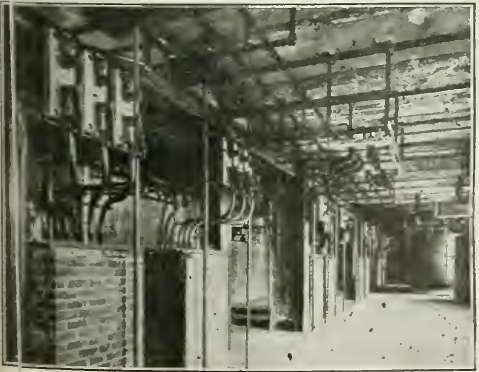


FIG. 6. LOW-TENSION GALLERY

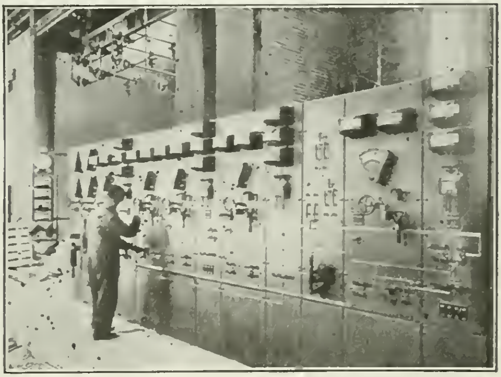


FIG. 7. SWITCHBOARD

been nearly [illegible] mile long, and to install two small [illegible] to pump a small stream over the dike. It might [illegible] 20 feet [illegible] to pump sewage from part of the first [illegible] over the dike.

Without doubt the Connecticut Power Company has a station that will compare favorably with the best plants of the country, for no expense has been spared to make it one of the best examples of modern engineering practice.

FIG. 8. TYPE OF STEEL TOWER USED ON TRANSMISSION LINE

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The following reference to the construction of a locomotive is worthy the reporters of the present day. It is taken from a publication in 1826, and reads: "The locomotive engines are made of thick sheet iron, and are obviously of the high-pressure kind."

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# Catechism of Electricity

## Typical Forms of Direct-current Motor

1079 *For what kind of service is the four-pole motor shown in Fig. 307 chiefly used*

For driving blowers and exhausters of small or moderate size to which it is direct-connected. This motor is built in sizes of from 1 to 100 horsepower running at speeds ranging from 600 to 1500 revolutions per minute.

1080 *Illustrate and describe the principal parts of this motor.*

Fig. 308 shows the principal parts separately. The magnet frame *m* consists of a cylindrical yoke of cast iron, machined to receive the pole pieces and bearing brackets, and has supporting feet cast solid with it. The bearing brackets, or end covers *u* and *v*, are of skeleton construction held in seats in the magnet frame by four bolts.

The pole pieces *n*, *s*, etc., of which there are four, are through-bolted to the yoke and offset axially from the center to permit the use of duplicate bearing brackets on either end. By taking out the through-bolts of any magnet pole, that pole, with its coil, may be removed without disturbing the armature or dismantling the motor. The pole pieces are built up of soft-steel punchings, held between cheek plates under pressure. The punchings are of such shape that they provide a support for the field coil, and cast-iron horns are used to eliminate the disagreeable humming while retaining all the advantage of the laminated construction.

The field-magnet coils are machine-wound and insulated by two layers of heavy tape.

The armature *t* is of the slotted-drum type, built up of annealed-steel stampings, each insulated by a coating of japan. These laminations are assembled on a cast iron sleeve which is provided with openings for free circulation of air and has an extended hub for the reception of the commutator shell, thus making the armature and commutator a self-contained unit. The armature coils are held in the slots by fiber wedges. The commutator is built up of bars of hard-drawn copper held in a cast-iron shell of spider co struction; amber mica is used for insu tion between the copper segments.

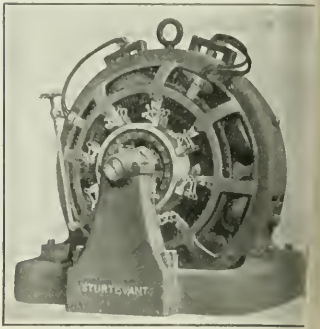

FIG. 309. STURTEVANT EIGHT-POLE MOTO PEDESTAL TYPE

The brushes are of carbon and slide brush holders of the box type. They provided with braided copper "pig-tail which relieve the brush-holder body springs from carrying any appreciable rent. The brush-holder studs are mo in lugs projecting inward from a ri which is supported in a machined rec in the magnet frame. It is held in si tion by the front bearing bracket *u*.

1081 *For what kind of service i the eight-pole motor shown in Fig. 309 c used?*

For driving large machine tools, bl

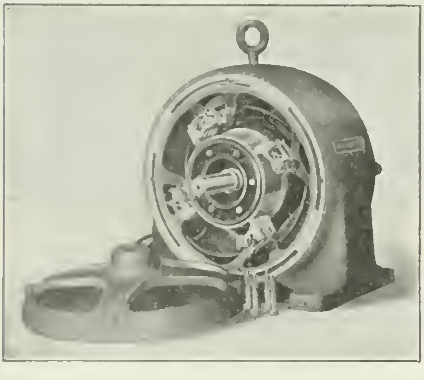

FIG. 307 STURTEVANT FOUR-POLE MOTOR: FRONT BEARING BRACKET REMOVED TO SHOW COMMUTATOR BRUSHES ARMATURE, ETC.

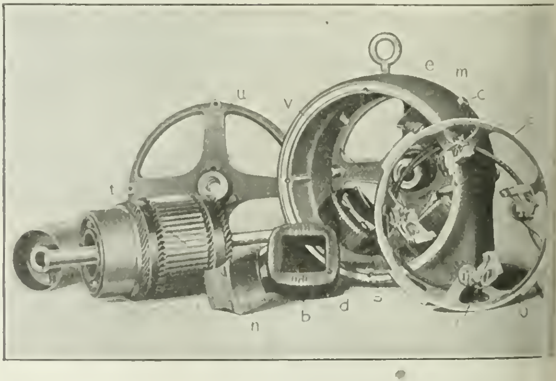

FIG. 308. DETAILS OF STURTEVANT FOUR-POLE MOTOR SHOWN IN FIG. 307

and exhausters to which it is direct connected. This motor is made in sizes up to 225 horsepower, running at 300 to 900 revolutions per minute.

1082 *Describe the principal parts of this motor which differ from those in the motor shown in Fig. 307*

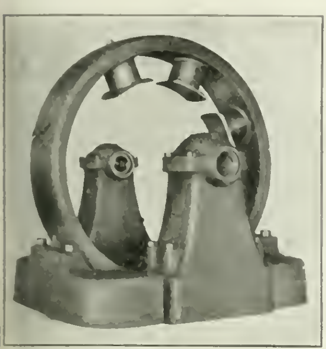

FIG. 310. MAGNET FRAME, PEDESTALS AND POLE PIECES OF STURTEVANT MOTOR SHOWN IN FIG. 309

There are no end brackets, the shaft bearings being supported in pedestals *m* and *c*, Fig. 310, which, with the magnet frame *r*, is bolted to a substantial base *b*. To inwardly projecting bosses on the magnet frame, which is split in a horizontal plane, are through bolted the pole pieces *z* with cast iron shoes *a* on the inner extremities.

The armature, Fig. 311, is of the slotted-drum type made from punchings of mild steel, which are coated with insulating varnish and clamped on a cast-iron spider, the hub of which is extended to support the commutator. Air is forced through and about the armature windings by ventilating ducts formed by brass space blocks with radial arms, which act like the blades or vanes of a centrifugal blower. A two circuit winding is usually adopted, so that a single pair of brushes is sufficient whenever small brush capacity is required. Armature and field coils are made waterproof and oilproof by drying and, after dipping in armalac, baking for twenty-four hours at a temperature of 100 degrees Centigrade

1083 *What form of direct-current motor is made by the General Electric Company for individual or group driving of machines?*

The motor shown in Fig. 312 is made in sizes of from one-sixth to 20 horsepower for this purpose

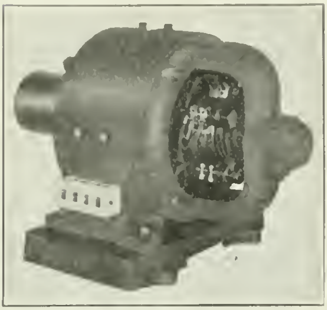

FIG. 312. DIRECT-CURRENT MOTOR MADE BY GENERAL ELECTRIC COMPANY FOR INDIVIDUAL OR GROUP DRIVING; $7\frac{1}{2}$ HORSE-POWER, 825 REVOLUTIONS PER MINUTE ON A 15-VOLT CIRCUIT

1084 *Illustrate and describe the principal parts entering into the construction of this motor.*

Referring to Fig. 313, which shows the principal parts separately, it is clear that the frame *m* is one cylindrical casting, with the feet cast integral. The frame is of steel. The pole pieces *n*, etc., are made of steel and are bolted from the outside to a machined surface *r* on the inner circumference of the yoke frame. Laminated pole shoes *s* of soft sheet steel are screwed to the magnet cores. The bearings *b* are a part of the bearing heads *h*, carry removable bushings and are provided with oil chambers and lubricating rings; they are bolted to the motor frame.

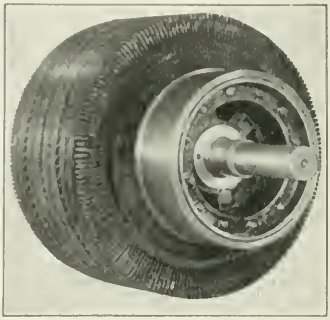

FIG. 311. ARMATURE AND COMMUTATOR OF STURTEVANT MOTOR SHOWN IN FIG. 309

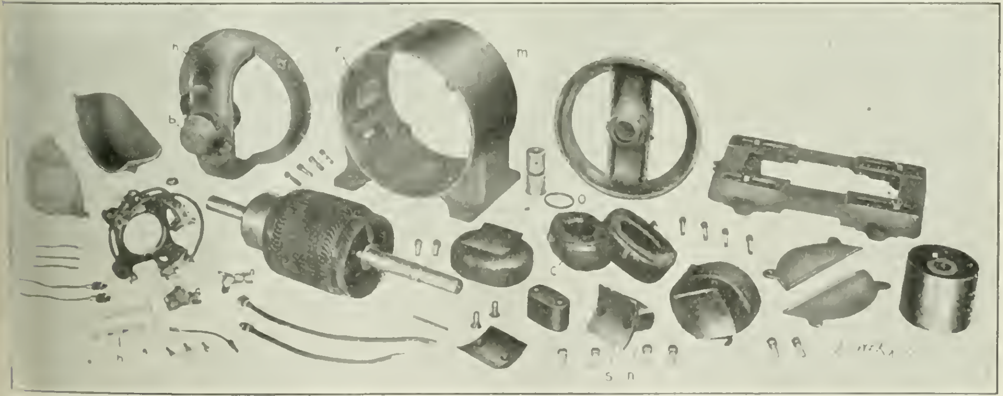

FIG. 313. PARTS OF THE GENERAL ELECTRIC MOTOR SHOWN IN FIG. 312

The bushings are made in one piece and may be readily renewed when necessary.

Each field-magnet coil *c*, etc., is held in place by the projecting pole tips. The armature core is of the usual sheet-steel construction with slots for the armature windings. The armature coils are form wound and individually insulated. The coils are held in the core slots by binding wires. The commutator segments are of hard drawn copper, insulated from the shell and from one another by mica.

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Monthly meetings of the American Society of Mechanical Engineers are to be held in New York on the evenings of October 12 and November 9, and the annual meeting will be December 7-10.

# Welding Pipe Work for Superheated Steam

## Welding Nozzles, Flanges, Brackets and Bosses to Steam Headers. Advantages and Efficiency of the Weld, Various Processes Employed

BY WILLIAM F. FISCHER

With the advent of superheated steam and the correspondingly higher pressures and temperatures in use in most modern power stations of today, the engineer is brought face to face with some entirely new problems in the design and construction of high-pressure piping systems which modify all previous ideas as to the proper materials to employ in the construction of valves, fittings, pipe, etc.

It is generally understood that valves and fittings of cast iron undergo a slow but constant increase in volume and a consequent loss in strength when subjected to the direct action of superheated steam at temperatures of approximately 500 degrees Fahrenheit and higher and do not return again to their original dimensions when cooled. In many cases where only a moderate degree of superheat was used in steam mains, cast-iron valves and fittings have been replaced by those of cast steel, owing to the rapid disintegration of the metal, which is usually shown by cracks appearing on the surfaces of the casting, or in some cases a crumbling and falling away of the surface metal exposed to the action of the gaseous steam is noted, and the strength of the casting as a consequence is seriously impaired. This, as stated by several authorities, is probably due to the high percentage of carbon and silicon contained in the metal.

The occasional spraying of the highly heated interior surfaces of the fittings with small particles of water carried by the steam is stated as another cause of such difficulties with cast-iron parts, as it is generally believed that under certain conditions, water may exist in the presence of superheated steam, which would result in extremely rapid local cooling of considerable extent.

As stated by August H. Kreusi in a paper read before the Association of Edison Illuminating Companies, it appears that cast iron fails more on account of lack of elasticity than because of insufficient strength, and this failure is probably due more to incessant and rapid variation in temperature, rather than to high temperature. The widely varying temperature of the steam as it leaves the superheater would account for this in practice.

From this and similar knowledge gained by engineers in the past few years, it would seem that pipe, valves, fittings, flanges, etc., of cast iron, and the so-called semisteel are totally unfit for use in high-pressure steam mains carrying superheated steam, owing in part to the lack of elasticity inherent in these metals, and to the structure of the fittings or castings themselves. In a case pointed out to the writer not long ago, a cast-iron fitting removed from a main carrying superheated steam at a temperature of from 450 to 500 degrees Fahrenheit fell apart in spots when lightly tapped with a hammer. The metal may have been of poor quality, leaving the casting brittle after cooling in the mold, and as no knowledge of the original strength of the fitting was obtained before installing it in the steam main, it is a question whether the superheated steam was responsible for the distintegration of the metal or not. An examination of several extra heavy cast-iron flanges which burst while being screwed in place on the tapering threads of pipe, showed the metal to be badly burned and crystallized, and consequently weak and brittle. The remaining pieces of the flanges were easily broken by striking them sharply against each other, or by striking with a hammer.

Before condemning cast-iron and semisteel valves and fittings as being unfit for the control of superheated steam, it is first necessary to know the exact quality and strength of several casings both before and after installing in a steam main carrying superheated steam at high temperature. Some engineers still proclaim good gray-iron castings to be absolutely safe for the control of superheated steam, but as a general rule all valves, fittings, flanges, etc., are specified to be of cast steel for safety.

### Steel Castings

A steel casting is not appreciably affected in any way by the action of superheated steam at high temperature, but may look sound and perfect in all respects,

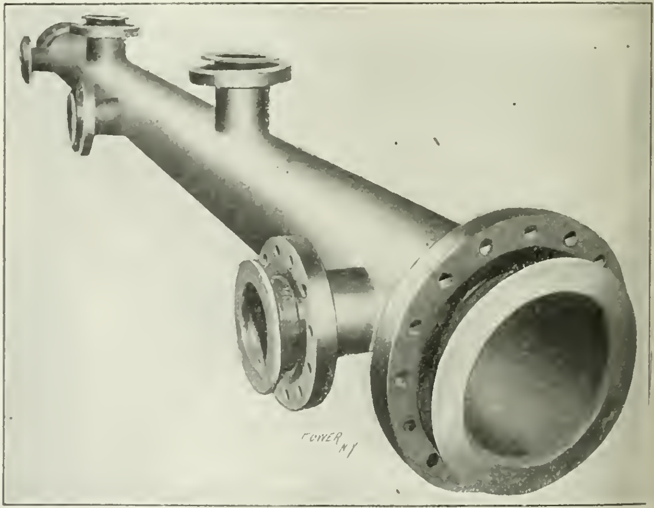

FIG. 1. WELDED HEADER WITH VAN STONE FLANGES

however, and still contain serious defec such as blow holes or sand holes ju beneath the surface metal, which tend weaken the casting to a considerable c tent. Wrought- or open-hearth-steel pi is absolutely free of such defects, and used extensively in the construction welded headers.

### Welded Headers

The total number of pipe joints in steam main may be decreased 50 to per cent., or in some cases even more, doing away with the cast fittings entir and substituting what is known as wel headers. The pipes are butt-welded at ends, making lengths of 40 feet or more and having all outlets or nozzles welded to openings cut in the side of the main header. The advantages of doing away with as many joints as possible are readily appreciated when the extra cost of maintenance due to the frequent necessity of renewing gaskets and the annoyance and loss caused by leaky pipe joints is considered. In most cases as much as two-thirds of the total cost of renewing gaskets is for labor alone, not to mention the additional loss due to shutting down one or more units while doing so.

The length of a welded header is limited only by transportation and erection facilities, which must be taken into consideration for each particular case. As a general rule the length is limited to about [illegible] feet. One of the large manufacturers, however, recently furnished over 7000 feet of 30-inch pipe welded up into lengths of from 54 to 56 feet, and having all flanges welded direct to the pipe. Welded headers have been used abroad for a number of years and from the increasing demand for this type of construction, their advantages are being recognized and appreciated in this country.

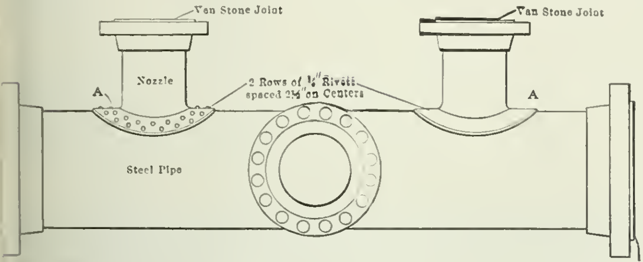

FIG. 2. Riveted Header with Van Stone Joints

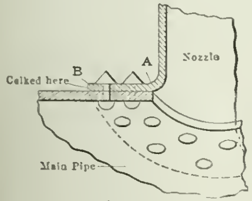

FIG. 3. S[illegible]

## RIVETED HEADERS

Before the electric and gas-flame methods of autogeneous welding assumed their present state of perfection, it was a custom [illegible] manufacturers to rivet nozzles or outlets to openings cut in the main pipe or header. The overall dimensions was [illegible] to stock lengths of pipe, which run from 18 to 22 feet. Although in some cases much trouble was experienced with leaks developing at the junction of the two pipes, the riveted header was, as a general rule, satisfactory.

A riveted header with Van Stone joints is shown in Fig. 2. Openings are cut in the main header slightly larger in diameter than the inside of the nozzle or outlets. The nozzles are then flanged over at the ends to fit neatly over the main header, as shown at *A*, and riveted into position, using two rows of rivets for the large sizes and one row for the smaller sizes.

Fig. 3 shows an enlarged section of this riveted joint. After the nozzle is securely welded in position, the joint is calked at *B*. It was found difficult to make a riveted joint of this description that would remain tight for any length of time after erecting, as the expansion and contraction of the branch pipes set up severe strains at this point, making frequent calking a necessity.

## WELDED NOZZLES

In Fig. 4 is shown a typical section of a welded header having the nozzles welded to the main pipe and the flanges welded on as shown. The openings in the main header may be cut by the use of an electric or gas torch to suit the different size of nozzles, which are then welded in position. The metal should then be reinforced all around the weld, as shown at *A*, to insure sufficient strength at this point.

Fig. 5 shows the same header with Van Stone joints. Nozzles may be welded to the main header in any desired position and direction, making special castings unnecessary except in rare cases where space is limited. In Fig. 4 the flanges are first welded to the nozzles which are then in turn welded to the main header. After all welding is complete the flanges are then faced and drilled to insure proper lining up, position of bolt holes, relative position of faces, etc. Van Stone flanges being loose and free to swivel on the pipe, are faced and drilled before placing in position on the pipe, and all Van Stone joints are rolled before the nozzles are welded in position on the main header. The flanged ends are then faced front and back, as is customary with this type of joint.

## STRENGTH OF WELD

The necessity of a welded joint equal in strength to the main body of the pipe is readily apparent when the excessive expansion and contraction strains are considered. The expansion and contraction of the branch pipes throw the greatest strain on the welded joint, where the nozzle joins the main header. The weld may be reinforced by adding molten metal from a stick of the same material as the pipe to be welded, after the nozzle is in position. To insure a more perfect union of the metal the joint should be lightly hammered or otherwise worked during the welding process.

## POSITION OF WELDED NOZZLES IMPORTANT

That part of the construction of a welded header which requires special skill and attention on the part of the operator is the lining up of the nozzles or outlets in order to bring the axis of the nozzles to the desired angle with the axis of the main header. This is illustrated in Fig. 6, which shows a nozzle welded to the main header at *C*. The nozzle should have been at right angles with the axis of the header, although the drawing is exaggerated for clearness. In this case any increase in the center-to-center dimension *A* will throw the branch pipe *D* more and more out of its proper position, as shown by dimension *B*, and in some cases it may be impossible to couple the lines together without the aid of an angle, offset bend or special fitting as the case may be. A nozzle out of line may be brought back to its proper position by reheating the metal all around the weld *C*.

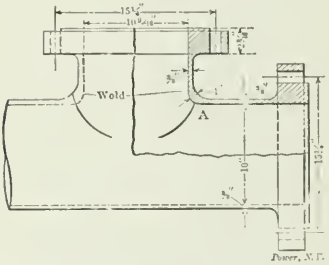

FIG. 4. WELDED NOZZLES AND WELDED FLANGES

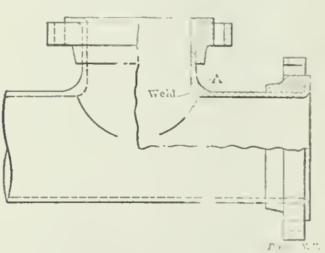

FIG. 5. WELDED NOZZLE WITH VAN STONE JOINTS

## MATERIAL FOR WELDED HEADERS

The best piping material to withstand

a high degree of superheat is open-hearth steel pipe, which material is used by many prominent manufacturers for the construction of welded headers. When raised to a temperature of 575 degrees Fahrenheit, open-hearth steel pipe has shown by actual test a loss of strength of approximately 1.1 per cent., and when raised to 750 degrees, a loss of 8 per cent., making this material satisfactory in all respects for the control of superheated steam at high temperature.

### Advantages of Welded Headers

1. Fittings may be entirely eliminated, thus doing away with the possibilities of porous steel and iron castings.

2. The saving of a great many joints liable to leakage.

3. The lightening of the piping system, and all steel work, brackets, hangers, etc., supporting the piping.

4. The saving in first cost of pipe covering and the cost when renewing the covering, due to the fact that there are fewer fittings and flanges to be covered.

5. The neater appearance of the piping system when covered.

6. The better quality of piping material used throughout the entire system.

7. The saving of time, labor and expense when erecting.

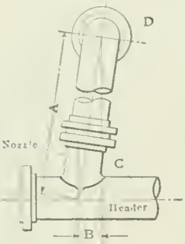

FIG. 6

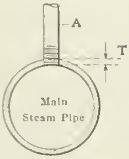

FIG. 7

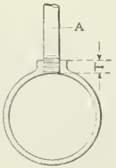

FIG. 8

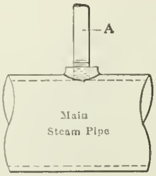

FIG. 9

Welded Boss for Drip Connections

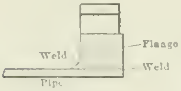

FIG. 12
Welded Steel Flange

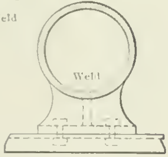

FIG. 10

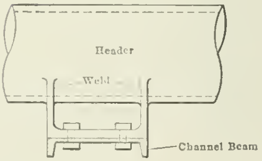

FIG. 11

Welded Brackets

Power, N.Y.

### Welded Bosses for Branch Pipes

The practice of tapping a steam main for branch pipes, drip connections, etc., as shown in Fig. 7, should never be permitted in high-pressure work, as the wall of the pipe *T* is not as a general rule of sufficient thickness to provide a proper bearing for the threads of the branch pipe *A*. In Figs. 8 and 9 bosses are shown welded direct to the steam main, thus increasing the bearing for the threads. One method of forming this boss is to heat the pipe to the proper welding temperature, adding molten metal from a stick of the same material as the pipe until the boss is of the proper dimensions, or the boss may be made separately and welded direct to the pipe.

### Welding Brackets to Header

In Figs. 10 and 11 is shown a method of welding anchor brackets, supporting saddles, etc., direct to the steam main itself, thus doing away with straps or pipe clamps which are liable to loosen up under the strains of expansion, contraction or vibration. The illustration shows an anchor bracket welded to the pipe and bolted to a channel iron, which is in turn bolted or riveted fast to the building columns or other rigid steel work.

### Welded Flanges

Fig. 12 shows a method of welding steel flanges to pipe. The flange is bored out slightly less in diameter than the outside of the pipe and is shrunk on, after which both the pipe and flange are heated to the proper welding temperature in a coke, oil or gas furnace. The actual welding process is carried out under a steam hammer, using special horns and dies for the different sizes of pipe and flange.

Fig. 13 shows the method of welding by means of the electric arc or by the gas-flame welding process. The flange is beveled or chamfered off, as shown at *A A*, to permit the penetration of the arc or flame to the remotest part of the surfaces to be welded. The electric arc or gas flame is then applied to the front and back of the joint at *B B* until the meta in both pipe and flange has reached welding temperature, after which the joi is fed by adding molten metal drop b drop from a stick of the same materia A fillet is also built up at the back of tl flange in this manner, as shown at The heavily shaded portions *B B*, show tl metal added to the joint during the wel ing process.

Unless great care is used by the operat in making up a welded flange of tl description the joint is very apt to be i perfect, as at *C*. In this case the fla and the molten metal did not penetr through to this point, and as a con quence the joint is considerably weak than if properly and thoroughly w One bad feature about it is that tl fect cannot be detected upon inspecti the surfaces, after the welding ope is complete, will show a perfect w all respects. The results obtain welding flanges, as described unde 12, are more satisfactory in all r than the above.

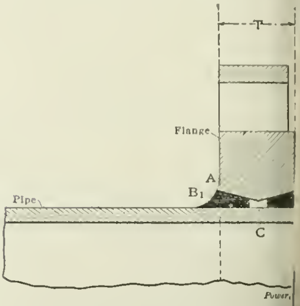

FIG. 13. WELDING BEVELED FLANGE ON

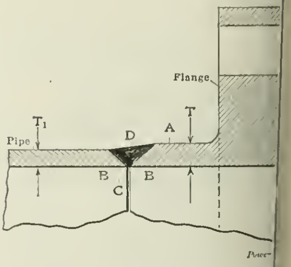

FIG. 14. BUTT WELDING FLANGE TO

In Fig. 14 is shown a method o welding flanges to pipe. In this ca wrought-steel flange and shoulder made in one piece. The thickness *T* shoulder is usually somewhat great t the thickness of the pipe *T*. The d f the shoulder and the end of the p are both beveled off, as shown at *B* a the two pieces butted carefully t ther at *C*. The flame is then applied t V-shaped joint, bringing the met to a welding temperature while the pip s being revolved slowly in a special 1e or y other suitable means. When the metal at the joint is at the proper heat, molten netal is added to the joint, as shown at *D*. During the welding process the metal ll around the welded joint is hammered ghtly, but rapidly, in order to insure a more thorough union of the metal in he flange and pipe, and to prevent the rmation of coarse crystals due to the inense heat to which the metal is subjected.

Another method of butt-welding flanges s shown in Fig. 15. The ends of the and flanges are rounded, as shown *A A*, and heated to a semi-melting contion, after which they are butted to-

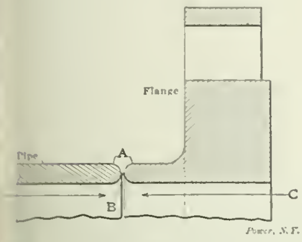

FIG. 15. BUTT WELDING ROUNDED ENDS

r at *B*. A heavy pressure is then b t to bear on the pipe and flange, a g in the direction of the arrows *C C* ueezing together the plastic ends of tl pe and flange to effect the weld. T ur or upset which is left at the *B* is either finished off when cold, may be hammered down while the m is still hot. This method of welding flanges to pipe has not proven very factory, especially in the larger sizes. S l pipe up to 6 inches in diameter, h ever, is being satisfactorily welded the "Goldschmidt Thermit process," w h is quite similar. All facing and dr ing of welded flanges should be done after welding to insure proper lining up, position of bolt holes, etc.

### EXAMPLES OF WELDED PIPE WORK

Some practical examples of welded pipe work are shown in the accompanying photographs, which will no doubt be of interest. Fig. 1 shows a welded header with Van Stone flanges. This header was made by Robbins, Gamwell & Co., of Pittsfield, Mass., for the Byron Weston Company, of Dalton, Mass. The header, in connection with similar piping, was installed in the company's Centennial mills over a year ago and has given excellent service in all respects. Fig. 16 shows part of a system of welded-pipe work, with welded outlets and improved Van Stone flanges made by the M. W. Kellogg Company, of Jersey City, N. J., for the New York Edison Company. The illustration is an 8-inch expansion U bend installed in the new Waterside station. The pressure carried on this line is 200 pounds, with approximately 200 degrees superheat.

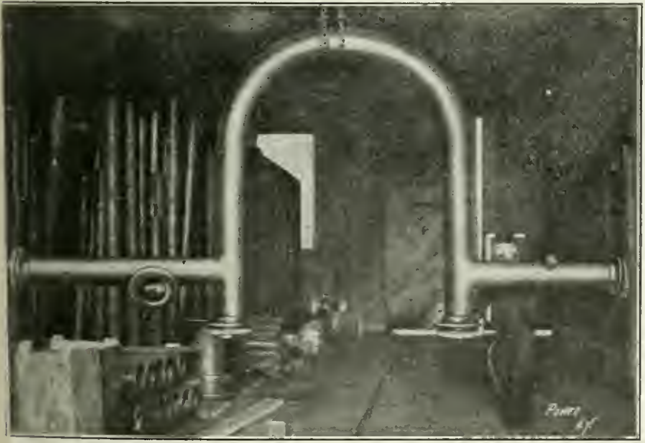

FIG. 16. EXAMPLE OF WELDED PIPE WORK BY M. W. KELLOGG COMPANY

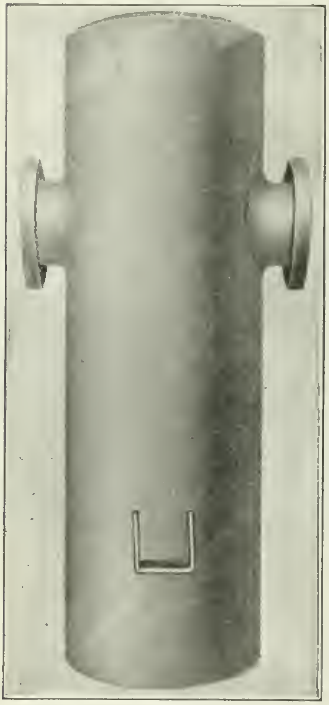

FIG. 17. KELLOGG WELDED SEPARATOR OF OPEN-HEARTH STEEL PIPE

Fig. 17 is a good example of what may be satisfactorily accomplished in the line of special welding. The illustration is from a photograph of a 30-inch welded steam separator of the receiver type. These separators, several of which are now in actual service, are made in all sizes by the M. W. Kellogg Company, of Jersey City. The construction of this separator is shown in detail in Fig. 18. The main body *A* of the separator is 30 inches in diameter and is made of open-hearth steel. The 8-inch inlet and outlet nozzles *B B* are made up of bent pipe welded in position and reinforced at the weld *D D*. The inlet and outlet flanges *C C* are shrunk on and welded as already described and illustrated in Fig. 12. A semicircular baffle plate *E* is welded inside the separator and reinforced at the weld *F*. The top and bottom nozzles *G* and *H* are also welded to the dished heads *K* and *L*, which are in turn welded to the main body of the separator. The body is reinforced and tapped for a gage-glass connection below the baffle plate at *M M*, and as a means of supporting the separator, two supporting lugs or brackets *N N* are welded in position. A welded separator of this description will run from 35 to 40 per cent. lighter than an ordinary separator made up of cast iron or cast steel throughout.

In Fig. 19 is shown a 16-inch welded open-hearth steel header with one 14-inch, one 10-inch, two 8-inch and one 2½-inch flanged steel nozzles welded in place, with flanges of rolled steel. The two flanges on the header are of the Van Stone type. On the under side are two bosses which are tapped for drip connections. As it stands, the header was tested to 1000 pounds hydraulic pressure and was thoroughly tight. The header was made at the works of W. K. Mitchell & Co., of Philadelphia, Penn.

Two good examples of both welded and bent pipe work, made by the Ball & Wood Company, of Elizabeth, N. J., are shown in Figs. 20 and 21. Fig. 20 shows a 90-degree bend in open-hearth steel pipe, having a flange welded to each end. The two nozzles are reinforced all around the weld and are made up with welded flanges. Fig. 21 is a good example of the bent pipe work done by this company, this particular illustration being a compound or double offset angle bend with welded flanges. The greatest difficulty encountered in making bends of this description is in lining up to the required center-to-center dimensions of the outlet flanges, and lining up the flange faces, bolt holes, etc. The flanges in these two cases are shrunk on the pipe, heated in a coke furnace or oven and welded under a hammer, as previously described and illustrated in Fig. 12.

### WELDING PROCESSES FOR PIPE WORK

The oldest and up to comparatively recent years the only method of welding wrought-iron and steel parts was by the forge process. The parts to be welded are first heated in a forge or coke furnace until they have reached a semi-melting condition, after which the joint is prepared by the blacksmith and the pieces united by hammering or rolling. Whether a weld made in this manner is good or bad depends entirely upon the skill of the blacksmith, and all his care does not always prevent internal flaws which cannot be detected after the welding process is finished, for to all appearances the finished surfaces may present a perfect weld in all respects and still cover an imperfect joint inside. Welding is in itself a handicraft and requires not merely strength of arm for its accomplishment, but special skill on the part of the blacksmith as well. Commercially speaking, forge welding is practically limited to wrought iron and mild steel.

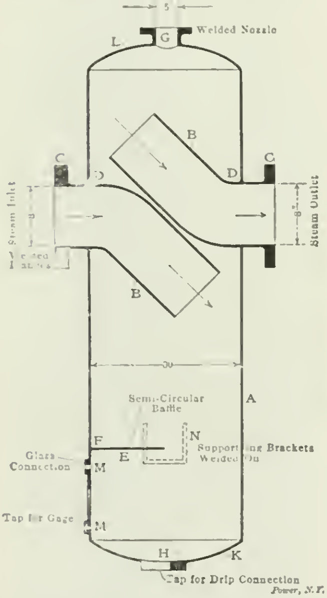

FIG. 18. SECTION OF KELLOGG WELDED SEPARATOR

### THE WATER PAIL FORGE

This process, known as the Hoho and La-Grange, or more commonly the water-pail forge, is very often referred to as an electric welding process. It is, however, merely an electric process for heating the metal to be welded to the proper welding temperature, the actual welding being carried out in the usual manner under a hammer. A wooden tank is filled with water or other suitable fluid in which the positive electrode is placed. The negative side of the circuit is connected to the metal to be welded, which is immersed in the fluid and allowed to remain until it reaches a proper welding heat, when it is removed and welded in the usual manner.

Since the introduction of the electric, oxy acetylene, oxhydric, thermit and other processes of the so-called autogenous welding, the above processes are not used as extensively as in the past.

### ELECTRIC WELDING

During the past few years several processes of welding by electricity have been devised and perfected, and now play an important part in the manufacture of a great many articles. Operations quite impossible by the older method of forge welding are now performed with comparative ease and in short time by the electric, gas-flame and thermit processes. Four distinct methods of welding by electricity are in common use and are known as the "Zerner," "Bernados," "Voltex" and "Thomson" processes.

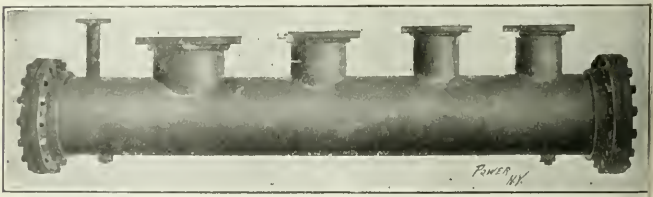

FIG. 19. MITCHELL WELDED STEEL HEADER

### THE ZERNER PROCESS

In the Zerner process, also known as the electric blowpipe, an electric arc is drawn between two carbon electrodes and caused to impinge upon the metal to be welded by means of an electric magnet which deflects the arc, making a flame similar to that of a blowpipe but having the temperature of the electric arc. The apparatus contains a self-regulating device driven by a small electric motor.

### THE BERNADOS PROCESS

In the Bernados process an electric arc is drawn directly between the metal to be welded and one pole of the electric circuit. The article to be welded is made to constitute one pole of the electric circuit, while a carbon pencil attached to a portable insulated holder and held by the workman, constitutes the other pole. The electric arc is struck between the two poles thus formed. The metal parts to be welded are melted on their faces together with a small rod of the same material which feeds the joint by flowing in between the two surfaces to be joined.

### THE VOLTEX PROCESS

The Voltex process consists in the use of an electric arc drawn between two special carbon rods inclined to each other at an angle of approximately 90 degrees. This arc is caused to impinge upon the surfaces to be welded, and the joint is fed during the welding process as mentioned above. The apparatus is generally so arranged that it can be held in one hand.

### THE THOMSON PROCESS

The principles involved in this process were first conceived by Prof. Elihu Thomson, and the method is sometimes known as the incandescent process. The pieces to be welded are brought into intimate contact, being usually held closely together in a machine by metal clamps actuated l springs or weights to permit a permane pressure on the parts; this pressure applied until the metal fuses or melts the joint. The pieces to be welded a each made to constitute one pole of electric circuit which is completed by t contact of the two pieces to be weld Intense local heating is caused by passi heavy electric currents across the imp fect joint thus formed, and this being t point of greatest resistance, a welding te perature is produced in a few secon while at the same time the two pieces forced together, as described above, a welded.

A bur or upset is produced around welded surface, consisting of the oxidi metal, scale, etc., which is expelled fr the joint during the welding process w under pressure. When this oxidized otherwise inferior metal is remove perfect and practically imperceptible j is the result.

A distinctive feature claimed for process is, that the interior surfaces raised to a welding heat before the terior surfaces reach that temperature therefore follows, that if the exterior surfaces weld, the interior surfaces must also be welded, since they are necessarily at a somewhat higher temperature. This process is not to the writer's knowledge used in welding pipe work as described under "Welded Headers," being more adapted to the welding of rods, cables, shafting, etc.

### Gas-flame Autogenous Welding

Several processes of the so-called gas-flame autogenous welding have been developed during the past few years, which, having passed out of the experimental stage, now play an important part in the welding of pipe work of all descriptions. The two processes described below are those known as the oxy-acetylene and oxhydric processes.

### The Oxy-Acetylene Process

In this process oxygen and acetylene are generated in separate pressure generators and conveyed through separate armored s to the blowpipe, where the flame can be regulated to suit the requirements of the operator. By this process a flame having a temperature of over 6500 degrees Fahrenheit is possible, while the temperature of the best solid-fuel furnaces is somewhere in the neighborhood of 3000 degrees. Although the temperature of the flame is high, the heat is rapidly dissipated through radiation, and with proper care there should be little danger of burning the metal while welding. Like other welding processes previously described, the flame is caused to impinge on the joint of the two pieces to be welded. The faces are thus melted, and also a rod of the same material which feeds the joint during the welding process.

### The Oxhydric Process

This process, which was described and illustrated to some extent in the June 24, 1909, number of the *American Machinist*, is a development of a method patented by the Cologne Meusen Mining Company in 1901. Oxygen and hydrogen are stored under a heavy pressure in separate cylinders, each holder being provided with a needle valve to which is attached a pressure regulator governing the flow, so that the gas will be delivered to the mixer and thence to the torch at constant pressure. From the regulator on each cylinder the gas is conducted through separate heavily armored rubber tubes to the mixer, and thence to the blowpipe or torch through a single tube. A mixture of one part oxygen and from four to six parts hydrogen is used for welding purposes, and the actual process of welding is the same as already described. The oxy-acetylene and oxhydric processes are also used in connection with special torches and mixers for cutting metals, the flame cutting a narrow path through the metal and resembling in some respects a clean saw cut.

### The Thermit Welding Process

In this process, which is the result of important researches conducted by Dr. Hans Goldschmidt, of Essen-Ruhr, Germany, and known as the "Goldschmidt thermit process," a mixture of finely divided aluminum and iron oxide is used. This mixture possesses the property, that when ignited in one spot, the combustion so started continues throughout the whole mass, producing superheated liquid steel and superheated liquid slag (aluminum oxide). The heat which is thus generated in from 15 to 30 seconds is estimated at 5000 degrees Fahrenheit. This process is used chiefly for the repair of heavy castings, broken machine parts, for bonding steel rails in place, for the repair of propellers, rudders and posts and in fact any large work. The process is also used to a considerable extent for butt-welding pipe up to 6 inches in diameter.

The ends of the pipe to be welded are first filed and then butted carefully together between metal clamps. A cast-iron mold in two parts is then placed around the joint, the upper one having a narrow gate to admit the superheated metal. The thermit is ignited in a flat-bottomed crucible held in a pair of tongs. After the reaction the slag fills the upper part of the crucible and has three times the volume of the superheated liquid steel which collects at the bottom when the whole mass is liquefied. This superheated liquid mass is then poured into the opening in the mold; the slag, flowing first, adheres in a thin layer to the walls of the mold and the surfaces of the pieces to be welded, protecting them from contact with the liquid steel which flows in last. After waiting for the ends of the pipe to soften, the clamps are drawn up and effect the weld by squeezing together the now plastic ends of the pipe to be welded. The bar left at the joint when the mold and clamps are removed can be machined off if so desired, or may be allowed to remain, adding slightly to the strength of the joint. In this manner pipes may be welded together to make any length desired.

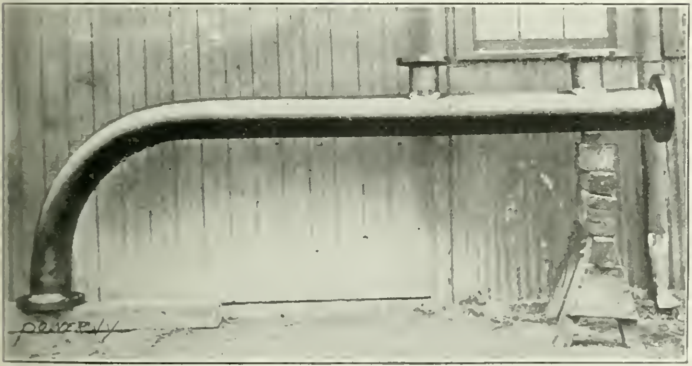

FIG. 20. WELDED NOZZLES AND FLANGES ON 90-DEGREE BEND

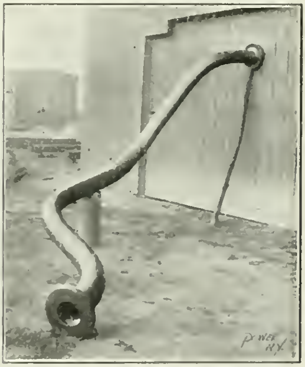

FIG. 21. COMPOUND BEND WITH WELDED FLANGES

### Efficiency of Welded Joints

An efficiency of 100 per cent. for equal areas is claimed for most of the welding processes just described, but as the edges to be joined are merely fused together in welding, which is practically the same as joining them with cast steel, a joint having an efficiency of 100 per cent. at the weld, for equal areas, should never be expected with rolled-steel or forged-steel parts. In a number of tests recently made on welded pipe work, the metal at the weld showed a loss of strength of from 8 to 10 per cent. for equal areas, and all welds were made by operators experienced in this class of work.

### Effect of High Temperatures

From tests made by Professor Ledebour, steel of good quality was found to lose its fibrous structure when heated above 1850 degrees Fahrenheit and allowed to cool in air without hammering or working the metal. It would therefore seem that the high welding temperatures employed in some of the aforementioned processes would tend to destroy the fibrous structure of the metal, which may be brought back to its original quality by annealing, hammering lightly, or otherwise working the metal during the welding process. Hammering tends to break up the coarser crystals formed by the high temperatures employed, and also brings the fibers of the metal into more intimate contact with each other, thus strengthening the metal at the weld and insuring a more thorough union of the parts. Where overheating or burning has caused the metal to crystallize through to both sides of the weld, the fibrous structure of the metal may be so far destroyed and consequently the strength of the weld so impaired as to make the piece worthless, and even a thorough annealing of the joint may fail to restore the metal to its original condition.

In welding pipe, the usual procedure is to chamfer off the pieces to be welded, if not already of a form which permits the penetration of the flame to the remotest parts of the surfaces to be welded together. The gas flame or electric arc is applied to the joint until the metal fuses, or is in a semi-melting condition. There is then added to the joint, drop by drop, molten metal from a rod of the same material as that to be welded. The metal, which is now in a fluid condition, runs together and unites in a homogeneous mass, and is hammered lightly during the process. Any bur or upset remaining after the welding process is completed may be finished off if desired. The welding of pipe work of any description should never be instrusted to inexperienced welders, as a poor joint is sure to be the result. A careful, experienced operator can control the action of the metal while welding, and thus insure a more perfect joint in all respects.

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As we recently remarked, it has been claimed on good authority that all boiler corrosion is traceable to galvanic action. A paper recently read by G. N. Huntley before the Society of Chemical Industry on investigation of the cause of pitting in a standby boiler seems to prove that sulphur is an important factor in some cases, which hardly coincides with the electrical theory. An increase in the proportion of caustic soda used had no effect, and blisters were found, especially near the water line, which, on being pricked, were found to contain liquid with a fine black powder in suspension, consisting of ferrous sulphate with a slight excess of sulphuric acid, while the boiler water was slightly alkaline. It would seem that sulphur in the water is first oxidized to free sulphuric acid which attacks the metal in its neighborhood, the deposited oxides forming a membrane permeable to oxygen but not to alkali, and permitting the curious acid corrosion in alkaline water.—*Scientific American.*

# A Remarkable Condenser Performance

Some ten or fifteen years ago the designing and proportioning of surface condensers crystallized into a more or less standard practice but the steam turbine, by its ability to make good use of steam at low pressures and temperatures, or by its requirement of a high vacuum, has forced the question of condenser efficiency again to the front. In the past, steam engineers have generally considered that, from the standpoints of coal consumption and plant operation, the reciprocating engine gained little from a vacuum above 26 inches of mercury. This opinion was in part due, especially in marine circles, to the practice of driving the auxiliaries from the main engine, so that, there being no auxiliary exhaust to heat the feed, a lower vacuum meant hotter feed water. The steam turbine, however, because of its ability to deal efficiently with steam in large volumes, easily shows a gain of from 5 to 10 per cent. in steam economy for every additional inch of vacuum above 26 inches, and the heating of the feed water is properly left to the economizers or to heaters utilizing the exhaust of auxiliaries.

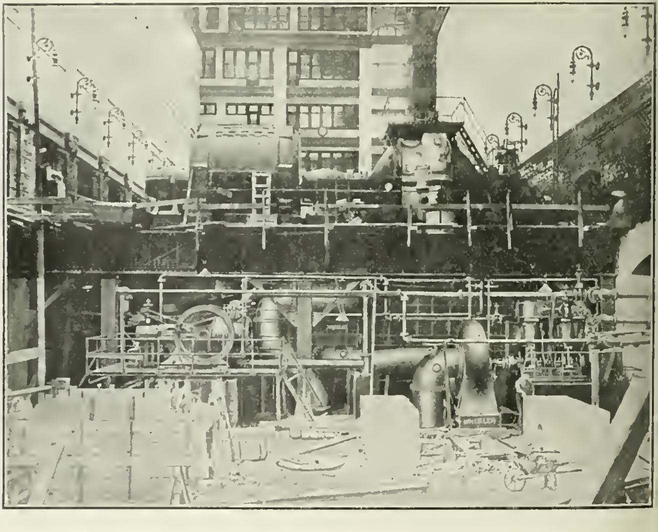

FIG. I. CONDENSING OUTFIT INSTALLED IN KENT AVENUE STATION

This high efficiency of the turbine at low pressures is not surprising when the temperature ranges and differences in total heat in steam between ordinary boiler pressure and atmospheric pressure, and again between the latter and a high vacuum, are considered. For instance, from 164.7 pounds pressure absolute to atmospheric pressure, or 14.7 pounds absolute, the drop in temperature is 153.9 degrees Fahrenheit, and the reduction in the total heat in a pound of steam is 112.3 B.t.u., while the drop in temperature from atmospheric pressure down to 1 pound absolute is 110 degrees Fahrenheit, and the total heat available is 161 B.t.u. That is, the heat available for conversion into mechanical work is greater in the latter case than in the former.

It would appear that the reciprocating engine, in order to utilize steam efficiently at low pressures needs enormous cylinders, with their consequent weight and friction losses, or two or more low-pressure cylinders, as in many recent engines. A pound of steam at 164.7 pounds pressure absolute occupies 2.7 cubic feet; at atmospheric pressure, 26.4 cubic feet, and at 1 pound absolute, 334.2 cubic feet. With the steam turbine, on the other hand, it is an easy matter to proportion the low-pressure stages to take care of thi great volume.

The premium thus put upon condense performance has resulted in a close scrutiny of the several processes which g on in a condenser. The ordinary surfac condenser, which has been found satis factory and suitable for reciprocating-er gine work, consists of a bank of tube each about 1 inch in diameter, throug which the circulating water is caused t flow in one, two or more passes, whi the steam is introduced among the tube usually at the top of the condenser she The reason for introducing the steam the top is that air is heavier than stea and naturally settles, and is driven by tl velocity of the steam to the bottom the condenser shell, where consequent the air-pump opening should be locate The presence of hot steam at this poi ould render the air pump useless. If e circulating water be introduced into e bottom row of tubes it is thus posble to have the air in contact with the ldest water just when leaving the conmser shell.

The activity of the several groups of bes in a surface condenser can be quite curately inferred from the rise in temrature of the water passing through em. By inserting thermometers in the ter boxes, it has thus been discovered t in the ordinary surface condenser st of the heat is absorbed—that is, st f the steam is condensed in the st few rows at the top. This at once ggested the possibility of a rearrangent of the tubes so that more of them d approach the high efficiency of the rows.

Now, the transmission of heat through lenser-tube surface may be affected by t following conditions, among others:

First, whether or not the tube is flooded l water descending from the tubes above.

ond, the velocity of water through th e.

rd, the velocity of steam against the tu.

r:h, whether or not the tube is imm l in air.

h, the material, thickness and cleanli f the tube.

much scientific investigation has be levted to the effects of water velo and of steam velocity, the possibi f improvement in this direction ar ted by the fact that excessively hi team velocities involve back pressu n the prime mover, while very high ai wning and avoidance of flooding w r velocities involve the consumption of excessive amount of power in the cirlating pumps. According to reliable ex rimenters, the heat transmission incr es only as the square root of the w r velocity, while the pressure, and he e the power required to force the wa r through the tubes, increases as the square of the velocity. That is, the power consumed by circulating pumps increases as the fourth power of the heat transmission when it is attempted to augment the latter by increasing the velocity of the water. As for the thickness of the condenser tube, it is found that this plays so little part in the final result that it can practically be neglected, while the material of the tube is usually determined by other considerations. Attention to the remaining items, namely, avoidance of air drowning and avoidance of flooding, has been rewarded with the most striking results.

Air drowning is prevented by avoidance of air leaks, provision of sufficient air-pump capacity and arrangements for removing the air at the lowest possible temperature and hence at the greatest density. The flooding of tubes has been met in various ways. That it becomes really serious in a large condenser will be appreciated from the fact that the large turbine condenser described later in this article discharges hourly over 220,000 pounds of condensed steam, equal to the discharge of a 1¾ inch fire hose. This deluge of water pouring down from the upper tubes upon the lower would so effectively blanket the latter that there could be little direct communication of heat from the steam to the lower tubes.

The arrangement illustrated in the accompanying drawing, showing one of four Wheeler dry-tube condensers installed in the Williamsburg power station of the Transit Development Company, of Brooklyn, N. Y., has been adopted. In appearance this condenser is similar to the Admiralty type, introduced by the Wheeler Condenser and Engineering Company about twenty years ago.

There are two exhaust-steam inlets at the top of the shell to receive the steam from the double-flow Westinghouse turbines installed on the floor directly above. The circulating water from the Wheeler engine-driven centrifugal circulating pump is introduced into the lower compartment of the water box at one end and makes two passes through the tube before being discharged from the upper compartment of the water box. The condensation is collected in a cylindrical well forming a part of the bottom of the condenser shell, whence it is removed by a Wheeler centrifugal hotwell pump. The air is taken from the side of the condenser at a point near the cold-water inlet and is exhausted by a Wheeler rotative dry vacuum pump.

The novel feature of the condenser consists in horizontal baffles interposed between the several banks of tubes. These rain plates catch the water from the tubes above them and carry it to the outside against the shell, down which it flows to the hotwell without coming in contact with other tubes. To permit the passage of the steam past these rain plates there are openings, around the edge of which the plate is turned up to form a vertical lip, preventing an overflow of water. These openings are so staggered that the steam will reach all parts of the tubes, insuring complete utilization of all the surface.

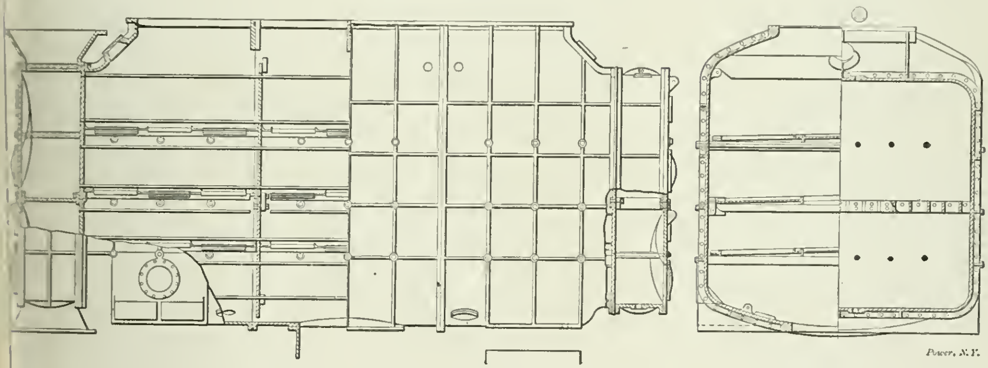

FIG. 2. WHEELER DRY-TUBE CONDENSER, SHOWING RAIN PLATES WHICH PROTECT LOWER TUBES FROM STEAM CONDENSED ON UPPER TUBES

Simple as this expedient appears, the results obtained by means of it have been remarkable, as will be apparent from a consideration of the rate of heat transfer developed in this condenser under working conditions. It was formerly customary to assume the rate of heat transfer through surface-condenser tubes, closed feed-water heaters and similar appliances as between 200 and 300 B.t.u. per square foot per hour per degree difference of temperature between the water inside the tubes and the steam outside. Inasmuch as the temperature of the water within the tubes rises as heat is absorbed, while the temperature of the steam outside falls somewhat as the mixture becomes richer in air, it is necessary to adopt some method of calculating the average difference of temperature. A simple method is to take the arithmetic mean, that is, add the entering and leaving temperatures of the circulating water and divide by two to find the average water temperature, which is subtracted from the steam temperature corresponding to the vacuum, or take the mean between the latter and the hotwell temperature to give the mean difference in temperature. If greater refinement is desired, the logarithmic mean of the water temperatures may be taken, although it is doubtful if much greater accuracy is gained thereby. The formula reads:

$$S = \frac{W\,H}{U\,D}$$

where

$S$ = Cooling surface in square feet.
$W$ = Weight of condensed steam per hour.
$U$ = Coefficient of heat transmission in B.t.u. per degree difference in temperature per square foot of cooling surface.
$D$ = Mean difference in temperature.
$H$ = Total heat in the steam entering the condenser above the total heat in the condensation leaving the hotwell, as determined from the respective temperatures and reference to the steam table.

The values of $U$ obtained with the condenser herein described have been calculated from a test made on unit No. 6 on November 27, 1908. This condenser was designed to handle 180,000 pounds of steam per hour and to give a vacuum equivalent to 2 inches absolute pressure with 70 degrees Fahrenheit, circulating water.

RESULTS OF TEST ON WHEELER SURFACE CONDENSER.

| Time of Reading | Barometer Reading. | Vacuum, Inches of Mercury. |
|---|---|---|
| 10:09 | 29.98 | |
| 10:25 | | 28.5 |
| 10:55 | 29.99 | |
| 11:10 | | 29.0 |
| 11:20 | | 28.95 |
| 11:40 | | 29.0 |
| 11:50 | | 28.95 |
| 12:00 | 29.99 | 29.0 |
| 12:20 | | 29.0 |
| 12:30 | | 29.0 |
| 12:40 | | 28.95 |
| 1:10 | 29.95 | 29.0 |
| 1:30 | | 29.0 |
| 2:00 | 29.96 | 29.0 |
| 2:25 | | 29.0 |
| 2:45 | | 29.0 |
| 3:00 | 29.97 | 28.95 |
| 3:15 | | 29.0 |
| 3:30 | | 29.0 |
| 3:45 | | 29.0 |

The transmission of heat per square foot per hour per degree difference of temperature was found in these tests, during which the rate of condensation varied from 164,586 to 220,200 pounds of steam per hour, to be between 800 and 900 B.t.u., which is two to three times greater than was formerly obtained. These results show that the guaranteed vacuum could have been maintained with even less condensing surface than was actually installed, although the latter is considerably below usual practice. That is, while the ordinary condenser would contain 2 or 3 square feet of surface per rated horsepower, this condenser contains only 1.5 square feet per rated electrical horsepower.

Another point to be noted in connection with the performance at the Williamsburg station is the high temperature of the condensate at all times, closely approaching the theoretical temperature of the steam vapor. Inasmuch as this condensate is used as boiler feed and as each 10 degrees Fahrenheit amounts to about 1 per cent. of the fuel bill, this is also highly important from the standpoint of plant economy.

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# Erecting an Engine

By F. Wiegand

In previous articles directions have been given for erecting and alining the bed, cylinder and bearings, and next in order are the piston and reciprocating parts.

The piston rod should be smooth and parallel, as any rough or high places will be hard on the packing, and the piston head should be from 0.004 to 0.008 inch smaller than the cylinder bore and should have a little "shake" when put into the cylinder without rings. Sometimes a piston will stick and not shake near the steam ports, and measurement with a pin gage will show high places where the unsupported and not properly braced cylinder wall has sprung under the pressure of the boring tool, and consequently has not been bored to size. These high places should be scraped down, as they afford a good chance for cylinder cutting.

## Piston Rings

Piston rings, whether sectional or of the snap type, should be fitted with red lead to a good bearing on the cylinder bore, as hard places on the rings are liable to cut. Take a snap ring which has been turned from 1/4 to 1/2 inch larger than the cylinder bore; 3/4 inch to 1 1/2 inches is cut out, either on a slant or the ends tongued. The ring is clamped in a vise and sprung together, the protruding ends filed down and it is now considered ready for the cylinder. There are no sharp points to cut into the cylinder, but the bearing of the ring is not what it should be and it will take a good deal of filing to get a ring into shape and avoid unnecessary hard spots. Some builders drill four or six 3/16-inch holes through the head- and crank-end flanges of the piston head into the ring grooves, in order to admit steam under the rings and press them tight against the cylinder walls. If such a ring has not a good bearing, it is almost certain that it will cut when water flushes the cylinder and wear away very fast under all conditions.

It has been argued that cast-iron rings adapt themselves very soon to any surface under the influence of heat and pressure, but that does not always seem to be
the case, and the erecting man will do
well to rub the rings or ring sections
to the bore of the cylinder to insure a good
fitting and easy running piston. The rings
should also make a good "tapping" fit i
the grooves, but should not be tigh
enough for a driving fit. There are ad
vocates of both extremes, but in both case
there is something wrong with the en
gine elsewhere, as a loose ring will tak
care of a slightly conical cylinder, an
a tight ring will cure, to some extent,
knock in the cylinder due to faulty alin
ment.

With properly fitted rings the pisto
can now be placed into the cylinder an
connected to the crosshead, but not locke
Move the crosshead toward the crank en
until the piston strikes, and measure to se
if the piston rod is central and parall
to the guide. It pays to make a tra
stick (radius of bore less radius of pi
ton rod) for this purpose, as calipers ca
not be handled accurately in most case
Where the cylinder is out of center a
the direction and degree of this devi
tion has been noted, the crosshead or t
piston rod, where clamp nuts are us
should be set accordingly, as otherw
the rod will never come parallel. T
deviation, if forgotten, will be found ag
in setting the rod parallel, but it ta
more time and it is often a puzzle to
it.

## Piston Rod

Parallelism of the piston rod to
guide is absolutely necessary, as there
sure to be trouble from leaking thro
the rod packing, the piston knocking
rings clicking or even cutting if the sli
est movement of the rod in a radial
rection prevails.

Before locking the rod to the crossh
the bearing of the locknut to the
of the hub should be tried in the foll
ing way: Cut two small strips fro
piece of paper and place them diametri
opposite one another between the nut
crosshead. Screw the nut up gently
it just clamps the papers, and by pul
the paper strips note if they are held
even friction. Try at least four p
this way, and if the two faces are
mark the closest point on the cross
and nut. Turn the nut back part
turn and measure with a piece of tin
thick feeler plate.

If the nut is irregular it shoul
carefully refaced on a true arbor,
if the crosshead is out it must be scr
to come true. The piston rod can no
locked and the crosshead and piston s
move freely; in fact, if everything
true condition, they will move easier
when unlocked. If they are still bin
loosen the top shoe of the crossh
the guide caps, lift up the crossh
little and put four papers of even t

ness under the corners. Let the crosshead down and try the papers. A hard place can thus easily be located and relieved. When the crosshead and piston move freely and the crosshead has a good bearing top and bottom, the job can be considered reliable. The setting of the piston rod to divide up the clearance space between the piston and cylinder heads can be done more accurately after the engine has been trammed and the position of the crosshead at the dead centers marked on the guide.

### Connecting Rod

The connecting-rod boxes should be taken apart and the bearing on the bottoms of the straps and on the gib blocks examined. It sometimes happens that the boxes touch the bottom of the strap only on one side or even one corner. This is not noticed in lining up the rod, but when the engine begins to run under full load, such a box will come to a full contact with the strap, the rod will be out of alinement and sometimes the rim of the box be cracked off. It is therefore advisable to paint the bottom of the strap with red lead, drive the box home, take it out again and note the contact, which, if imperfect, should be improved to a good general bearing in order to prevent a change in the position of the box. The straps should hold the boxes tightly and especially the wrist-pin strap, as otherwise the boxes will begin to "work" on account of the reversals of motion. Many a hidden knock has been traced to this cause. The butt boxes are not so liable to give trouble, especially where a gib block is used, as the gib-block bolts will clamp the strap a little and hold the box securely.

Next fit the boxes singly to the crank and wrist pin respectively. The crank boxes should have little side play, and in engines with bored guides none at all, as the connecting rod has to hold the wrist pin level to the crank pin. The crosshead boxes should have 1/64 inch side play, and in case of a pin with a washer and clamp screw, up to 1/32-inch to allow for clamping and expansion by heat. The boxes should be relieved liberally to prevent pinching. Some manufacturers do this by clamping eccentrically a set of boxes contained in their regular strap or a long strap to the faceplate or boring table of their machines and cutting out the desired amount at the joints.

Care must be taken that on a center-crank pin the boxes do not ride on the fillet, as such boxes will not only heat up but also throw the rod out of line when they come to a bearing. The fillet should be filed down to a slightly greater radius than the fillet of the pin to allow for wear and take up. This should be done before the box is filed to a side fit, as one is liable to file too much off the sides while the fillet is binding. A fillet gage or a pair of spring calipers set to the width of the pin can be used to advantage to watch the side fit of the box.

The rod can now be assembled, connected to the crank pin, keyed up and tried into the crosshead. In most cases the rod will not enter it, but show out more or less. Suppose it stands ⅛ inch to the right when looking from the crank end, then the bore of the crank box has to be changed in such a way as to throw the crosshead end of the rod ⅛ inch to the left. If the crank pin is 3 inches wide and the connecting rod 30 inches long, then it would be necessary to take 1/80 inch off the left-hand side of the butt box, and the same amount off the right-hand side of the strap box. Mark the sides of the boxes which have to be dug out, disconnect and take the boxes out. Now measure the sides of the boxes that have to be reduced from the rim to the bottom of the crown by setting a pair of spring calipers, a surface gage or micrometer, and file or scrape a spot 0.012 inch below the surface of the bearing, using the feeler blade to get this exact. Run a scale across the bore of a taper box and try the feelers under that to get the spot right. The bore of each box has then to be scraped down to this spot, using a pin covered with red lead or a proper size of arbor to insure a good bearing. If this work has been done exactly the rod will show true when connected and tried again. A little material must be filed off the sides of the boxes to allow them to follow the changed bore. To guess at the amount to be removed from the boxes and keep on trying until the rod comes true is tiresome and expensive, especially with large vertical engines where it takes help to connect and take down the rod. It also leads to overdoing the work, leaving the rod out the other way and reducing the boxes needlessly.

### Correcting the Crank Pin

After the rod is right on the top quarter make sure that the shaft is taken up snugly in its bearings and is level; then turn it to the other three quarters and try it to the crosshead successively. If it is out any amount, find the two opposite points where the rod is out farthest. Mark the position of the center of the boxes on the pin when the crank is on one of these points. In a side-crank engine draw a line parallel to the axis of the rod across the center of the pin. The points so found on the pin have to be filed to get the pin square to the disk or parallel to the shaft. The same calculation applies as with the connecting rod, but only one-half of the amount has to be filed off the pin. For instance, the rod is true on the top quarter, shows 1/16 inch to the right on the crank-end center, ⅛ inch on the bottom quarter and 1/16 inch on the head-end center. The greatest divergence is ⅛ inch, but it is only necessary to file the pin to throw it 1/16 inch to the right on the top quarter, which brings it 1/16 inch to the left on the bottom quarter and makes all four points show alike, in this case 1/16 inch to the right, which has to be thrown by scraping the crank-pin boxes.

Assuming the proportion of crank pin to length of rod to be 1 to 10, it will require that 0.006 inch be filed off the pin to make it true. Now measure the pin carefully with a micrometer, note the size and set the micrometer 0.006 inch smaller; then note the finished size of the pin. Where no micrometer is at hand set a pair of spring calipers to the exact size of the crank pin, file a piece of 3/16- or ¼-inch round steel to such a length that with the 0.006-inch feeler blade added, it will just touch the calipers; then set the calipers down to the pin gage. I have tried to file flat guide spots on crank pins, as is so often recommended, but have found it is almost impossible to make a good job of a pin that way, as the high ridges on both ends of these flats will always remain and the pin is liable to be reduced too much on these flats. It is preferable to keep the pin as round as possible during this operation, filing first one side partly, then the other about the same amount, and using micrometers and calipers freely until the finished size is nearly reached, when it is well to try the rod again in order to detect any mistake in filing. After the rod shows true all around, the pin can be finished up, using the boxes in the strap, or if the strap is solid, a suitable clamp to locate hard spots. The boxes have to be scraped to throw the rod 1/16 inch to the left. Center-crank pins are not so liable to be out as side-crank pins which are pressed in.

The crosshead end of the connecting rod requires different treatment for flat or confined crossheads and such as are free to turn. In the first-named type the wristpin is set level to the shaft and kept there in order to make the crank end of the rod swing in the same vertical plane with the path of the crank pin, while in the other type the connecting rod itself has the function of holding the wristpin in that required position. Connect the rod to the solid crosshead, key up tight and try the crank end without the strap, or boxes where the strap is solid, the crank being on the top quarter. Measure the exact position of the end of the rod on the crank pin; turn the crank to the bottom quarter, let the rod down on it and measure again. The rod end ought to come to exactly the same place on the crank pin, and in this case there should not be a trace of an allowance, as the least deviation will interfere with the smooth running of the engine. The crosshead will have to be scraped or adjusted to suit, and then the wrist-pin boxes can be scraped to bring the crank bearing exactly central to the pin in the same way as the crank-pin boxes were previously scraped

### Twist in Connecting Rod

The crank-pin brass and boxes can now be placed on the pin, driven home or keyed up snugly, and the butt of the rod clamped over the strap. In doing this it will sometimes be found that the butt of the rod does not come true to the strap, but will bind on one side and show open on the other. The bore of the wrist-pin bearing is not level with that of the crank-pin bearing. In such a case the rod has a twist as it is termed. In order to get the bearings level with each other one of them has to be worked over with file and scraper on the top of one side and the bottom of the other across the faces of the boxes, but without disturbing the alinement. The rod has to be tried for alinement and freedom of twist after this operation, also for the proper bearing of the boxes. Take the twist out of the bearing whose strap is out of level in order to keep the rod right. To find a twist in a rod with solid straps, connect up one side and try a level on the planed surface of the butt; then loosen and try the other side. A difference in the showing of the level will show how the rod has to be corrected. A level cannot always be relied on in places where vibration from other engines will interfere with its reading. It is safer therefore to avoid using it for close adjustment.

A solid-strap rod must be keyed up on both ends, the shaft turned, the rod taken down and the boxes looked over. The hard spots will tell the tale. A twist will heat up the crank bearing intensely, and is liable to destroy it, but with flat crossheads can wear out if the engine is handled carefully. It is a more serious matter in an engine with bored guides, as it is not detected so easily and will have the same effect on the running of the engine as a wristpin out of level has on a flat crosshead, because the connecting rod holds the wristpin in its position relative to the crank pin. Still, erecting men who would not think of setting a flat-crosshead pin out of true to the shaft, will argue that a round crosshead will take care of a twist. The round crosshead will take care of a shaft out of level, but never of a twist. The necessity of watching this point and correcting the connecting rod is obvious, and it can be done in the following way:

Connect up both ends of the rod with the crank on the top quarter, key up good and tight, take up the crosshead snugly, move the crank a little to allow the crosshead to come to the right position and lock up the crosshead. Now take off the crank-end strap or boxes and measure the position of the rod on the crank pin exactly. Leaving the crosshead locked, turn the crank to the bottom quarter and try the rod there. The rod has to be removed and connected again, where a solid strap is used and in center-crank engines where the butt will interfere with the balance weights of the crank disks. If on an engine having a 24-inch stroke, the rod shows 1/16 inch more to the left on the bottom quarter than on top, it has a twist of 1/32 inch to the foot, to which amount one of the bearings would have to be worked over. This cannot be measured exactly on the bearing itself, as it is relieved top and bottom, but the crosshead can be turned to a position where the rod will swing true to the path of the crank pin. Mark the present position of the crosshead with a clear line on the bottom guide and the crank end face of the bottom shoe, loosen the crosshead and turn it an approximate amount to the right, 0.068 inch, if the bore is 26 inches; then try the rod and adjust the crosshead until the rod comes the same top and bottom. Mark this position in the same way and try the butts of the rods crossways with a level. If the butts are level, either the crank or wrist-pin bearing will have to be corrected. If it is the wrist-pin bearing, connect up the crank end and disconnect the crosshead, take the boxes out and scrape them right top and bottom an approximate amount, using the pin for spotting; connect up again, noting where the crosshead stands, and after a few trials the right position of the crosshead will be attained, so that the wristpin boxes can be scraped to bring the rod central to the crank pin. .

Some of the consequences of careless fitting and lining up of connecting rods will be interesting. There is the rumbling found in many, if not in most, engines with bored guides, caused by a slight twist of the rod. There is the slapping connecting rod due to the same cause, a wristpin being out of level or a crank pin wrist pin being out of level or a crank pin untrue. This slapping is often remedied by increasing the width of the crank boxes to a snug fit, but in such cases the shaft often moves sideways and greatly increases the friction load and starts side cutting in center-crank engines. Again, in belted units the belt frequently begins to sway, a little at first and increasing until it looks as if it were going to leave the dynamo pulley.. Then suddenly it starts to run straight again. This is caused by a slight and sometimes invisible side movement of the shaft. The belt receives the impulses and after awhile sways too far and gets out of time, so that its movements oppose those of the shaft, when they will be temporarily stopped.

The fitting and lining up of the connecting rod is the most important part of the work of building an engine, especially since the speeds have been increased and the rods in many designs shortened below the old standard of 1 to 3. However, if all points mentioned in these articles are duly considered and all the corrections faithfully carried through, there will be no trouble about the smooth and successful running of a well-designed engine.

## Avery Engine Presented to the American Society of Mechanical Engineers

Prof. John E. Sweet, past president and honorary member of the American Society of Mechanical Engineers, and a nephew of William Avery, the inventor, has presented to the society the rotor of one of the original engines built in Mr. Avery's shop in Syracuse, N. Y., sometime between 1835 and 1840. The Avery was a rotary engine, or turbine of the reaction type, having a hollow forged rotor in the form of two diametrically opposite arms. The arms were hung on a hollow shaft through which the steam entered, passing through the hollow arms and escaping through orifices at their ends.

In a description of the engine, Professor Sweet states that the shaft had no metal bearings except at the extreme outer end and beyond the driving pulley; at the end of the shaft opposite the steam pipe, where the steam entered the hollow shaft, rollers were placed to take the pressure of the steam, usually 150 pounds. The metal bearing referred to was in connection with these rollers. On each side of the case in which the arms revolved was a packing box in which hemp packing was used. These two packing boxes made the main bearings of the engine.

A Mr. Herrick, who helped build and operate the engines, said that when slide-valve engines were substituted for Avery engines no gain was made in steam economy. Trouble was had with the packing and with the cutting out of the blades at the ends of the arms. Mr. Avery refers in his notebook to a rotor 7 feet long which ran 14¼ miles a minute.—*Journal*, A. S. M. E.

## Turbines for Big Warships

Parsons turbine engines are to be installed as the motive power of the tw new American Dreadnaughts, the battle ships "Wyoming" and "Arkansas," au thorized by the last Congress. This de cision was reached at a meeting, Septembe 10, of the naval board on constructio Contracts for these ships will be awarde by the navy department to the Willia Cramp Sons & Co. and the New Yor Shipbuilding Company of Camden, N. J.

The board made a thorough inquir into the propositions to combine the ele tric motor with the turbine as a portio of the motive power of one of the vessel and also to combine reciprocating ar turbine engines for the other ship, b adverse action was taken in both cases.

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It is estimated that there are 200,0 square miles of peat in the world, i cluding 36,000 square miles in the Unit States.

# Single Belted Electric Elevators

## Descriptions of Various Types of Direct-connected Machines, Showing the Principles of Their Operation, Control and Adjustment

BY WILLIAM BAXTER, JR.

### DIRECTED-CONNECTED ELECTRIC ELEVATOR MACHINES

A direct-connected electric elevator machine consists of a suitable hoisting apparatus and an electric motor to drive it, both mounted upon the same bed. The hoisting apparatus generally consists of a winding drum upon which the lifting ropes of the elevator car are wound in lifting the car. The motion of the motor is transmitted to the drum in most cases by worm gearing, but in some machines intended for freight service only spur gearing is used. Direct-connected machines are classified according to the way in which they are controlled. If the operator in the car controls the elevator machine by pulling on a hand rope, or by moving a lever, a crank or a hand wheel, it is called a mechanical-control machine. If the operator operates the machine by moving an electric switch in the car, it is called an electric-control machine, and also a full magnet-control machine, from the fact that in such machines all the operating switches are actuated by magnets.

There is another type of machine that is arranged so that a person in the car can by pushing a button cause the elevator to start up and run to its destination and stop there automatically without any further action on the part of the operator. In such elevators there are in the car as many push buttons as there are floors at which the car is to stop, and by pushing the button corresponding to a certain floor the elevator is set in motion and will run until it reaches that floor, where it will stop. Such elevators are also arranged so that the car can be set in motion from any floor by pushing the button on that floor, and they are further made so that they may be started from any floor and be made to stop at any other floor desired. All elevators of this kind are called "automatic" elevators. The elevator machine proper, differs but slightly for these three types of elevator, but, nevertheless, there is some difference. The principal difference, however, is to be found in the controlling apparatus.

Figs. 24 and 25 show two different designs of mechanical-control elevator engines, made by two different manufacturers. The first is one of the early designs made by the Otis Elevator Company, and the second is one of several designs made by the Haughton Elevator and Machine Company, of Toledo, Ohio. While there is a considerable difference between the two designs, both have several parts in common, thus in both there is a motor $M$ to provide the actuating power, a hoisting drum $D$ to move the elevator car, a controller $C$ to control the motion of the machine and a brake $F$ to stop the machine and hold it still while the car is standing at a floor. In addition there is an operating sheave $A$ by the rotation of which the machine is set in motion or stopped as may be required. There is also a stop motion mechanism at $A'$ arranged to stop the machine automatically when the elevator car reaches either end of its travel.

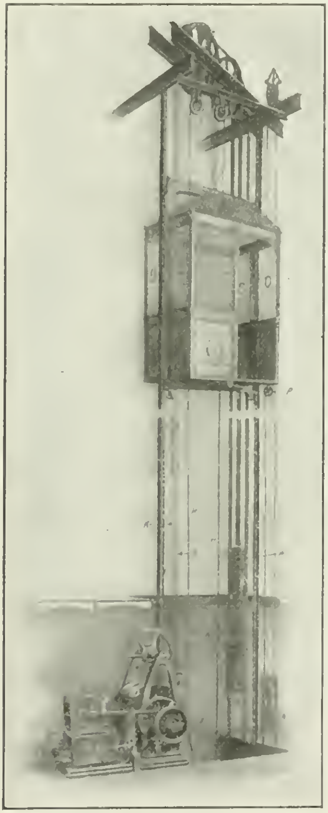


FIG. 24

The governor $M'$ in Fig. 24 is a safety device that acts to stop the car if from any cause it attains a dangerous velocity. This governor is driven by the rope $N$ which is made fast to the elevator car, so that the speed of the governor is proportional to that of the car. When the car speed becomes too great, the governor grips the rope $N$ causing it to slip through its fastening on the car and then a short rope attached to it near this point is drawn over the small sheave $P$ under the car, until a safety clutch is thrown into action which stops the movement of the car. The elevator machine is also provided with what is called a "slack cable stop;" as soon as the car stops and the cables slack up, this device acts and stops the machine by breaking the circuit so that no current can flow through the motor, and also by putting on the brake. The weight at $N'$ is provided so as to give the governor rope $N$ the proper tension. In Fig. 25 the governor $M'$ is not shown, as it is back of the machine, but the tightening weight $N'$ and the governor rope $N$ can be clearly seen. The slack cable stop, which is not shown clearly in either illustration, is used on both, and in several different forms, all of which will be fully described hereafter.

Looking at the Haughton machine in Fig. 25, it will be seen that two ropes $K$ run down from one side of the hoisting drum $D$ to the top of the car and are made fast to an equalizing bar $G$. From the other side of the drum two other ropes $K'$ run down to a similar equalizing bar $R$ on top of the counterbalance $W$. These equalizing bars act to keep the strain equal on the two ropes even if one should stretch more than the other. In Fig. 24 it will be noticed that the ropes $K$ run up from the front of the drum to the top of the elevator well and there pass over a sheave $L$ and then run down to the top of the car, where they are made fast. The ropes $K'$ run up from the back of the drum under the traveling sheave $B$, and to the top of the elevator well where they pass over a sheave at the side of $L$, over another sheave $L'$ and then run down to the counterbalance $W$. The traveling sheave $B$ revolves freely on the shaft and slides along it, following the ropes $K'$. Four ropes run upward from the car, the two marked $K$ and two others which run up and over the sheave $L'$, or another sheave at its side, and thence down to the counterbalance. The object of this arrangement is to provide four ropes to hold the car, and also to take some of the weight off the ropes *K* and *K'*. The weight that hangs from the ropes that run up directly from the top of the car is called the independent counterbalance, and the weight that hangs on the ropes *K'* is the back counterbalance. If the independent counterbalance weighs two-thirds as much as the empty car, the weight on the ropes *K* can never be more than one-third the combined weight of the car and the load. As only a certain amount of counterbalance can be used, it is clear that whatever weight is placed in the independent counterbalance will be taken off the back counterbalance; hence, the strain on the ropes *K'* will be reduced by this amount.

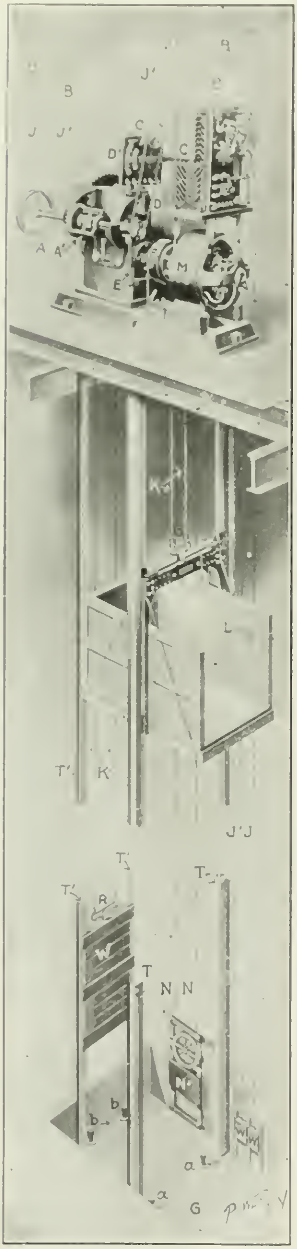


FIG. 25

Although Fig. 25 does not show an independent counterbalance, it must not be supposed that this arrangement is not used when the elevator machine is located at the top of the elevator well. Neither must it be supposed that an independent counterbalance is provided in all cases when the elevator machine is placed at the bottom of the well. As a rule the independent counterbalance is provided whether the machine is located at the top or the bottom of the well. When an overhead machine is intended to be used with an independent counterbalance, a sheave is provided in the position of the traveling sheave *B* in Fig. 24, and the independent counterbalance ropes run over this. In such an arrangement the sheave is made of larger diameter than the drum *D* so that the ropes running down from it may clear the drum and the ropes wound upon it. The machine shown in Fig. 25 is for freight service, and therefore is not provided with an independent counterbalance.

The first electric-elevator machine that was made and put in operation was located at the top of the elevator well, as in Fig. 25, and although this location gives many advantages, in the early days of electric elevators the machine was almost invariably located on the ground floor. Of late years, however, the overhead location has been coming into favor, and now it is not unusual to find installations in which the machine is at the top of the well. The advantages of this arrangement are clearly shown by the simple diagrams in Fig. 26, which represent an overhead installation on the left and a ground-floor installation on the right. In both diagrams the hoisting drum of the machine is marked *D*, and *S S'* represent the sheaves at the top of the well required for the ground-floor location of the machine. Comparing the two diagrams it can be seen that the length of rope required with the ground-floor machine is about double that for the overhead machine, all the rope below the point *a* being unnecessary with the overhead location. In addition the ground-floor machine requires the sheaves *S S'*. Therefore the first cost of ropes is greater, and their renewals will also be greater. It requires more power to operate the ground-floor machine because there is the additional friction of the sheaves *S S'*, and in addition the ropes are bent over these sheaves as well as around the drum *D*. Finally, the space required for the elevator machine is much more valuable at the bottom of the building than at the top of the well.

The controller of the Otis machine, Fig. 24, is contained in the box *C*, and is actuated by the rod *E*, which also serves to put on the brake when the machine is stopped and take it off when the elevator is running. In the Haughton machine, Fig. 25, a portion of the controller is mounted on the back of the motor and the balance, which is the reversing switch is mounted on a portion of the frame tha supports the hoisting drum. This reversing switch is rotated by a sprocket chai that is moved directly by the shaft o which the operating sheave *A* is mounte The brake is operated by this sha through the connecting rod *E*.

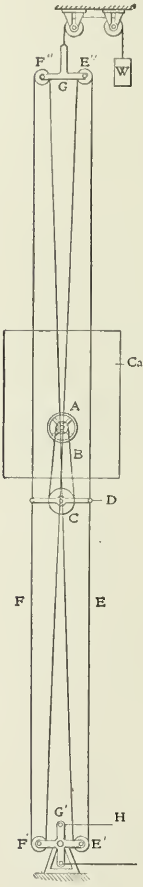


FIG 27

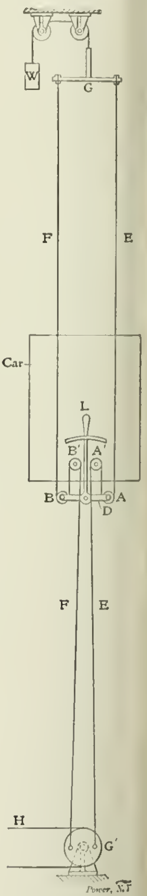


FIG. 28

In Fig. 24 the operator in the car co trols the elevator by means of a hand rop *H*, pulling it down to cause the car t ascend and pulling it up to cause the c to descend. This type of control, whi ictly speaking mechanical, is generally signated as "hand-rope control." It was ed extensively eight or ten years ago, en for rather high-speed first-class eletors, but now it is seldom installed ex-ot with slow-speed freight elevators. oking at Fig. 25 it will be seen that re is no hand rope but instead there a crank *L* in the side of the elevator ge The motion of this crank is trans-itted to the operating sheave *A* on the evator machine by means of the ropes ." There are many ways in which ropes be rigged up so as to cause a crank the moving car to revolve the sheave *A*, they can all be reduced to two funda-ntal types that are known as the "run-g-rope system," and the "standing-rope stem." The principle of operation of two systems can be made clear by aid of Figs. 27 and 28, the first being

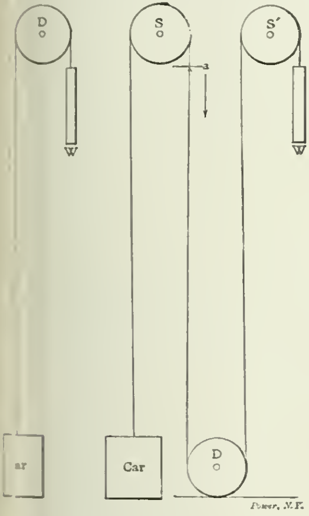


FIG. 26

gram of the running-rope system, and nd the standing-rope system. The *I. F* in Fig. 27 are made fast to the i the lever *D*; hence, when the car the ropes also move. The hand-*A*, in the car, when rotated, turns eel *C* through the driving chain *B*. *C* is rigidly mounted on the same with the lever *D*, the latter is rocked. wheel *A* is rotated clockwise, the nd side of *D* will move downward left-hand side upward. This move-wil let out the rope *E* and pull up *F*, and thus the frame *G′* at the m f the well will be tilted clockwise, the ropes *H*, which are connected wi the operating sheave *A* of the ele-machine, will transmit the movement sheave. To see this action clearly, it m be understood that the frame *G* at op of the well is rigid, and holds the shes *E″ F″* in the position in which

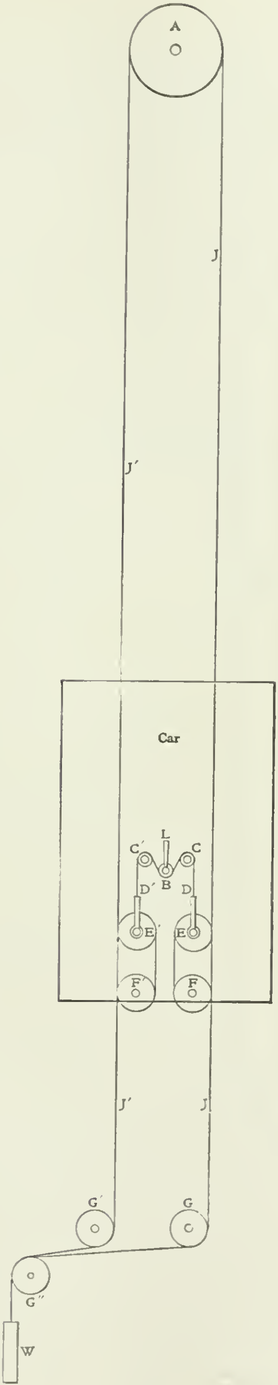


FIG. 29

they are shown, and also that the rope running up from the inner side of the sheave *F′* passes over the sheave *E″* at the top of the well.

In Fig. 28 the ropes are anchored at the top of the well to the frame *G*, and their lower ends are secured to the sheave *G′* as shown. When the elevator moves, the ropes stand still, hence the name of the system. If the lever *L* in the car is moved to the right, the sheave *A* will be depressed and *B* raised, so that the rope *F*

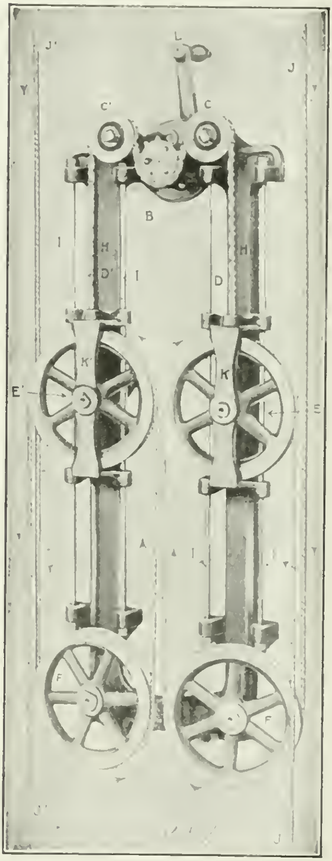


FIG. 30

will be lengthened out and the rope *E* will be drawn up; this will cause the sheave *G′* to rotate counterclockwise, and through the rope *H* its motion is transmitted to the operating sheave *A* of the elevator machine. The sheaves *A′* and *B′* are fastened to the side of the car, and remain in the position shown.

The rig used in the Haughton elevator, shown in Fig. 25, is of the standing-rope system; the way in which it is arranged is shown diagrammatically in Fig. 29 and Fig. 30 shows the actual construction of the mechanism that is attached to the outside of the elevator car. To make the diagram as simple as possible the ropes J J' in Fig. 29 are shown running directly up to and around the sheave A. This direct connection cannot often be used in practice but on the other hand it is seldom necessary to run the ropes in so roundabout a way as they are shown in Fig. 25. In this illustration the ropes are run up above the elevator engine so as to not be confusing, but in actual installations it is generally possible to find a more direct way of running them. In Figs. 29 and 30 the parts of the rope rigging are marked the same to facilitate the comparison of the drawings. When the crank *L* is turned clockwise, the chain *D* is drawn to the left and sheave *E* is drawn upward, while *F* is depressed; consequently the rope *J'* is lengthened out and *J* is shortened, so that the sheave *A* is rotated clockwise. If the crank *L* is turned in the opposite direction, the sheave *A* will also be turned in the opposite direction. It can further be seen that if the lever *L* is moved a short distance, the sheave *A* will be rotated through a small angle; the movement of *A* will in all cases be proportional to the movement of the lever *L*.

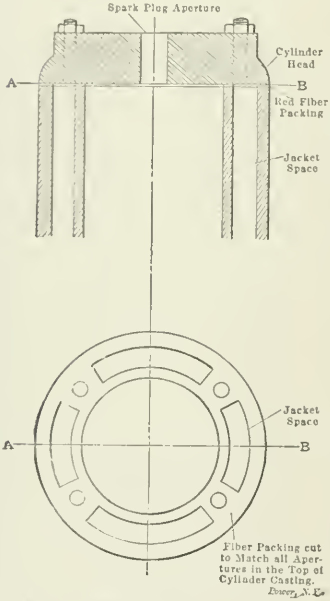
The sheaves *E* and *E'* are carried in frames *K* and *K'* that slide freely on the guide rods *I*. The sheaves *F* and *F'* are held on studs that are secured in the lower end of the frame *H*, as indicated in Fig. 30. The ropes *J* and *J'* are weighted at the lower end so as to be under the proper tension and are held so that they cannot move upward; hence, when the sheaves *E* and *F'* are moved, the ropes above the car are moved and the operating sheave *A* is rotated.

# An Experience with a Two-Stroke-Cycle Launch Engine

By John S. Leese

During my vacation this summer I shared an interesting experience with a gasolene engine in a small pleasure launch. It was a two-cylinder vertical Fairbanks engine working on the two-stroke cycle and developing about 10 horsepower. When I first made the acquaintance of this boat the engine was running none too well, but as the season was at its hight and the boat was requisitioned by visitors from dawn until dark, the owner was loath to lay up and make the necessary tuning up.

One morning, after the boat had been lying on the mud in the harbor at low tide, upon going out on the first trip the engine was found to be running very hot. Looking over the side, the skipper discovered that the water pump was not delivering. He at once stopped the engine, took the cover plate off the pump (toothed, wheel-type) and found that it was full of mud from the harbor, which had got up the intake. Having cleaned it out and let the engine cool down he tried to start up. Much to his surprise, the compression had quite gone. Not being an engineer, he decided to get a tow back to the harbor and investigate the matter with the help of a mechanic from the garage. Fearing badly scored pistons or broken rings (all joints being apparently tight), they got the cylinder heads off; the cause of no compression was then apparent. The cylinders and heads were constructed as shown in the sketch, and it was found that the fiber packing on the forward cylinder was charred in three big patches, owing to the great heat when running without water, and that on the aft cylinder was baked hard and cracked in two places.



SHOWING CONSTRUCTION OF CYLINDER AND HEAD

These packings were replaced by ⅛-inch asbestos, the pistons and rings having been inspected, to be on the safe side, and found all right. At the first pull over she started up; then we went out for a trial trip. All went well and we returned to the harbor for a load. Just as we entered the harbor the engine slowed down, kicked once or twice spasmodically, then quietly gave up the ghost. There was plenty of gasolene and the ignition system was all right; therefore, we looked first for choked connections from the tank to the carbureter. The pipe was blown through and the filter cleaned, the result being a thimbleful of scale and grit.

We connected up again and got to th steps for a "load," which quickly gathere We started the engine with some difficult and tremendous back-firing through tl carbureter and air intake. We then pr ceeded like a gunboat in action halfw across the harbor, when the engine aga struck work. After we had spent twen minutes pulling her over in vain, tl "load" grew restless and sarcastically r quested to be transferred "to a mot boat."

Having got rid of them, we "poled" a quiet spot where the derisive shou of the crowd could not be heard, ar rested, the skipper delivering a remarkal flow of invective which should ha started any engine. When we had cool off a bit we attacked the carbureter, whic much to my surprise, we found to equipped with a cork float. The engi was two years old and had been in c stant service, so that the cork had l come saturated with gasolene, impurit and grit, which made it so heavy tl it would not cut off the gasolene sup at all. We adjusted the cutoff valve that it acted at the right level of gasol in the float chamber, assembled the c nections again, and the engine started at the first turn over. Since then t boat has been in constant passenger a towing service and the engine has ne run better.

The stuff we got out of the gasol pipe had choked the supply about eno to counteract the effect of the float va being always open, and the mixture just good enough to run on. When we l got the dirt out, the engine was floo with gasolene and of course would fire.

From my experience with two-str engines of this type I should say t the most trouble experienced is with mixture. Even with a good carbur the mixture has such a long way to go t by the time it reaches the cylinder it not in a good condition for efficient c bustion. Another common trouble is loss of compression down the piston through the ports in the cylinder w when the top rings get even a trifle w Yet another fault is the deposition water and condensed vapors in the cr case, which may emulsify with the oil, if not, give a false impression of amount of oil present. Again, if the cr shaft main bearings are not very fitted and kept carefully adjusted, crank-case compression is easily through them.

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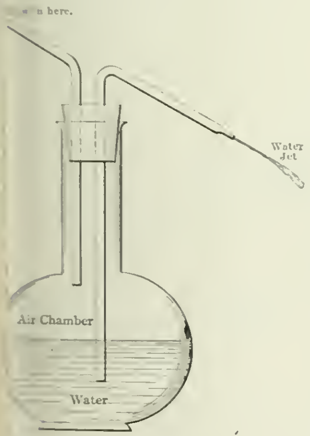
An English exchange states that Key Engineering Company, Limited, made an arrangement by which Me Galloways, Limited, will manufac large gas engines in England accor to the design of Ehrhardt and Schme Germany. This will mark a distinct in the production of the big gas engi the United Kingdom.

# Some Useful Lessons of Limewater

## How to Use a Blowpipe; Some Simple Experiments with a Candle Flame; Analyzing Boiler Scale from Permanent Hardness Water

### BY CHARLES S. PALMER

About this time you will want to be g hold of blowpipe analysis; and tle the books that you have probably t on analysis in general, or blowpipe alysis in particular, will give you all reactions which you need, yet most them will spend their time more in cribing at length the oxidizing and re-ing flame, rather than in telling you w to master the easy trick of making lowpipe deliver a constant flame, say r ve to fifteen minutes. I assume that have provided yourself with a com-n blowpipe and that you know how to the oxidizing and reducing flame, er from a common gas jet turned low re convenient still, from a common I shall have something to say that in a moment, but in the first t me show you how to learn to de-r a constant flame with a blowpipe.



Power, N.Y.

FIG. 1

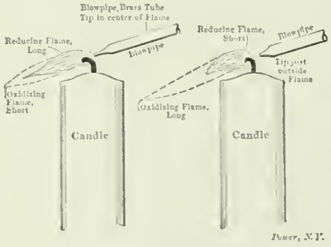
e trick consists in blowing from the l with the cheeks distended around a n fl of air. When your lungs are e sted, by a quick gulping motion you c the passage from the back of the n th into the lungs and quickly fill the l through the nose. While you are d ng this, the blowpipe is kept supplied f the moment with the mouthful of air; a again by releasing the gulping contrac-t at the back of the mouth you supply th blowpipe for another ten or fifteen s onds with a new supply of air, filling the lungs, noting that when blowing from the lungs you always want to keep the cheeks blown out or distended with that indispensable mouthful of air. Now, it would be easy to do this if you could only see what you were doing; and while many students learn the trick of blowing the blowpipe continuously and almost unconsciously, yet I have never found anyone who could not learn the trick very easily by practising on a wash bottle.

Suppose you make a wash bottle, as shown in Fig. 1. Here you have a small, constant stream of water and you can watch this stream with your eye. You can at first learn to give a steady stream of water from the wash bottle by clapping your tongue over the blow tube from your mouth, when the reservoir of compressed air in the wash bottle will keep the stream going while you are breathing in. As soon as you have learned this trick, do not depend on your tongue to hold the pressure of air in the wash bottle, but learn to depend on your mouth and your cheeks, using a mouthful of air to hold the pressure of air in the wash bottle while you are breathing in fresh lungfuls of air. By practising with a wash bottle for a few moments a day, in two or three days you will master the little gulping trick of closing the back of the mouth, so that you can breathe in through the nose to the lungs while you are blowing out to the blowpipe through the lips.

When you begin to get a little familiarity with this blowing, then practise holding the reducing and oxidizing flames in turn on charcoal and when you have learned this, try the reducing flame on a piece of blue vitriol (copper sulphate) the size of a small pea. Take a nickel and hollow out a little cavity in the charcoal by twisting the coin around and pressing down into the charcoal; also put the tip of the blue reducing flame not directly on the blue vitriol, but toe it down onto the charcoal, say a quarter of an inch in front of the copper sulphate. In this way you will not only get the assistance of the reducing action of the reducing flame from the blowpipe, but you will also get the help of the stream of carbon monoxide from the half-burnt carbon, which stream flows around the blue vitriol and helps the reduction. It will take from three to eight or ten minutes to reduce a little shot of copper from the blue vitriol; and often you will be fooled into thinking that you have metallic copper when you have nothing but the red oxide of copper (cuprous oxide).

If you want to be sure that you have some metallic copper, all that you have to do is to pick out the reduced spongy mass and lay it on an anvil or any piece of hard metal on which you can hammer. If there is any metallic copper there you will get a coherent flat-metallic scale which will be quite malleable, while any unreduced copper sulphate or copper oxide will pulverize into loose friable dust. When you get so that you can reduce a little globule of metallic copper on the charcoal and hold it in a molten condition for a moment or two within four or five minutes from the time when you throw the blowpipe reducing flame on it, you can consider yourself as beginning to be expert with the blowpipe.

Of course, if you miss a gulp now and then and lose your flame for a bit, that will not make any difference if you catch it again in a moment and keep the heated particle hot. A little litharge or red oxide of lead can be reduced on charcoal much easier than metallic copper can be reduced from blue vitriol; but the lead compounds are reduced so easily and the globules of metallic lead appear so quickly that that is hardly a test. Of course, in all reduction before the blowpipe on charcoal it may be easier to work with a little sodium carbonate, although this is not necessary in all cases.



Power, N.Y.

FIG. 2

Regarding the oxidizing and reducing flames as shown in Fig. 2, you will have no difficulty in producing these with a common blowpipe from the flame of an ordinary candle; and you can easily learn to see the sharp, clear, fine-pointed, blue inside cone of the reducing flame, and the longer, more diffuse and less visible part of the outer or oxidizing flame; but notice this point: if you want to get a long and powerful reducing flame, put the tip of the blowpipe into the inner non-luminous part of the flame. The reason for this is that you want to catch this nonluminous and still unburnt center of the gas flame of the candle as the basis for your reducing flame, while if you want to get an oxidizing flame you will withdraw the tip of the blowpipe just a fraction of an inch from the center of the candle flame, and so that you will not only blow air through the blowpipe into the flame, but your blowpipe will also suck in a current of the surrounding air into the flame, thus helping your blowpipe to produce the oxidizing result. Now for the use of this in analyzing boiler scale.

### Analyzing Boiler Scale

Most books of analysis are very full in telling the student how to analyze a solution that is already made up for him, but often the books are strangely wanting in telling the student how to make his own solution, and particularly in telling him how to get insoluble things into solution. The analysis of boiler scale of permanently hard water is a good illustration of just what you need to know here. Let us suppose, for simplicity, that you have a boiler scale of hard calcium sulphate, or sulphate of lime; and if you do not happen to have any of this, you can take some plaster of paris, either the fresh powder or that which has been hardened with a little water; in the latter case remember that you are working with calcium sulphate plus a little water chemically combined. Now, you can take the boiler scale or calcium sulphate, and you can dissolve it quite readily in *strong* hydrochloric acid; but this acid solution of calcium sulphate is too strongly acid to use in following through the groups; for, of course, hydrochloric acid itself would produce no precipitate in the first group, neither would hydrogen sulphide produce any satisfactory precipitation in the second group, and when you come to the third group, which should come down with ammonia, the addition of this would simply reprecipitate the calcium sulphate as calcium sulphate and in a white gelatinous or curdy form which might make you think it was alumina of the third group, when it would be only calcium sulphate coming down again by neutralizing the acid which first dissolved it.

Very few of the books would say anything about this, because they fail to treat sufficiently the subject of getting insoluble things into solution; and, in the group analysis, one is not expected to use such a strong solution of hydrochloric acid as that which is required to dissolve calcium sulphate. Hence if you should dissolve it with hydrochloric acid and then reprecipitate in the third group with ammonia, you would have your trouble for your pains; for your calcium would seem to be coming down in the third group as a sulphate, when it ought to come down in the fifth group as a carbonate in orthodox fashion.

There are two or three ways in which calcium sulphate can be dissolved and you will notice that we must look out to catch not only the calcium or lime part of the scale, but we must also find the acid part, which in this case is "sulphion," the acid radical characteristic of sulphuric acid; for permanent-hardness scale is largely calcium sulphate. If you take some of this calcium sulphate and boil it in a strong solution of sodium carbonate (calcined soda) for an hour or so, the calcium sulphate will be changed into calcium carbonate; both calcium sulphate and calcium carbonate are insoluble in water and so at first sight you would not seem to have made much progress. But if you wash off the sodium carbonate and sodium sulphate from the calcium carbonate and the calcium sulphate, you will find insoluble calcium carbonate, which is formed according to the following reaction:

| $CaSO_4$ | + | $Na_2CO_3$ | = | $CaCO_3$ | + | $Na_2SO_4$ |
|---|---|---|---|---|---|---|
| Calcium Sulphate Insoluble. | | Sodium Carbonate Soluble. | | Calcium Carbonate More Insoluble. | | Sodium Sulphate Soluble. |

And you will have left behind in your beaker mainly calcium carbonate. Now of course you remember that this calcium carbonate dissolves easily in very dilute hydrochloric acid, with effervescence of carbon dioxide and according to the following reaction:

| $CaCO_3$ | + | $2HCl$ | = | $CaCl_2$ | + | $H_2CO_3$ |
|---|---|---|---|---|---|---|
| Calcium Carbonate Insoluble in Water, Soluble in HCl. | | Hydrochloric Acid. | | Calcium Chloride Soluble. | | Carbonic Acid. |

After you have boiled the calcium sulphate or the permanent-hardness scale in a strong solution of sodium carbonate for an hour, pour it into a fruit jar and fill up with water. Let this settle clear, the calcium salt going to the bottom; then pour off all the clear upper liquid in a separate jar, leaving the white milky mud at the bottom; fill this up again with water, shaking it around to wash it well; let it settle clear, and again pour off the top water, saving the milky residue at the bottom of the fruit jar, and so on half a dozen times, "washing by decantation," until you are sure that all of the sodium carbonate and sodium sulphate formed are washed away and you have only lime salts left. By the way, I should mention that you must save the first clear water decanted off to test later for sulphuric acid (for this contains the excess of sodium carbonate and most of the sodium sulphate of the reaction given in the foregoing). Put this solution into a bottle and label it: "First Sodium Carbonate Decantation from Calcium Sulphate."

Now going back to the white insoluble residue of calcium salts which have been washed by decantation, treat this with a little dilute hydrochloric acid. You will note the effervescence of carbon dioxide and the quick solution of most of the lime salts into what, of course, is calcium
chloride. Any insoluble part left behin
is only some of the unchanged calciun
sulphate. This solution of calcium chlorid
if not clear, should be filtered; and, i
you have been careful to use just enoug
hydrochloric acid, you will have a solu
tion which you can put through the grou
analysis. You will get no precipitate, a
you test portions of this solution in se
arate test tubes, for either the first, secon
third or fourth groups; but you will g
a precipitate with ammonium carbona
for the fifth group, bringing the lime dow
as calcium carbonate in the group whe
it ought to be, and in the chemical form
which it ought to be. You can confirm t
presence of calcium, also, by the other test
such as the insoluble oxalate which
precipitated by ammonium oxalate, solub
in hydrochloric acid, but insoluble wi
either acetic or oxalic acid.

Now for the acid part, the "sulphio
(of that which was originally calci
sulphate), which is hidden away as sodi
sulphate in the bottle labeled: "Fi
Sodium Carbonate Decantation from C
cium Sulphate." Pour a little of this i
a test tube, and add hydrochloric a
gradually until the effervescence of carb
dioxide from the sodium carbonate
over and the solution reacts slightly a
with litmus. Add to this same soluti
(which contains sodium sulphate a
sodium chloride) a little barium chlor
or barium nitrate, when you will get
quick white insoluble precipitate of bar
sulphate. And so you have cornered
sulphate part of the calcium sulph
But there are other ways in which to
at the analysis of this permanent-hardn
scale. Some of these include the use
the blowpipe which we will consider
the next lesson.

## Gas-Engine-Driven Compressors High - Pressure Natural - Gas Transmission Lines

Gas-engine-driven "booster" stat
have demonstrated their economy
utility very thoroughly. A recent exa
of this class of installation is the W
inghouse twin-tandem equipment in
Mohican Oil and Gas Company's plan
Howard, Ohio. The compressors del
to the long-distance pipe lines at 16
200 pounds gage pressure and the ga
received at 25 to 80 pounds pressure f
wells located within a radius of
miles of the plant, which delivers ga
towns at distances of 80 miles. The c
pressor engines take their fuel from
well mains, through reducing regula
at about atmospheric pressure. They
1250-horsepower (23½x48-inch) twin
dem engines and run at speeds ran
from 44 to 88 revolutions per mi
they consume, on an average, abo
per cent. of the compressor ou
Natural gas in this locality has a
value averaging 974 B.t.u. per cubic

# Practical Letters from Practical Men

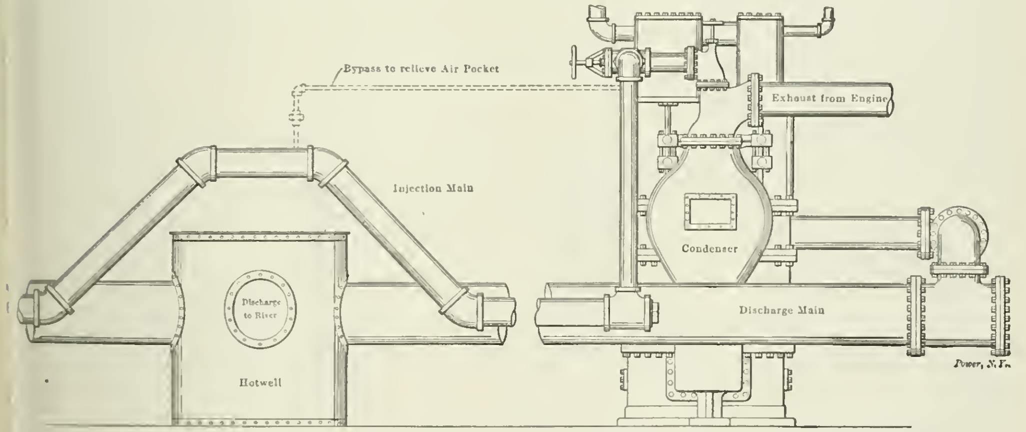
Don't Bother About the Style, but Write Just What You Think,
Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

## A Balky Air Pump

The engine equipment in an electric-railway power station had grown in the course of time from the original single-unit installation, consisting of a cross-compound condensing engine rated at about 1400 horsepower, to five similar units ranging in size up to 2200 horsepower. Each of these engines was fitted with an independent jet condenser, and all five condensers received their injection water through branch pipes leading from a common main through which the water was conveyed by suction from a cistern located on the premises, and which, in turn, received its supply through an intake tunnel from an adjacent river. As each succeeding unit was added to the plant, the injection main was extended to accommodate its condenser equipment by running out a section of pipe from the point at which the main branched to supply the previously installed condenser.

During the interim preceding the installation of the fifth generating unit, a hotwell with a crudely contrived filtering ttachment was rigged up for the purpose of entrapping a portion of the water disharged from the condensers and utilizing it for feeding the boilers. The discharge rom the condensers passed into a common main which emptied its contents into the iver, and which emerged from the building near the end opposite to that through which the injection main entered, so that at the time of erecting the hotwell, the only location available was at the end of the row of four condensers, already in place, in the direction in which the plant was expanding. This circumstance, coupled with the fact that the injection and discharge mains were laid closely side-by-side, necessitated a loop in the injection main, as shown in the accompanying sketch, when it was extended later on to accommodate No. 5 condenser.



SHOWING LOCATION OF INJECTION AND DISCHARGE MAINS, ETC.

This condenser was furnished with a vertical, duplex, single-acting air pump, the steam end of which comprised a cross-compound engine with high- and low-pressure cylinders, instead of the conventional duplex-pump type of double engine. For a brief space after it was first put in service, this pump gave an entirely satisfactory performance, running smoothly and quietly and maintaining a vacuum which was quite up to expectations, considering the temperature of the water available for condensing purposes and some minor drawbacks which attended the working of the apparatus.

As time progressed, however, the machine developed balky characteristics; the placid and even action of the plungers being frequently broken by transitory shifts to an irregular, jerky motion, accompanied by terrific hammering and jarring of the structure as the plungers apparently traversed a portion of the stroke against the attenuated air and vapor in the cylinders before meeting the resistance of the compact body of water, the mercury column of the vacuum gage the while falling perilously low and hovering in the neighborhood of the altitude at which the automatic relief valve was usually thrown, and the vacuum failed altogether.

Repeated examination of the plungers and bucket and foot valves of the pump, as well as of the spray cone and passages in the condenser, showed these parts to be intact and in perfect order; it was manifest, therefore, that the cause of the alternate periods of tranquillity and turbulence in the action of the pump would have to be searched for in some extraneous quarter. The symptoms seemed to indicate periodic contraction in the flow of injection water, but after every joint in the injection line, back to where it branched to supply the preceding condenser, had been inspected with sedulous care for any trace of a leak which might impair the suction, and nothing had been found amiss, the engineer in charge was prone to acknowledge his utter inability to account for the trouble.

Finally, after months of profitless experiment and more or less vexatious tinkering and monkeying around, the engineer concluded to appeal to the builders of the condenser for a diagnosis of the case and the application of a remedy. In response the builders sent an expert condenser man to investigate, and the first thing this man did when he got on the job was to order the looped portion of the injection main tapped at its highest point and a 1½-inch by-pass connected between this point and the upper end of the vertical section of the branch from the injection line to the balky condenser, as indicated by the dotted lines in the sketch. This being accomplished, the irregular action of the air pump immediately ceased.

The loop in the injection line had simply formed a pocket for the lodgment of air bubbles passing in with the condensing water, and this air, in the course of time, had accumulated to such an extent as to contract the passage through the horizontal portion of the loop and render it inadequate for conveying the proper volume of water.

It was a rather mortifying experience for the engineer, who was an intelligent man and entirely capable of figuring the thing out for himself, if only some slight suggestion, occurrence or hint during these months of desultory investigation had directed the current of his thought toward the consideration of problems of the character really involved. The instant the expert man ordered a hole cut in the injection main, the whole thing flashed before the engineer's mental vision with all the prominence of a ten-story building. Hitherto he had been in the psychic condition of a man searching for his hat with his hat in his hand.

A. J. DIXON.

Chicago, Ill.

## Water Level Gage for Elevated Tank

It was once my misfortune to spend some time in a gas-engine power plant where the cooling water for the cylinder jackets was supplied from the city mains, and, to cut down expenses, the water was cooled in a homemade cooling tower on the concrete roof and used over again. After running down through the cooling tower, the water was run into a tank 30 inches deep, from which the jackets drew their supply. This tank was located on the top of a two-story building and there was no way to ascertain the depth of the water in the tank but to climb up and look, a rather strenuous task, and one not in strict accordance with the general atmosphere of the place.

This difficulty was overcome by constructing a float and a bank of lamps in the engine room that accurately—if the float didn't stick—read the depth of water in the tank. In the following description I have attempted to eliminate the bad features of the contrivance:

The framework of the float, Fig. 1, was made of some crossarms found out in the yard, braced with inch strips. The two bottom pieces, *K K*, were secured to the walls of the tank and supported the framework, which consisted of the pairs of vertical and horizontal pieces, *L*. These

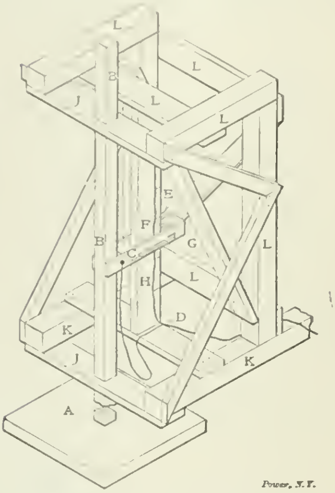


FIG. 1. FRAMEWORK AND FLOAT

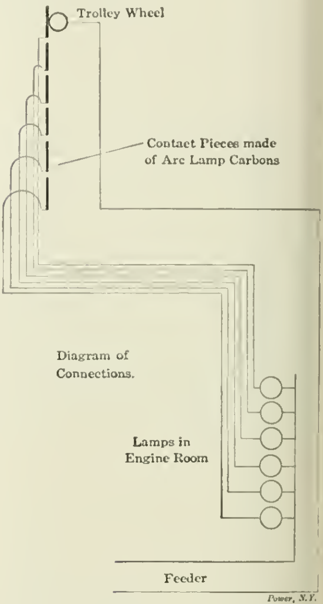


FIG. 2

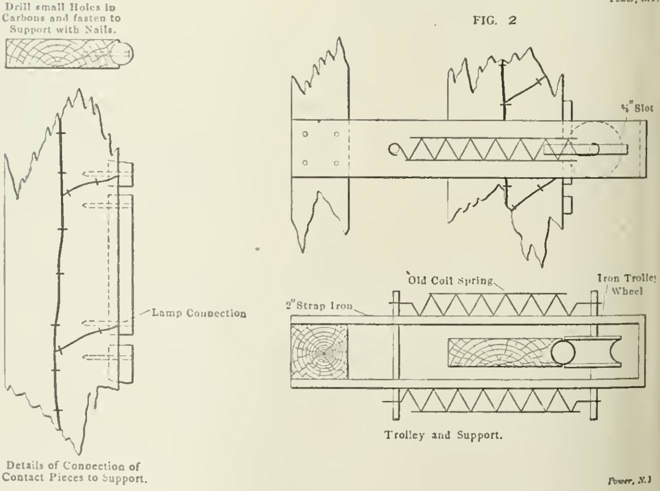

Drill small Holes in Carbons and fasten to Support with Nails.
Lamp Connection
Details of Connection of Contact Pieces to Support.
⅜" Slot
Old Coil Spring
Iron Trolley Wheel
2" Strap Iron
Trolley and Support.
Power, N.Y.

FIG. 3. DETAILS OF WATER-LEVEL GAGE FOR ELEVATED TANK

pieces were held together by spikes and were rigidly braced by cross bracing in the back and diagonal braces on the sides, as shown in Fig. 1.

The float *A*, Fig. 1, was made of two pieces of 2-inch planking, 12 inches square securely fastened to the bottom of the movable wooden rod *B*, which was 2 inches square and free to move vertically a trolley wheel support made of a piece of 2-inch strap iron *C*, bent as shown and rigidly fastened to the rod. The trolley wheel consisted of an old iron wheel *E* about two or three inches in diameter, and was mounted upon an axis that was su ported in slots *G*, in the strap iron a was held against the contact pieces by t through the holes in the boards *J J* nail across the framework. This rod carri coil springs *F* on either side. A bett idea of the trolley wheel and its supp can be had from Fig. 3, which shows a side and a top view.

To indicate differences in the depth of the water in the tank, a trolley wire made up of six separate pieces of arc-lamp carbons five inches long was fastened to the edge of the vertical board *H*, Fig. 1, with spaces of about $\frac{3}{8}$ inch between them. The trolley wheel was pushed up and down over these carbons as the water level in the tank changed.

Seven wires were run down from the framework to the engine room, where they were connected to the six lamps and the feeder circuit, as shown in Fig. 2, one wire going directly from the feeder to the trolley wheel and the other six connecting the six carbons to their respective lamps. It is easy to trace the flow of current and see which lamp burns with the trolley wheel on any carbon.

J. C. PARMELY.

Hoopeston, Ill.

## Condenser and Cooler Installation

The accompanying sketches outline a plan which we have formulated for a condenser and cooler installation.

We have a 20x42 Greenwald automatic-cutoff and an 18x36 Lane & Bodley Corliss engine, one 10 and 16 and 10 by 12 compound duplex pump, one 9 and 16 by 12 cross-compound Ingersoll-Rand air compressor, one 12x12 Platt Iron Works compressor and two boiler feeders, all exhausting into a common 10-inch main, the exhaust main and all joints being in first-class condition. Our idea is to exhaust into a closed heater, then to a condenser, erecting the condenser 55 feet, instead of 30 feet, and setting the hotwell [illegible] feet high, to furnish head enough to force condensing water out through 6- and 4-inch mains encircling a pond 100 feet in diameter by about 15 feet deep.

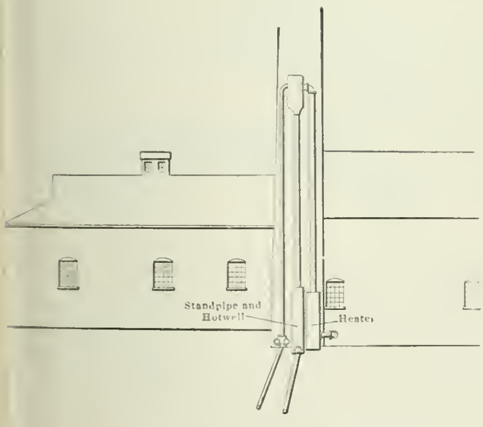


FIG. 1

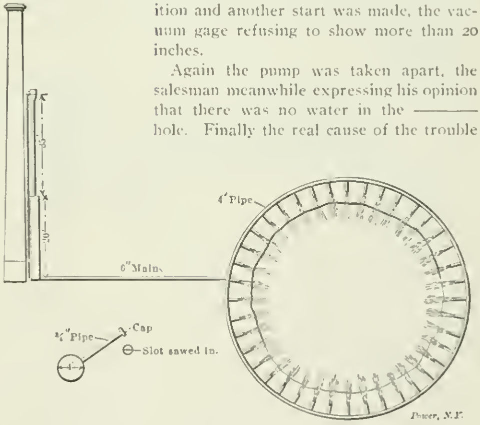


FIG. 2

Through the summer we have about half enough water running without a cooling apparatus.

The idea is to tap the 4-inch main encircling the pond about every 18 inches for $\frac{3}{4}$-inch pipe and cap it, sawing a fine slot in the cap so as to make a spray nozzle. We would be pleased to have POWER readers advise us as to the proposed installation.

W. E. TURNER.

Wilmington, O.

## Interesting Pump Experience

In our plant are two 4-inch driven wells, with a steam pump connected to each, the water cylinders being 4x6 inches. The lift is $26\frac{1}{2}$ feet and the pumps were mounted upon a brick foundation 18 inches high, making a total lift of 28 feet. There were a number of ells on both the suction and discharge lines, so it is not surprising that there was a scarcity of water. Finally, one pump became so badly worn that it was decided to install a new one. A certain make of pump was recommended by a man who was supposed to be an authority, and we began to negotiate for one. We thought it would be a good idea to dig a pit in which to place it, but were assured by the salesman that it would not be necessary, as the pump would positively create a vacuum of 28 inches. The order was given and in due time the pump arrived.

Sunday was spent in making the connections. The pump was placed on the floor close to the mouth of the well and connected thereto by a short 3-inch pipe on which were a check and a gate valve. Monday morning steam was turned on. The pump moved smoothly for perhaps half an hour but failed to raise a particle of water. As the maker was located nearby, we thought it well to leave it to him to make any necessary adjustments. A telephone message soon brought the salesman and a machinist. The latter, as he informed me, had been twenty-five years with this firm and was supposed to know all that was worth knowing upon this subject.

Their first work was to place a vacuum gage on the suction. The pump was started, the pointer moved around to 20 inches and remained there, and there was no more air expelled from the air cock. They immediately condemned the check valve. We called attention to the fact that the other pump that was then delivering a fair stream was also supplied with a check, which in no way interfered with its working. However, the check valve had to come out. Another start was made with no better results. About this stage the vacuum gage was transferred to the suction of the other pump and showed about 24 inches. Then the pump was given a thorough inspection, when it was discovered that it had been fitted with hard-rubber valves, when they should have been medium soft.

"But," we said, "our old pump there is working, and the valves in that are still harder, in fact, they are brass."

This was not at all convincing, so a messenger was dispatched for a new set of soft valves. These were placed in position and another start was made, the vacuum gage refusing to show more than 20 inches.

Again the pump was taken apart, the salesman meanwhile expressing his opinion that there was no water in the ——— hole. Finally the real cause of the trouble was located. It was found that the piston had been packed with Tuck packing, whereas this particular service required hemp. Attention was again called to our old machine and they were assured that that also was packed with Tuck packing, and was still able to maintain a 24-inch vacuum.

But the packing, like the valves, had to come out, and a hurry call was sent to the factory for hemp packing, which being fitted in another start was made with no better results. This had consumed the entire day.

The following day the makers sent up their mechanical engineer to look it over;

a very intelligent young man, determined to make that pump work at any cost. He went over every inch of it and seemed mystified at the work our old machine was doing. The third day brought no better results. Then he suggested a new piston with leather cups. We consented to this. The piston was hastily procured and placed in position, steam was turned on and with the remark that there was "nothing doing," he left, saying that he would report to his firm. After a lapse of two days we called him up on the telephone and were informed that they were willing to dig a pit in which to place the pump, or they would send their truck and take it away. When pressed for an explanation they said that they had been making some experiments and "the results were uniform," that they were unable to do better than 20 inches on "dry vacuum," so the new machine was hastily disconnected, the old one was put in its place and started, the gage moved around to 24 inches and the pump immediately proceeded to "deliver the goods."

Then we went to the telephone again and called a manufacturer who makes a pump that is practically the same as our old one. After getting his price, which proved to be less than half that of the one that failed, we told him that we would give him an order on condition that his pump would do the work as well as the one in use. This was agreed to and in a few days it arrived. This was connected as the first one. The old one was moved back to its original position, only placed on the floor instead of a foundation. Steam was turned on, the gage showed 24 inches vacuum and there has been a steady flow of water ever since.

Had this pump been bought by the superintendent of some distant factory, the unfortunate engineer whose duty it was to operate it would probably have considerable difficulty in convincing his employer that the pump's failure was not due to his own lack of knowledge of the subject.

That any machine should fail at times is not surprising, but it certainly is surprising that a firm whose specialty is building pumps should be unable, in their own factory, to get better results than 20 inches vacuum, and be obliged to confess it.

The question that will occur to the operating engineer is, what is there about a pump, with its simple arrangement of piston and valves, to give such different results?

J. Wadsworth.

Brooklyn, N. Y.

## Furnace Arrangement

The distance the grate should be from the shell of the boiler has occasioned many arguments. It is true that many of us have followed a fixed rule in setting boilers, always using the same distance regardless of the fuel to be used, being able only to determine between soft and hard coal; the variation in soft coal being so great that it would be impossible to suit all conditions. Some gaseous coals, high in volatile matter, should have a very low grate, lowered enough so that a deep fire can be run, thereby getting the full benefit of the gases. Nine out of ten furnaces are too high for burning this coal.

There is quite a difference in the gaseous makeup of coals. Some coals will melt and burn with a dense dark smoke, and such should be burned in a hot, deep furnace, otherwise great loss will be going on from waste of volatile matter passing up the stack in the form of gas. Should this gas pass through a hot flue it would quickly ignite, while coming in contact with a cold boiler shell or a cold furnace flue would only allow the gas to pass off as waste fuel. The gas from anthracite is more combustible at the point of generation, from the fact that the point of generation is more intensely heated and the gas is given off more slowly, and it can be consumed more evenly; the separation is not as sudden as with the low-carbon coals. Therefore, the hard coal can be burned with a grate much closer to the shell of the boiler than the soft coal. I do not wish to be understood as recommending raising the grate bars, as the majority are too high now, but the fact of having the grate bars set for a given coal is one of much more importance than many of us think.

The hydrocarbon gas must be subjected to a hot furnace of passage in order to get the full results. When chilled, it falls below the firing temperature and consequently a black smoke results. I have seen many devices used for controlling and allowing free air to enter close to the boiler shell, but with no practical value. While the idea may seem good, to prevent the cooling action of the shell sheet on the gas that is losing its temperature and passing off in waste smoke, from practice and demonstrations along this line I prefer handling this gas in another manner.

Grates may be placed at a distance to suit the coal and there may be complete flame combustion. When it is desired to heat anything in the flame of an alcohol lamp, it is found that the greatest heat i obtained at a point where the heat o flame is almost invisible. This is the poin of complete combustion. Lower dow there is less heat and still closer to th wick of the lamp, still less. Therefore grates must be lowered to get a complet flame combustion.

The accompanying sketches illustrat the results of tests and observations. W had two return-tubular boilers in a plan of exact dimensions. The stacks wer independent. All furnace dimensions wer exactly the same, including the stac There was one exception. The two fir boxes are shown in Figs. 1 and 2. W were burning a soft Tennessee coal good quality, and could carry a certa load with the boiler shown in Fig. but could never carry the same load wi the boiler shown in Fig. 2. We made offset piece for the front and cut out t ashpit, and the two boilers were of equ power from a practical steaming point.

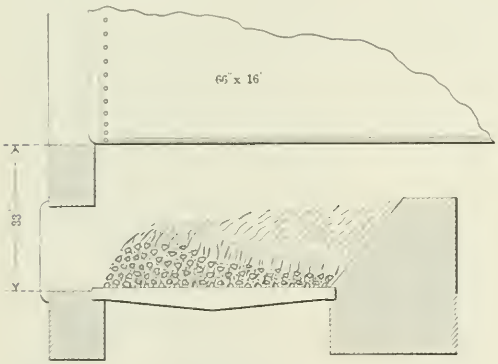


FIG. 1

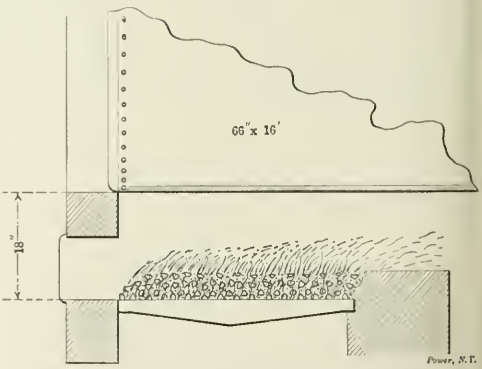


FIG. 2

Here was a practical test of this condition. We could never depend on pushng the boilers shown in Fig. 2, while we uld the one shown in Fig. 1. There was ample space for combustion and we ad to run a fire as shown on the grates n Fig. 2, an even layer: while in Fig. 1 we could run a fire high in front, coked nd thinner on the rear of the grate, and very hot. No gases would pass this ridgewall. The combustion chamber of oiler No. 1, which had a side door, showed right, while that of boiler No. 2 showed ark. The deep furnace and high bridgevall, with a good reflection, aids material- in burning gases. The ash from No. boiler was always less by weight and of finer character

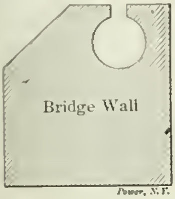


FIG. 3

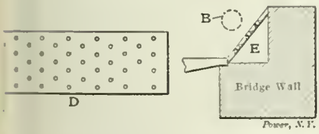


FIG. 4

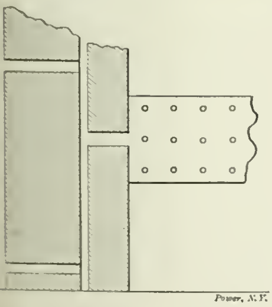


FIG. 5

In Fig. 4 is shown an arrangement ich aids combustion and saves fuel. bridgewall has a cast-iron reflection late, perforated as shown, and free air allowed to pass in back of this plate a come through the small holes in the late, while should be about one-half inch i diameter on the fire side and come to ig taper on the free-air side, so dust will not lodge in the holes but will fall i the space *E*, which can be easily cleaned d. I have installed this with a clean- door so as to rake the ashes out. h found it a good plan to have a small am jet on one side, when by opening t opposite door it could be blown out in a few seconds. A simple and effective method is shown at *D*. While these plates will burn out in time, they will save lots of coal and will last as long as, or longer than, a set of grate bars if kept clean.

In Fig. 3 is shown a method that was once patented. This was a tube, cut as shown, placed in the bridgewall, with small dampers at each end for regulating the flow of the air; but I found from actual trial that the first suggestion was far superior, as it accomplished several purposes. Small blue blazes can be seen burning at these holes when firing. I do not like cold air to enter here, and suggest having the furnace arranged as in Fig. 5, allowing the air to come in contact with the fire walls and pass behind the plate. The hotter this air is the better. Close the bottom doors more or run a tight fire door and pull more air through this way for a month and compute the coal consumption. If this system is properly and carefully installed one will get good returns. Like other methods, it must be kept clean, but it can be easily kept in order.

The heated air coming in at this point will aid combustion greatly and a small observation door cut through the side wall will prove of much interest to observe the working condition, as the moment the front doors are opened the operation can be checked to a certain extent. I have inserted a 4-inch pipe as shown at *B*, Fig. 4, and having a small sheet-metal cap could observe the working condition. The proportions must all be kept within reason, and it works better on a high bridgewall, as shown. I have never experimented on a low wall and cannot say what the results would be.

C. R. McGahey.

Richmond, Va.

## Steam Jacket and Cylinder Condensation

In the unjacketed cylinder, steam enters at the beginning of the stroke much hotter than the cylinder. A portion of the steam is condensed in heating the metal to the temperature of the steam. Condensation continues as the piston moves, until cutoff takes place, when the steam begins to expand; its pressure and temperature falling as the piston moves forward, and the cylinder, already heated, begins to give up heat to the steam. As the expansion is carried to the end of the stroke, and the temperature of the steam is lowered, a portion of the steam condensed at the beginning of the stroke is reëvaporated by the heat given up by the cylinder, raising the terminal pressure. The exhaust steam, being cooler than the cylinder and absorbing heat from it during the return stroke, lowers the temperature, which is raised by the steam which enters at the next stroke.

The function of the steam jacket is to prevent cylinder condensation. The heat given up in the jacket, being absorbed by the cylinder, preventing condensation, and increasing the power of the steam to do work after cutoff has taken place.

The difference in temperature between the cylinder and the entering steam is much less than where no jacket is used. At the beginning of the stroke the cylinder will be at or near the temperature of the entering steam, and none will be condensed, as would be the case in an unjacketed cylinder.

The loss of heat by condensation would be less if the inside of the cylinder were kept dry, so there would be no reevaporation at exhaust.

In an unjacketed steam cylinder both the latent heat given up by condensation and the latent heat required for reevaporation are lost.

In a jacketed cylinder the only heat lost is the latent heat liberated in transferring heat to the cylinder.

If possible, the steam that enters the jacket should have a higher temperature than the steam that enters the engine cylinder.

The greater the steam temperature range in the cylinder, the greater will be the loss due to condensation.

If superheated steam of sufficiently high temperature is used, a steam jacket is not necessary and should not be used as such; however, it may be used to good advantage as a vacuum jacket to prevent external radiation.

The steam jacket should not be used on a cylinder which exhausts into the atmosphere or into a condenser.

The steam jacket should always be kept well drained, as its condensation does not reëvaporate but is, or should be, returned to the boiler with the feed water.

The actual gain effected by using a steam jacket is undoubtedly very small.

T. H. Goldburg.

Walpole, Mass.

## Free Technical Library

As an instance of the increased attention that is being paid to engineering and technical subjects in the more progressive libraries, a large room, formerly the reading room of the Free Public Library, of Newark, N. J., has recently been converted into the "technical and scientific department." The department is designed to meet the need of the working man and the student and contains about 6000 books and 300 periodicals on scientific, engineering and allied subjects. A file of the United States, English and Canadian reports is also kept, and a large collection of trade catalogs is open for reference. An added feature is the fact that most of the technical books are not for reference only, as might be expected, but may be borrowed for home use.

# Subjects Under Discussion

Comment, Criticism and Debate upon Various Articles, Letters and Editorials Which Have Appeared in Previous Issues

BRING OUT YOUR IDEAS

## Proper Amount of Lead

The letter from S. Kirlin, in the August 31 number, page 357, concerning the proper amount of lead, raises a very interesting question, viz., the reason for lead. Mr. Kirlin discusses this ably from the mechanical standpoint, but he leaves out the thermodynamic. No doubt an engine with sufficient cushion but no lead, or even with negative lead, might run with less friction, but it would lose much steam.

The office of lead is to supply steam for bringing the piston face and cylinder head up to steam temperature before the stroke begins. Boiler pressure cannot be had on the piston in a chamber with limited inlet, like an engine cylinder, until the surfaces are steam-hot. And these surfaces, with the water upon them, have just been at exhaust temperature a moment before. They absorb heat with tremendous speed. They are the cause of the one biggest loss in steam engine operation, cylinder condensation.

The bulk of all the surface, and all the surface water, too, which is concerned in cylinder condensation is open to the steam the instant the valve admits. The ports themselves and the faces of piston and cylinder head offer the most and the coldest of the surface ever uncovered to live steam. Since cylinder condensation commonly amounts to from 20 to 60 per cent. of the steam supplied to the engine, this is equivalent to saying that from 15 to 50 per cent. of the steam entering the cylinder must enter before the crank passes the center, else the piston will start on its stroke with only a fraction of boiler pressure behind it. This would of course involve great waste of steam, for the cylinder must ultimately be filled to boiler pressure anyway, while much of its work had been lost in entrance. So if we measure the angle swept through by the crank during admission, before and after dead center, respectively, or in other words the time of admission before and after dead center, we shall find that before dead center commonly ranging along some such percentages of the whole as those mentioned, although the figures vary widely with different types of engine, and frequently range outside those given.

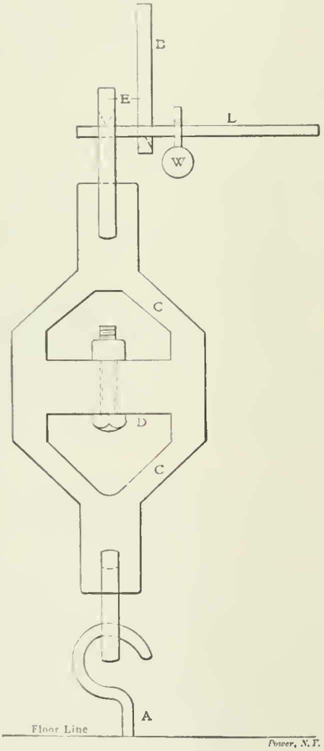
Thus the real element concerned in lead is time, or angle of crank motion; although for convenience it is commonly stated in linear dimension of valve travel.

Sidney A. Reeve.

New Haven, Conn.

## Safety of Pipe Fittings

In the August 10 issue, page 240, William F. Fischer instructs us in his diagram, Fig. 1, to screw down a nut to produce a tension of 1500 pounds on a bolt, and says that adding a weight of 1000 pounds causes no greater tension on the bolt, as far as the joint being made with or without a gasket is concerned, but that adding the extra weight will decrease the compression of the fittings by the stretching of the bolt.



MR. BUCKHALTER'S SUGGESTION

Suppose Mr. Fischer or any other engineer would experiment with a bolt that has a tensile strength of 1500 pounds, say a ½-inch bolt, having it in pieces as per Mr. Fischer's drawing, but arranged as follows: Let *A* be a convenient means of fastening to the floor, *B* a fulcrum for a lever and have *L* fastened to the ceiling *W* being the weight to be used on th lever to increase the tension, as require in the experiment. Now, screw down th nut on the bolt to produce 1200 pound tension, then gradually move out th weight on the lever until the bolt break Suppose the distance is 4 inches an the weight is 50 pounds; then the bol will break when the weight is moved ou 24 inches, thus showing that the strain i increased as the weight is added; but a the bolt stretches as the weight is in creased, it will relieve the compressio on the fittings because all of the weig that is added increases the force on t fittings, to pull the head of the bolt fro the nut.

Charles Buckhalter.

Philadelphia, Penn.

## Filing Clippings

From time to time I find suggestio on how to file clippings. Some of th are good, and I should like to subm an idea which I think is as good if better: Buy a 200-page standard invo book, costing about $1, and divide it i ten parts, using the first pages for most important clippings on boilers; t pumps, engines, valves, piping, dynam ice machines, wrinkles, etc.

On the front pages is an alphabeti index. Trim each clipping neatly, library paste on the top edge, paste it Record its title and the page number the index.

George Krame

New York City.

After reading for some time the arti regarding methods of filing clipping have come to the conclusion that the tem that I use has them all beaten. T years ago I purchased a loose-leaf bin with leaves and indexes, for two dol s, which has been the total outlay. W n I find an article of interest in the e i-neering magazines, of which I take e, I paste it in this book. If the ar le covers both sides of the paper, I l e it so it can be turned. If the paper is two articles of interest but on diff nt subjects, I file the paper under one head nd copy the other onto a page under ts own title.

If an article has a formula that is to e used frequently, it can readily be ken out of the binding for convenience. f the subject becomes out-of-date the ipping can be thrown away. When the nder is filled another can be bought and e indexed pages distributed in that, so hat the index will run through the two lumes and every article be readily und. By this system I have a reference k that is strictly uptodate and devoid t dead matter and formulas. My binder tains 200 pages and I have filed all les, formulas and articles of interest vering steam, gas and automobile engi- ering and machine design, and their d branches, that have appeared in WER and other technical and trade rnals for the past three years, and it t full yet.

While the envelop system has many of ese advantages, it is not as compact nor convenient.

H. K. WILSON.

Edgartown, Mass.

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In a recent number a contributor told s method of filing clippings, that is, ting them on loose leaves which are bered and indexed. This method is most compact and convenient for k reference only as far as any one ing is concerned. Instead of num- g the leaves and indexing the sub- ts (two motions), why not write the ect title on the upper right-hand r of each loose leaf and keep the es in alphabetical order, not bound? is method would require more leaves would group the subjects better.

y the method referred to the clippings pasted to the loose leaf, and when r appears on both sides of the clip- g it is either pasted at its edge only, e reverse side is copied on another leaf. The leaves could still be kept abetically.

e writer tears out "dead" clippings l presumably utilizes the spaces for clippings. This could not be done well if the leaves were kept in alpha- al order; but which is preferable, aving of space or a natural grouping ms on any one subject?

itting that envelops bulk more than leaves with clippings pasted on, knowing that there is a patented pbook in which there are leaves with ts so that clippings can be grouped, I prefer a specially made heavy nila envelop, size about 10x11 inches, on one 10-inch and one 11-inch side. I this envelop can be placed not only pings, but booklets or other data which uld be too bulky to place in a scrap- k. The subject title is written on the er right-hand corner of the envelop l the closed edges are at the bottom and nt. I place these envelops alphabetically on shelves. Old data can be thrown out, and more than one envelop can of course be used for one subject. The data are carried home and distributed among the envelops in the evening, or placed in a "distribute" envelop to be taken care of later. I admit that the distribute envelop is sometimes overloaded, and that the system becomes bulky through accumulation, but the same lack of time that makes this so would make a scrapbook bulky, even if it did not prevent pasting and indexing the clippings. This envelop plan has the big advantage of grouping subjects for quick reference, and of offering the easiest possible elimination of dead matter. A man can comprehend a subject more quickly when he can get hold of all the data on that subject at one time, instead of having to hunt up item after item by means of an index.

L. J. BERGER.

New Dorp, N. Y.

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The writer adopted a system of indexing which, after many years' perfecting, has become invaluable. Several methods suggested themselves, such as a series of envelops or notebooks indexed alphabetically, reading works of standard authors on various subjects, in which a marginal reference of volume and page of magazine articles could be made, etc., but the card index system was finally chosen. It grows as the library grows; cards can be removed when articles become obsolete. The cards can be reclassified.

There are several methods of card indexing. The "topical" classification, which I selected, divides and subdivides according to topics, the proper heading being on the guide cards and readily located.

I use an ordinary white card, 2x3 inches, 130 cards per inch. As the system grew, it was necessary to duplicate this small card by dividing a standard 4x6 card. It might be desirable to use a standard 3x5 index card, which could always be duplicated, but the small card costs less and needs less drawer room, and will be found large enough for a brief digest.

The guide cards were made 1/4 inch wider than the regular cards and the top trimmed to form a tab of suitable length for the particular heading, located so as not to obstruct the tabs on other guide cards.

When the system is started and the number of cards under many headings is small, the guide cards will be too close together. I used wood blocks the size of the card and of varying thickness to separate the guide cards, altering them as the index filled.

The cards are filed in a cabinet made by a manufacturer of sectional bookcases, and having large, shallow drawers, divided lengthwise by wooden partitions, into sections of suitable width. Before the system grew to its present size, a large tin tray, with tin partitions and made to fit the drawer of a roll-top desk, held the cards.

The classification will depend on the needs of each user. The index I use has three divisions, "Mechanical," "Electrical" and "General." To each is allotted a certain number of drawers. Each division is divided into sections, each representing some branch of engineering. The label on the front of each drawer shows the kind of cards it contains. The heads under each branch are on the tabs of the guide cards, and these are arranged in natural order. To illustrate: In the "Mechanical" division will be found "Steam Engineering," which will be labeled on the outside of the drawer. On opening this drawer we find the headings, "Coal," "Boilers," "Engines," "Turbines," "Pumps," "Condensers," "Piping," etc. As the system grows and the number of cards increase, subdivisions can be made and guide cards inserted in their natural positions. Following "Boilers" would be "Furnaces," "Stokers," "Injectors," "Safety Valves," "Scale and Corrosion," etc.

The various branches of electrical and mechanical engineering can thus be subdivided, and considerable skill will be required to make the proper classification and arrange the cards. It will be found convenient to have a "Technical" card in each branch, in order to file matter of a purely technical nature, also one marked "Unclassified," for articles which it is difficult to determine the proper heading.

In the "General" division will be found miscellaneous headings, such as "Legal," "Historical," "Statistics," "Bookkeeping," "Municipal Ownership," "Specifications," etc.

As the system grows many improvements will suggest themselves. One heading which will be found valuable is "Diagrams of Electrical Connections," under which are indexed sketches of apparatus and connections. Another heading is "Personal," under which will be indexed articles written by the indexer himself.

The index I use is entirely for technical magazines. Usually an article can be indexed from its title or after a glance through, but if the article is read a more extended entry is made. Frequently I make cross-references under several headings. This is often the case with central stations, isolated plants and transmission plants. Each of these has a separate guide card, with the name, location and special features noted. If the description of a plant includes heating, ventilating refrigeration, etc., in any valuable detail, a separate card is made for each. Volume and page numbers are written in the upper right-hand corner of the card, and if the article has received editorial comment, "Ed.," with page number, is added. A check mark is made at each article indexed, to assist in locating it and avoid indexing twice, in case the system is further extended.

If an article is [illegible] in later issues, the original article is indexed and any comments noted on the margin of the first article.

The magazines should be bound in a substantial though not necessarily expensive manner, and will be found more convenient to handle and ornamental to the bookcase. The publisher's volume number is used on the card unless there is likelihood of two conflicting, when a "1" is prefixed to one of them.

My scrapbook volumes are lettered, and catalogs and pamphlets are in cardboard letter files, with table of contents pasted on cover. No attempt has been made to index textbooks, they being arranged in groups on the shelves. The system requires but little time to keep it up. A pack of the cards lie on the reading table and are filled out during spare moments. It has saved a great deal of time which would otherwise be lost in looking up information.

LEWIS C. REYNOLDS.

Willard, N. Y.

## Expert Advice

What is meant by "expert?" Is it "skilful and dexterous?" It is interesting to read Messrs. Samuels' and Jackson's controversy as to the engineer's duties. When the steam plant is first contemplated by a company, is it not the custom to employ an expert to design the plant for the special work for which it is to be constructed? It should at least be so.

After the plant is laid out by the expert, the company looks for a stationary steam and electric engineer, who is expected to make good on all the specifications in the several branches of the plant, on which the expert has already fixed his seal of approval. As I understand it, this is the mode of conducting the business of construction.

So the engineer gets down to work with the expert designer, who dictates the birth of the "child" and names it after his grandfather or grandmother. On some bright sunny morning, the plant is put into motion and all are rejoiced at the new child's walking off.

But alas, the engineer is left alone to nurse the new-born child and bring it up to its full maturity according to the specifications which the father had planned. It has been said that the average steam engineer dare not know when the plant is on its best behavior, and cannot comprehend the real situation even if he is on the job 365 days out of the year. It makes little difference to the expert how many years he has given to the question at hand. There is always a slur at the engineer.

From my experience as steam engineer, I am of the opinion that the two gentlemen should go hand in hand and be men. There is room for us all to learn; each should have his due reward for his labor. You have undoubtedly heard of the painter who painted a knothole so plainly that the other fellow, a know-it-all, tried to put his finger in the "hole."

I could tell the readers of POWER of some practical work in our plant, as to economy and improvements, whereas many improvements that would have followed the ideas of the expert would have cost the company all its profits. I have recommended improvements this year, which were carried out at a cost of $10,000, and which will result in a saving of fuel and labor of at least $3485 per annum.

The maintenance of steam plants must be understood by the engineer in all the details, for the best interests of all concerned. He must not be afraid to illustrate his needs to his employer, and should not be considered the inferior of the consulting expert on matters of actual operation. Therefore, cut out all feeling of bad fellowship and come right down to hard pan and put each question where it honestly belongs. I say: "Live and let live," and ask that experts shall have some sympathy for "the man on the job."

GEORGE H. CHANDLER.

Kalamazoo, Mich.

A few more words in regard to "expert advice." Before a man is given an engineer's license he is asked where and what types of boilers and engines he has had charge of. If he satisfies the examiners he is given a license to take charge of a certain-numbered plant. Then, if he wishes to change to another, he is examined as to that particular kind.

The consulting engineer or "expert" may make a great improvement in a country place, where there is no license law; where an owner will almost take a farmer or truck-driver if he will work cheaply enough.

Mr. Jackson doesn't seem to recognize that the operating engineer of today is a different man than the operating engineer of twenty years ago. He must be a man of varied experience. The operating engineer of today is a trained philosopher. He knows the chemistry of combustion; he studies the elements of machinery, principles of mechanics, mechanics of fluids, strength of materials; takes a course in mechanical drawing, is able to lay out his whole plant and supervise it, and if necessary fit it up himself; is able if need be to take the shovel out of his fireman's hands and get the best economy per pound of coal used. He makes his profession a life study, sounds it from top to bottom. This practical experience the so-called expert doesn't get.

The first-class engineer of today has been from plant to plant and got his training in actual contact with different machines and different men. He has his technical magazines, describing the best-managed, best-equipped plants in the country; reads practical letters from practical men; applies the points when advisable to his own case. He has access to the correspondence schools, with some of the ablest practical engineers in the country for teachers.

I agree with Mr. Jackson in his definition of an expert, and I say the real engineer gets all this before he gets a license to take charge, at least in New York City.

I took a dictionary to define the wor "expert" because every word has a correc meaning, and I wanted to show that th man who merely visits plants is not th expert. I wanted to show, and think did show, that the operating engineer i the real expert. Actual practice develop a good fireman into a good enginee and an engineer who makes good in on plant, ninety-nine times in one hundre makes good in another.

I have had a good deal of experien with consulting engineers, and have four that they will let you effect great savir and hand the credit over to them. Th is distasteful to a practical man who h put in say thirty years and gone throu every branch of the science.

H. E. SAMUELS

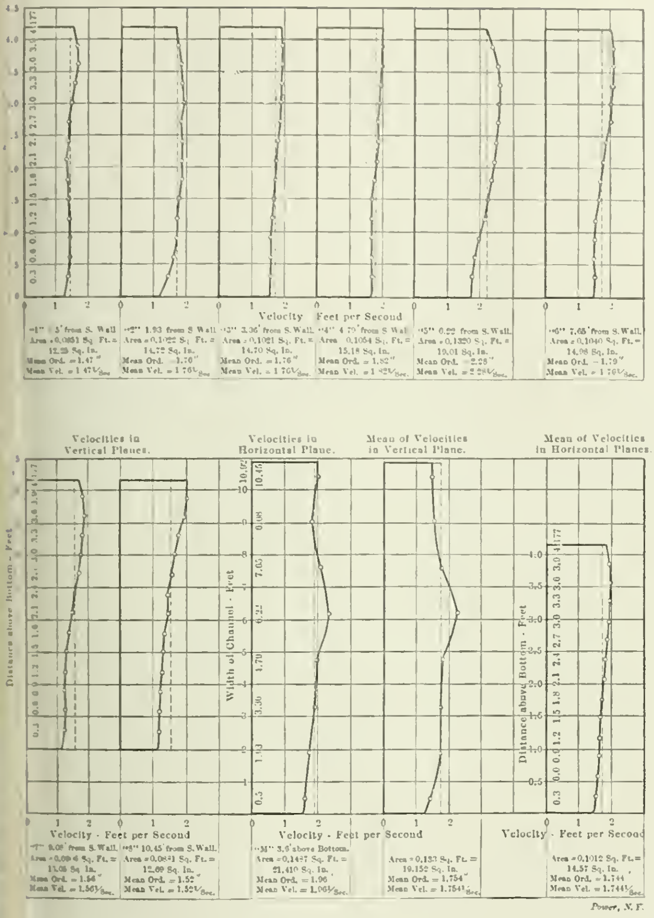
Brooklyn, N. Y.

## Test of Large Sewage Pumpin Station

In an article describing tests made the centrifugal and screw pumping u at the Thirty-ninth street sewage-pun ing station, Chicago, which was publisl in the August 3 number of POWER A THE ENGINEER, there were printed t tables of current meter observatic Table 1 was a summary representing average of each of the 104 meter p tions in the cross-section of the cent ugal-pump channel, for the full test d tion of 24 hours; and Table 2 sho averages for the same period at each the 120 positions in the screw p channel.

From the former were plotted thirt velocity curves, one of each horizo level above the bottom of the meas section, and eight velocity curves, one each vertical plane. From the latter s mary fifteen horizontal velocity cur with reference to average discharge w level, and eight vertical-velocity cu were similarly plotted.

Since the article appeared criticism been made that it does not show the st valuable feature of this part of the t viz., how the velocity curves were plo d. Hence the writer has had those for e centrifugal pump copied from the ori al record, in convenient form for pub a- tion, and they are reproduced herewith.



*Power, N. Y.*

FIG. 2. VELOCITIES IN VERTICAL PLANES

the screw pump the corresponding curves were made in the same manner.

The value of the tests made at the Thirty-ninth street station, so far as engineers generally are concerned, lies in the accuracy, the simplicity and the thoroughly uptodate character of the methods employed. Consequently, a careful study of the details, as described, will well repay those who have to do with municipal problems involving the pumping of water or sewage.

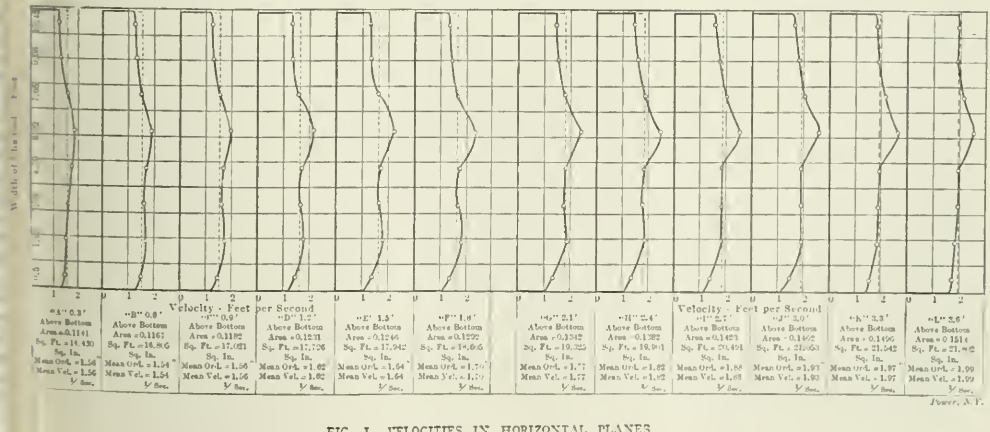
SIMPSON RICE.

Milwaukee, Wis.

## A Talk on the Economizer

I have just read the talk on economizers, by Warren H. Miller, in the July 27 issue, and thought readers might be interested in the experience of others along the same line.

In the first place, the furnaces used by Mr. Miller for burning soft coal must be of an inefficient type, or they are not properly handled. The economizer in my plant has now been running for twelve years, using soft coal only, and I have had no trouble from clogging or sticking of the scrapers. I have known of such troubles from imperfect combustion and the accumulation of tarry deposits on the tubes, but I believe it can always be avoided if the furnaces are properly operated. Even if it does occur, the hardened deposits can be scraped off periodically, after removing the sectional covers and using special tools, if need be, for the purpose. If the economizer is walled in so that such cleaning is not easily practicable, the coat of soot can be burned off by emptying the economizer of water and passing the hot gases through the chamber as in regular operation. This, however, is an operation which requires some care and I would not recommend



*Power, N. Y.*

FIG. 1. VELOCITIES IN HORIZONTAL PLANES

that it be undertaken by inexperienced persons.

In no case should the scrapers be run only for part of the time, as suggested by Mr Miller. That the amount of power consumed for driving the scrapers is insignificant is evident from the fact that the driving shaft can be turned readily by hand. As for the scrapers getting into bad condition, so that a number of the chains slip on the sheaves at the end of each trip, I can only say that an economizer should not be allowed to reach such a condition, while, if the scrapers get out of adjustment, from any cause, they are easily shifted by lifting up the chains and slipping them on the pulleys, or, as on the economizer in our plant, by loosening the set screw by which the worm wheel drives the sheave and then shifting the sheave to the desired position.

Cleaning the insides of the tubes can be avoided entirely if the proper amount of soda ash is fed with the water. I doubt if any sulphate scale forms in economizer tubes, anyway, as quite an amount of this substance, probably more than you find in most boiler-feed waters, is soluble up to about 250 degrees Fahrenheit. Although our water is moderately hard we have never had occasion to bore the tubes out, which we attribute to the regular use of soda ash and regular blowing down. We find that the blowing down removes quite a quantity of sludge, in spite of Mr. Miller's statement to the contrary.

The profit from putting in an economizer will depend, as Mr. Miller points out, to a large extent upon the cost of keeping it in running order. When we purchased our economizers twelve years ago, the builders offered to keep it in repair for 1 per cent. of the cost per year. We turned this proposition down and have never been sorry that we did so.

As to the actual amount of saving, I would say that Mr. Miller is taking a very low figure for the flue-gas temperature when he assumes 400 degrees Fahrenheit. This will be evident when it is remembered that the temperature of steam itself at 175 pounds gage pressure is 377 degrees Fahrenheit, and the boiler would need to be very large indeed to bring the gas temperature down so close to boiler temperature.

In our plant we have two boilers and develop regularly from 150 to 200 horsepower, although this means operating the boilers at about twice their normal rating. In fact we regularly take 125 horsepower from an old 60-horsepower return-tubular boiler, and we have found that we cannot run the shop at full capacity without having the economizer connected. Our coal bill last year was $3655.91, and as the rise in temperature of our feed water varies from between 120 to 150 degrees Fahrenheit, we are saving about $493 per year, which is a pretty good return on an investment of only $1150. As for the cost of maintenance to be deducted from this, we have fortunately had no repairs or replacements and the work of cleaning cannot be considered separately, as the fireman does it without extra pay, usually on Sundays, when he is overhauling the boilers. The results we have obtained are against Mr. Miller's finding that the economizer does not pay except in plants above 500 horsepower capacity.

Finally, I heartily agree with what Mr. Miller says about making economizers accessible and providing sufficient room to permit giving them the care which they require. Architects and engineers who design boiler plants sometimes seem to forget the poor operating engineer.

FRANK J. MCMAHON.

New York City.

# Trouble with Seams over Bridgewalls

In regard to E. F. Bruno's "Trouble with Seams over Bridgewalls," in the August 17 issue, I suggest that he look for the cause of the trouble. There must be something seriously wrong to require riveting the boiler seams seven times. The boilers are probably suspended by three brackets on each side, and, if the pillow blocks do not allow for the unequal expansion of the boiler shell, most of the weight of the boiler and its contents is at times thrown on the two middle brackets, which throws a great strain on the girth seam over the bridgewall. Or it might be caused by the boiler being set too low over the grates, or the bridgewall being too high.

Whatever the cause, if the boilers are in good condition, with the exception of the trouble mentioned, I think it would be best to make the repairs as the inspector suggested, but if the boilers are not otherwise in first-class condition, it would be a good deal cheaper—and well enough for the life of the boiler—to make the repairs according to his own idea, being sure to have the patch put on the inside, as some boilermakers prefer to put it on the outside to make the work easier, which of course results in the bagging of the boiler, sooner or later.

The indicator diagrams are pretty good, in fact better than the average taken from the modern engine. I have figured out the horsepower and find it to be 121.2 for the crank end and 114.3 for the head end. From this, and the shape of the diagrams, it is seen that the cutoff should occur a little earlier on the crank end, and the admission a little later on the head end.

I think it would be perfectly safe, as far as the flywheel is concerned, to increase the speed of the engine to 85 revolutions per minute.

J. H. JACOBUCCI.

Rawlins, Wyo.

# Kerosene in Boilers

James C. Mellen's article in the Augu
24 issue contains some very interestir
points regarding the use of kerosene
a scale remover. In the first place, w
are living in an age of advancement, a
methods and ideas of twenty years a
have proved to be absolutely wrong. F
instance, it seems to me to be absurd
imagine that kerosene will harden sca
as is implied by the suggestion that
was impossible to remove the scale fr
between the tubes after kerosene had be
used. If such a condition had exist
and the scale could be removed bef
using the kerosene, why was it nec
sary to remove the tubes continuously

A few years ago I took charge of a b
tery of boilers which were badly scal
and began a systematic method of cle
ing by the use of kerosene oil.
emptied boiler No. 1 and found it to
so badly scaled that it was necessary
drive in the handhole plate with a he
stick of wood. A gallon of kerosene
put into this boiler, which was 66 inc
by 16 feet in length (tubular) bef
any water was put in. This gave
kerosene a chance to come in contact
the scale as the water level of the b
rose when it was being filled. A s
fire was maintained under this boiler
three or four days, and a light pres
of steam carried. After that we
tempted to blow off the water but t
was "nothing doing" and it became
essary to remove the manhole plate
siphon the water out with a length of
hose. After the water was out, we
moved the handhole plate and discov
that a large quantity of scale had be
detached. The kerosene had worke
tween it and the shell. An illustrati
this may be had by applying kerose
a nut on a rusty bolt. This loos
cumulation of scale had completely st
up the blowoff pipe and had also s
in large quantities on the bottom o
boiler. We cleaned out the boiler an
plied the treatment to all the boiler

Mr. Mellen's statement that the
fits attributed to the use of keroser
more frequently due to the more fre
use of the blowoff is decidedly
my experience has proved. Had I
those boilers down every fifteen m
the scale would still have remained.
not want to be quoted as having
that the indiscriminate use of keros
right in every case, as I believe that
scale troubles occur a careful a
of the feed water is desirable,
scale solvent should be compoun
neutralize the scale-forming proper
the water; but to say that kerosen
remover (not a preventer) of s
worthless is absolutely wrong.

CHARLES H. TA

Bridgeport, Conn.

# The National Engineers' Convention

## Twenty-seventh Annual Meeting of the N. A. S. E. at Columbus, Sept. 14-18; Ladies' Auxiliary and Ohio Association Also Meet

## THE EXHIBITS THE BEST YET

The opening exercises of the convention took place in the auditorium of the Board of Trade at 10:30 a.m., September 14, with Charles M. Gilbert, chairman of the local convention committee, presiding. After invocation by Rev. P. H. Fry, Governor Judson Harmon, of Ohio, was introduced. In welcoming the delegates and their friends to Ohio the governor paid a glowing tribute to the character and work of the stationary engineer, his standing and place in the industrial world. Response to Governor Harmon, in behalf of the N. A. S. E., was made by National President Fred J. Fischer, of Los Angeles, who declared that even the warmth of Western hospitality had been outdone by the warmth of the governor's welcome.

Past National President Joseph F. C[illegible]ey then spoke with reference to the satisfactory progress that had been made by the organization in the twelve years since the national body had met in Columbus.

In the absence of Mayor Bond, George S[illegible]rhall, city solicitor, welcomed the convention to the city, and paid a high compliment to the attainments of the modern engineer. Response to the mayor's representative was made by National Vice-President William J. Reynolds.

In the afternoon session the preliminary report of the credential committee was followed by the address of President Fischer. In the course of the address many important suggestions for the good of the order were made. One of the interesting features of this session was the awarding of the prizes by the educational committee, the first prize of $25 going to Illinois No. 28, of Chicago, with a percentage of [illegible], the second prize, $15, to Illinois No. [illegible], of Moline, with a percentage of [illegible], and the third prize, $10, to Massachusetts No. 17, of Lowell, with a percentage of 96.70.

One of the important matters discussed at the Thursday morning meeting was the report of the pension committee, on the proposition of establishing a pension fund for the support of indigent engineers who through sickness, accident or old age are unable to support themselves, as proposed by the Ladies' National Auxiliary of the N. A. S. E. A motion was adopted referring the matter to the committee on ways and means.

Proposals for publishing the *National Engineer* for a period of five years commencing January 1, 1910, were received, the contract finally being awarded to L. L. Rice, of Philadelphia.

Niagara Falls, Mobile, Rochester, Put-in-Bay and Atlantic City were bidders for the 1910 convention, and after a spirited session, during which several ballots were taken, Rochester was selected as the place of next meeting.

In the Life and Accident department the auditing committee reported all books, papers and accounts correct, with 2886 members and a balance in the treasury of $3312.73. Nine candidates were in the field for the office of secretary-treasurer, J. Douglass Taylor, of New York City, winning on the final ballot.

Election of officers of the National body resulted as follows: W. J. Reynolds, of Hoboken, N. J., president; Carl S. Pearse, of Denver, vice president; Fred W. Raven, of Chicago, secretary; Samuel B. Forse of Pittsburg, treasurer; A. C. Strickland, of Richmond, Va., conductor; Gilbert J. Gibney, of Mobile, Ala., doorkeeper; trustee of the *National Engineer* for a period of five years, William M. McLean, of Boston.

Altogether there were about 400 delegates in attendance.

### The Ladies' Auxiliary

All the sessions of the twelfth annual convention of the Ladies' Auxiliary were held in Convention hall, Southern hotel. The convention opened with a violin solo by Master Edwin Shoemaker. This was followed by prayer by Rev. D. A. Clark.

The address of welcome was delivered by Mr. Wirmel and the response was by Past National President Matie E. Van Arsdale.

Three vocal solos by Mrs. Clark Elliott were greatly enjoyed, when, after another violin solo by Master Edwin Shoemaker, Rev. D. A. Clark gave a very able address.

A pleasing feature of the session was the presentation to National President Weaver of three souvenir spoons, a gift from the Illinois auxiliaries: Peoria No. 1, Peoria; Alcyon No. 2, Chicago; and Excelsior No. 3, Chicago. The president responded in a feeling manner.

Election of officers for the ensuing year resulted in the choice of the following: Mrs. Dora Weaver, Columbus, past president; Mrs. Nella C. Moore, Worcester, Mass., president; Mrs. Daniel Delaney, Cincinnati, vice-president; Mrs. Margaret A. Flynn, Chicago, recording secretary; Mrs. Emma L. Stone, Framingham, Mass., treasurer; Mrs. Anna C. Tetlow, Chicago, conductor; Mrs. Ella Mansfield, Denver, chaplain; Mrs. Ellen A. Hogan, Boston, doorkeeper.

### Entertainment Features

Entertainment features were not lacking, and included a visit to Olentangy park, the city pumping station and filtration plant, trolley trips about the city, a smoker, a lecture on "Metallurgy as Applied to Steam Valves and Fittings," by George K. Elliott, of Cincinnati, and a vaudeville entertainment at Memorial hall.

One of the entertainment features which was especially appreciated was a minstrel show by the Euterpean Ladies' Chorus, at the Southern theater, given with the compliments of the local Ladies' Auxiliary.

A baseball game between the packing men and valve men of the Exhibitors' Association was another interesting feature. The valve men won, 11 to 7.

### National Exhibitors' Association

The new officers of the National Exhibitors' Association were chosen as follows: William G. Le Compte, of Jenkins Brothers, president; William D. Purcell, of Quaker City Rubber Company, vice-president; Harry Ashton, of the Ashton Valve Company, secretary; M. B. Skinner, of the James McCrea Company, treasurer; executive committee—Hudson Dickerman, of the Vanda Company; Robert E. Hills, of the Hills, McCanna Company; Frank E. Ransley, of Greene, Tweed & Co.; G. D. B. Van Tassell, of the Westinghouse Machine Company; Homer Whelpley, of Strong, Carlisle & Hammond Co.

On Friday evening the convention was brought to a close with a grand ball at U. C. T. hall. The adjourned meeting of the morning was taken up and the new officers installed. Following the installation Past President Fred J. Fischer was presented by his friends in the association a magnificent silver service and by the organization the official past presidents' gavel. The silver service consisted of more than fifty pieces of flat silverware in handsome mahogany cabinets. Following this ceremony incoming President Reynolds was presented a handsome ivory gavel, with silver bands and inscribed: "Presented to William J. Reynolds, by his friends, 1909."

The installation of the Ladies' Auxiliary followed that of the regular association, after which Past President Mrs. Dora L. Weaver was presented a handsome cut glass water service, by her friends of the auxiliary.

The Exhibitors' Association presented retiring President Herbert E. Stone a magnificent gold watch, chain and Masonic emblem, as a token of their esteem, and to Vice President Purcell a purse of $500 in recognition of past services, and also gave a gold medal to Past State President Walter H. Damon, of Massachusetts.

### THE EXHIBITS

The mechanical exhibit in Memorial hall was declared to be the largest and finest ever held at an N. A. S. E. convention. Following is a list of the exhibitors and representatives:

Fairbanks-Morse Company, Cleveland-Cincinnati branch, fire, steam and power pumps. H. W. Vine, B. M. Brooke, J. F. Reeves.

Homestead Valve Manufacturing Company, also Columbus Mill and Supply Company. P. L. Rhodes. Souvenirs, paper cutter and blotter.

The Brownell Company, engines and boilers. H. V. Neff. Souvenir, magnetic splinter remover.

Liberty Manufacturing Company, tube cleaners, "Twin" strainer-separators, feed-water regulators, oil filters, water columns. G. R. Noble, assistant sales manager; H. A. Pastre, special; D. S. Tucker, Cleveland manager. Souvenir, leather notebook.

Buckeye Engine Company.

Leadville Mining and Improvement Association, lead and silver ores and tripoli. N. N. Robertson.

George W. Lord Company, boiler compounds. George W. Lord, Edward McCarthy, C. M. Brown, William Hulverstone, B. L. Lord. Souvenirs, leather purse and barrel watch charm.

H. B. Underwood & Co., cylinder boring machine, portable crank pin turning machine, "St. John" cylinder packing, vacuum dashpot, safety suction valve for ammonia compressors, etc. E. J. Rooksby, E. C. Crawford. Souvenir, book of useful information.

Ohio Grease Lubricant Company, grease lubricator and grease. F. W. Rogers, W. S. Hissem, J. C. Ross, G. Mull, E. E. Miller. Souvenir, cigars with company's own band.

Northern Equipment Company, "Copes" boiler-feed regulator. J. D. Pounds, L. S. Taylor, L. J. Murray. Souvenir, cigars.

Manning, Maxwell & Moore, Ashcroft Manufacturing Company, Hayden & Derby Manufacturing Company, Consolidated Safety Valve Company, Hancock Inspirator Company. L. M. Brigham, C. Monroe Smith.

General Electric Company, direct-connected turbo-generator unit, switchboard and tungsten lamps; fans, new luminous magnetite arc lamp, heating devices, etc. T. V. Gantt, Cincinnati; Dr. Loewinstein, of steam-turbine department, Lynn, Mass., engineering department; W. S. Culver, Cincinnati.

Pilley Packing and Flue Brush Man
facturing Company, tub. cleaners, packin
"Briggs" packing gage and gasket cutt
M. E. Briggs, Grant J. Rawson. Souven
watch fob.

Bayer Soot Blower System. F. Walk
Maury, E. R. Blacksham, George S. Bak
Souvenir, pencils.

Westwater Supply Company, "N
Century" chain hoist. D. O. Reinohl.

*National Engineer.* S. J. Hamilton, E. Reilly, F. M. Bailey, J. W. Lane, S. Kenfield.

Westinghouse Companies, portable n
tor-driven air compressors, steam-driv
air compressor. S. H. Mills, T. H. Par
Pittsburg; R. W. Williams, Cincinn

DELEGATES AND VISITORS TO THE N. A. S. E. AN

M. H. Burchard, G. D. B. Van T.
Chicago. Souvenir, watch fob.

Trill Indicator Company, indicator
L. Trill, L. T. McElroy. Sou
patented hook for indicator cord.

Sight feed Oil Pump Company,
feed oil pumps. W. E. Richardson
waukee; L. G. Finlay, Cleveland. S
nir, paper clamp.

Revere Rubber Company, packin
W. Dudgion, A. C. Kingston, L. H.
Souvenir, watch fob.

McLeod & Henry Company, boile
arch, arches and jambs, "Foote's'
combustion arch. John H. Foot
manager New York office; John H.
Jr. Souvenir, cigar lighter.

Anchor Packing Company, "
sheet, automatic expansion plunger.
and semi-metal packings. F. A.
Detroit; F. G. Bremer, Columbus

Patten, Cincinnati; E. H. Morrison, Philadelphia; J. F. Edwards, Pittsburg.

Morehead Manufacturing Company, return, nonreturn and vacuum steam traps. M. L. Abrahams.

New York and New Jersey Lubricant Company, nonfluid oils. J. D. Kelvie, New York.

Hills, McCanna Company, force-feed lubricating pumps. R. T. Hills, W. R. Bosson.

L. G. Finlay & Co., Turbo-Blowers, Blackburn-Smith feed-water filter and rease extractor. L. G. Finlay. Souvenir, esk clamp.

A. W. Cadman Manufacturing Comany, Cadman blowoff valves and alumi-

Cleveland Feed Water Regulator Company, "Cleveland" boiler feed water regulator. R. J. Bissett, J. B. Youngblood.

Penberthy Injector Company, "Penberthy Engineer and Fireman." George S. Hammond

Desmond Stephan Manufacturing Company, Desmond injectors and brass goods. H. H. Dowell, A. C. Miller. Souvenir, union-nut paper weight.

Dodge Manufacturing Company, water softener. George W. Matthews, W. E. Galway, "Bert" Richards.

Concos Manufacturing Company, "Concos" metal polish. H. Harmstad.

G. M. Davis Regulator Company, Davis

B. M. Bulkley Souvenir, "Palmetto" cigars.

Albany Steam Trap Company, "Albany" return and nonreturn traps. Thomas F. Ryan. Souvenir, post cards.

Philadelphia Lubricator and Manufacturing Company, grease cups. John F. Lewis. Souvenir, deck of cards.

Joseph T. Ryerson & Son, "Morrison" corrugated-furnace boilers. "Glyco" process bearing metal. J. T. Corbett, Lewis E. Skinner. Souvenirs, paper weight and key puzzle.

Mound Tool and Scraper Company, scraping and packing tools. A. F. Langenohl, W. R. Kosching. Souvenir, letter opener.

NVENTION AT COLUMBUS, O., SEPTEMBER 14-18, 1909

m babbitt metal. R. W. Cadman, A. . Cadman. Souvenirs, pencil and comb.

Western Kieley Steam Specialty Comy. Kieley steam specialties. E. N. rphy.

Ashton Valve Company, Ashton pop s and gages. Harry H. Ashton, umbus Dill. Souvenir, pen and pencil.

Hawkeye Compound Company, boiler pound. H. E. Tribbles, W. F. Ebert, S Dodge, Theodore Brommenschenkel, E Cook, J. P. Everitt, R. S. Everitt. uvenir, "Hawkeye" watch fob.

Diamond Rubber Company, packing and bber goods. W. E. Hardy, David Pearn, Jr., J. R. Bailey. Souvenir, the iamond Girl" picture.

William Powell Company, Powell valves d brass goods. Charles E. McFarlan, harles Cullan. Souvenir, "White Star" b.

pressure-reducing valves, Davis steam trap. J. C. Kinsley, M. D. Neely.

Cling Surface Company, "Cling Surface." W. D. Young. Souvenir, puzzle card.

Keystone Lubricating Company, "Keystone" grease. C. A. Hepper, L. L. Lacey, T. W. Armstrong, C. M. Gilbert, M. B. Urquart, L. A. Christian. Souvenir, clothes brush.

American Steam Gauge and Valve Manufacturing Company, recording gages and indicators. E. H. Webster.

George H. Thacher & Co., Coe sectional shaking grate. George H. Thacher, Jr.

The Griscom-Spencer Company, Reilly multicoil feed-water heater, Reilly (Ebsen) grease extractor. R. J. Pabodie.

Greene, Tweed & Co., "Palmetto" packing, "Favorite" wrench. F. E. Ramsley,

*Mining World.* J. W. Holman, P. J. Cosgram.

POWER. F. R. Low, C. W. Dibble, "Jack" Armour, F. L. Johnson, O. Monnett, A. J. Bamford, C. N. Beard, J. B. Barrowman, W. B. Sellers, G. W. Beattie.

Under Feed Stoker Company of America, Jones under-feed stokers. William T. Johnson, W. R. Faben. Souvenirs, mirrors and Jones stoker paper weights.

Erie Foundry Company, "Erie" stokers. J. A. Leiter, J. S. Van Cleve.

Lagonda Manufacturing Company, tube cleaners. "Pat" Malloy, W. J. Patterson, J. H. Johnston, H. F. Weinland, C. F. Overly, Oliver Hanse, E. E. Hauer, M. M. Sellers. Souvenir, key tag.

Peerless Rubber Manufacturing Company, "Rainbow" sheet and "Peerless"

*(Continued on page 550)*

POWER
AND THE ENGINEER

DEVOTED TO THE GENERATION AND TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

John A. Hill, Pres. and Treas. Robert McKean, Sec'y.

505 Pearl Street, New York
355 Dearborn Street, Chicago.
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of Power solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "Powpub," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During* 1908 *we printed and circulated* 1,836,000 *copies of* Power.

*Our circulation for August* 1909, *was (weekly and monthly)* 174,000.

| | |
|---|---|
| *September* 7 | 42,000 |
| *September* 14 | 33,000 |
| *September* 21 | 33,000 |
| *September* 28 | 33,000 |

*This paper reaches* 42,000 *separate readers each month and* 33,000 *each week.*

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*

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## Watch the Safety Valve

Not long ago a locomotive boiler exploded at Cardiff, England, resulting in the death of three men and injuring an equal number. The engine in question was of the eight-wheeled, six-coupled type of large power and had been built only a year previous for a working pressure of 160 pounds gage. It had twice been tested by water to 240 pounds without producing any permanent deflection, once with steam to 180 pounds, and from all appearances was well made from excellent material.

The boiler exploded under unusual circumstances. As briefly expressed in *The Engineer*, of London, there were two Ramsbottom safety valves on a cast-iron manhole cover. The joint leaked, and in remaking the joint it was necessary for the steam fitter to dismount the safety valves. The joint was made, the valves put back in place and a report made to the foreman. Next day the engine was taken out in the yards, and in a very short time the pressure gage indicated 200 pounds, with the hand pressing hard against the stop. There was plenty of water in the gage glasses, although the injectors had refused to work. Before long the gage glasses broke and the engine was taken back to the shed. Two men began to drop the fire, and at this moment the boiler exploded.

From the facts that, although the safety valves were loaded to begin lifting at 145 pounds and blow hard at 155 pounds, they would not move; that the pressure was too high for the injectors to work and broke the gage glasses, it is apparently conclusive evidence that the boiler exploded from over pressure, caused by the nonoperation of the safety valves. To make this supposition more plausible, it is explained that all Ramsbottom valves are fitted with a safety link to prevent the valves and lever from being blown away if the spring breaks. Washers of various thickness are used to regulate the tension on the spring, and adjustment is always made to give the slot in the safety link ample clearance. It is only natural to suppose that the fitter, who was called away from the job several times, got confused about the washers and put the thick washer above instead of below on the central pin. This would lock the valve hard down on its side, and explain clearly the cause of sticking fast.

In American stationary practice there are no valves, to our knowledge, of similar make, in which by an exchange of washers it would be possible to lock the valve tight to its seat. It is easily possible, however, to have the same condition arise from various causes. In many plants the safety valve blows only at rare intervals. Such an occurrence is looked upon as waste of steam, and the result is, that the engineer is never positive of the valve opening at the pressure for which it is set. It is not an uncommon occurrence for a valve of the old lever type to stick fast to its seat either from corrosion or wedging, and even in the pop safety valve some defect might seriously interfere with its operation.

It is surely no great hardship, nor an extravagant waste of coal, to try the safety valve at least once a day. Raise the pressure to the point of blowing and note the gage. The safe side is best, and a knowledge that all is right will repay the effort.

## Seaweed and Condensers

The engineer who runs a plant upon
the seashore can usually tell a story o
condenser troubles due to the clogging
the suction mains by seaweed. No sor
of cribbing or screening has been yet de
vised which will at the same time kee
the marine growth out and let the wate
enter with sufficient freedom.

This apparently trivial factor has bee
the most important difficulty with whic
the Redondo station of the Pacific Ligl
and Power Company has had to conten
This is a beach plant located at the se
shore town of Redondo, eighteen mil
southwest of Los Angeles. The pla
proper is situated quite a distance ba
from the surf line.

It would be impossible on account of tl
variation in the beach contour, duri
storms, to employ a canal system or
tunnel or conduit system for the circul
ing water. It has been necessary to u
a circulating-water suction line carr
on a pile trestle considerably above t
high-tide or wave line. The length of su
tion and return lines totals about 17
feet. Even at the distance which tl
wharf is carried out into the ocean, it
impossible to place the suction inlets
any considerable depth below mean l
tide. During the storms, which are f
quent, the ocean bed is scoured out, or
sand is piled up to a depth of from
to 10 feet, and the suction inlet must
free from hindrance due to these s
drifts.

The seaweed accumulates in great qu
tities, and during certain seasons of
year there are beds of kelp which ext
for miles and are carried up and d
the beach line by the ocean currents. T
kelp and seaweed extends to an apprecia
depth below the water's surface and
certain seasons of the year is so thick t
the large strainers (approximately 6
in diameter by 20 feet in length) bec
packed tight and the entire suction
from the beach back to the inlet
filled solid with this mass of seaw
There is no system of straining ever
vised and so far thought of that wo
seem to take care of this accumulat
and permit a continuous operation of
circulating lines.

Those who have been to Catalina island off the coast of southern California, and have gone around in the glass-bottomed boats, have been shown a dense submarine growth of almost limitless variety. In the warm water of southern California this marine growth thrives, and seems to shed its foliage at different seasons of the year, and during storms, giving an almost continual annoyance in the operation of the circulating lines. During certain months of the year, the accumulation of seaweed is such that with duplex lines it is possible to alternate these lines, cleaning the strainers every few hours, and get a fairly continuous supply of circulating water. There is a considerable period of the year, however, when even with a large crew of men it is impossible to clean the strainers with sufficient rapidity to overcome this nuisance.

It would appear to a layman that by building a pierhead of piles or something of the sort around the suction intakes, all troubles due to seaweed would be overcome. Engineers acquainted with the conditions tell us, however, that during storms the quiescence inside of this pierhead would cause the sand to fill into it and the flow of water thus would become stopped. There would also be an accumulation of marine life, crabs and the like, which would grow inside of this enclosure and eventually cause trouble. The inlet portions would become clogged and the flow materially impeded. In addition to the larger varieties of seaweed, there are vast quantities of a fine sea grass which flows endwise in the water, and which would penetrate the finest screen that could be reasonably used. This grass accumulates in the water boxes of condensers, making it necessary for frequent shutdowns. At Redondo, having two condensers upon each unit, they clean one condenser at a time, operating both sides of the engines on the second condenser during the cleaning process. Such a process would be impossible with a turbine station, as ordinarily equipped, having one condenser per turbine.

Under this condition of affairs a steam turbine would simply lie down, making it necessary to reduce considerably the load of the plant. A turbine recently purchased for a Pacific Coast plant has a guaranteed peak load of 15.000 kilowatts when running condensing. The maximum load guaranteed for running noncondensing is 7500 kilowatts. Even then, it takes practically the same amount of steam that it would take under peak load condensing.

Were the turbine to operate noncondensing with no cutout valves between the turbine and condenser, the condenser would become overheated, with the result familiar to all marine engineers. On resuming operation of the circulating water, it would be found that most of the tube packings would leak and the trouble due to salt in the boilers would be very serious. It is the belief of the designers that if turbines were installed at the Redondo plant, with one condenser per turbine and without cutout valves, they would simply find the troubles due to salt water in boilers so great that they would shut the turbines down rather than operate noncondensing, and this opinion is held by others on the coast who are operating turbines.

## Power Plant Jumbles

Simplification and standardization are two elements which should have a great deal of weight when proposed power plants are being considered. The idea should not be carried to extremes, however, as the most simple device is not always the most efficient, and because a certain device will serve for one purpose is no reason that it will do equally as well for another of somewhat similar nature.

The slide-valve engine is simple in construction, when compared with a Corliss type of engine, but it is not to be compared with it in the matter of efficiency. An old cylinder boiler will produce steam, but is not considered at all suitable for a modern steam plant.

Standardization of equipment is desirable, both from a financial and an artistic standpoint. Take the boiler room of a power plant, regardless of dimensions, if the boilers are of the same design and size they make a less expensive installation than as if they were of different sizes and of many makes. Naturally it is less work properly to install them as the layout for one battery; also, the piping and fittings of one will be duplicated in the other, and the necessary supply parts for renewals will be suitable for any boiler in the plant, thus eliminating the necessity of keeping in stock a large assortment of spares.

As an illustration of this point, a certain power plant has in its construction a curious collection of apparatus of which a number of different manufactures are represented. The old adage of "try, try again" had evidently been adhered to, on the part of the chief engineer, as there are return-tubular boilers, several types of water-tube boiler, slide-valve engines and turbines, and a fine array of auxiliaries. Picture such a plant, and then contrast it with one where the boilers are all of the same size and make, the engines of the same type, even though they may be of different sizes, which is necessary for economy. The one represents an old curiosity shop, the other an uptodate business enterprise.

Such methods of power-plant design savor greatly of the methods employed years ago, when a plant was put in and, owing to lack of foresight or ignorance on the subject, the demand soon became greater than the capacity of the plant. This resulted in an additional unit to take care of the increasing load, the process being repeated as the load increased. When all available space had been occupied the building was extended and the collection of boilers, engines and generators added to again.

Under such conditions economy could not be obtained, and it is small wonder that many of the smaller installations, after struggling along for years, gave up the fight and either abandoned the field or built more modern plants with greater unit output and of a standard design.

That such methods should be followed today is assuredly a lack of judgment, and while the idea may not be carried quite so far as it was in the old design of steam plant, the germ is present and frequently develops into an undesirable reality.

It may crop out in the matter of condensers, where several different designs are installed, or in the design of pumps for supplying the cooling water, feed water to the boiler, or other purposes. There is scarcely a steam plant in which cannot be found several designs of apparatus used for the same purpose, and there must be a reason.

One reason is because no two men look at the same thing with the same view. Because of this, what may be a satisfactory device to one chief engineer will not be looked upon with favor by the next chief, and naturally when another device for the same purpose is required, the new chief will install the design that best meets his views. The apparatus may be of equal reliability, but the difference of opinion of the two men decides for or against.

Another, and perhaps most common reason for different designs of apparatus is due to the fact that a mistake was made in the original selection which, when put to the test in everyday operation, did not come up to what was originally expected. This may be due to a misrepresentation as to its ability to do the work, or to ignorance on the part of the designer as to just how a device will act and what it will really do. Naturally, if a certain unit does not give satisfaction, another type will be installed when one is desired, and in this manner an array of different designs is brought into the plant.

As a preventative to such condition arising, a careful study of the condition that will be met with is essential, and when this is done there will be a simplicity of design and a standardization of apparatus.

---

Alcohol is obtained from peat by treating the fiber with sulphuric acid and fermenting with a special yeast. A ton of dry peat yields forty-three gallons of pure spirit at one-fourth of the cost of potato alcohol.

## N. A. S. E. Convention

(Continued from page 547)

valve rod packings. Herbert Seli, Stephen Roberts, D. L. Cubberly, H. J. Neff. Souvenir, pocket knife.

C. P. Bassett, McNaughton sectional grate.

Monarch Valve Manufacturing Company, gate and globe valves. W. D. Hosley. Souvenir, "Monarch" button.

Randolph Brandt, "Zeva" and "Seldon" packings.

James McCrea & Co., "Emergency" pipe clamps. M. B. Skinner, F. P. Upson. Souvenir, office motto.

Scully Steel and Iron Company, "Everlasting" blowoff valve. H. B. Ham. Souvenir, lead pencil.

Lyons Boiler Works, Lyons boiler. W. P. Lyons.

Vanda Company, "Vanda" packing. Hudson Dickerman. Souvenirs, leather card case for men, purse for women.

Mason Regulator Company, Mason regulating valves. F. A. Morris.

Hoppes Manufacturing Company, Hoppes heaters, scale pans and exhaust heads. J. J. Hoppes, Charles Hoppes, J. F. Ware.

Lunkenheimer Company, "Lunkenheimer" valves and brass goods. A. O. Brown, C. Davis, L. Thompson, A. W. Dodds, George Elliott, William Schmitt, L. Kramer. Souvenir, steel folding rule.

Garlock Packing Company, "Garlock" packings. C. D. Owen, G. A. Morrison, C. J. Carr, E. A. Smith, T. C. Green. Souvenir, deck of cards.

Arrow Boiler Compound Company, boiler compound. F. A. Foster, D. F. Adams. Souvenir, match safe.

Triumph Ice Machine Company, ammonia fittings and refrigerating machinery. H. D. Pownall. Souvenir, celluloid rule.

Joseph Dixon Crucible Company, Dixon's graphite. F. R. Brandon, L. W. Brooks. Souvenir, pencils.

Jenkins Bros., Jenkins valves and '91 packing. William Le Compte, Frank Martin, C. F. Beckwith, H. C. McLaughlin.

*Practical Engineer.* A. L. Rice, E. R. Shaw, C. B. Leech, C. S. Clark.

American Steel and Wire Company, steel and copper wire. C. S. Knight, Jr., J. E. Evans, A. T. Merriman, George Chandler.

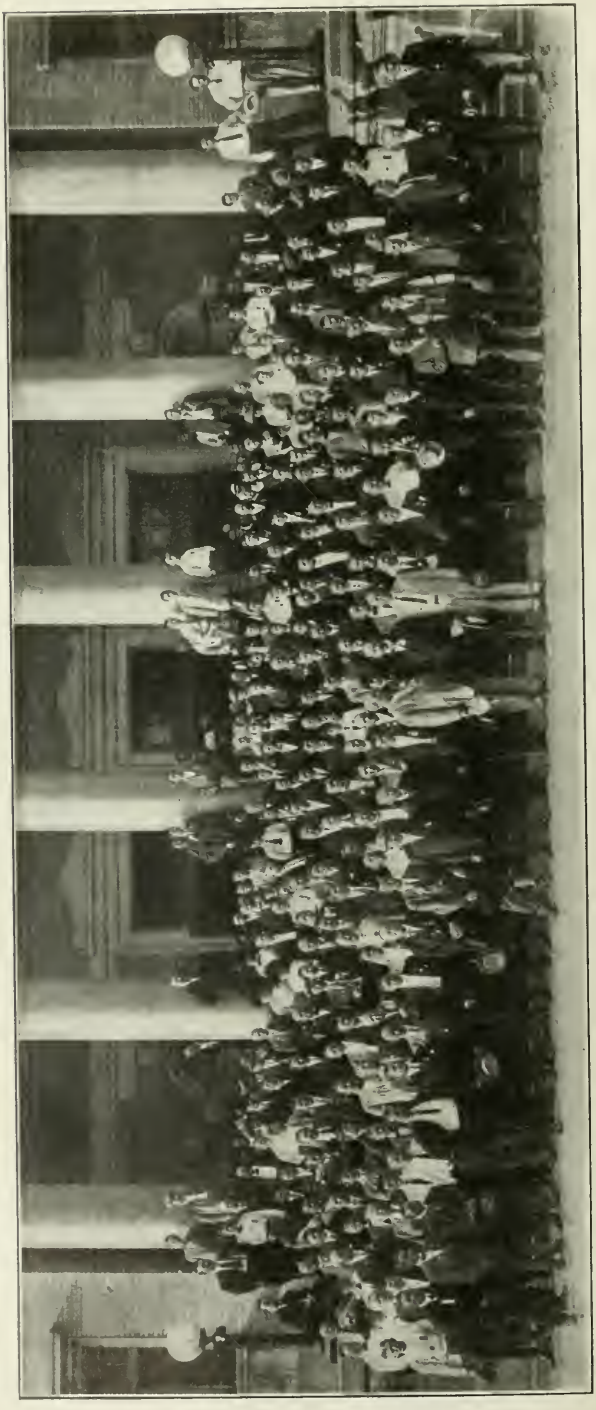
D. T. Williams Valve Company, Williams valves and brass goods. C. R. Thomas, D. T. Williams, H. J. Ernst.

Kent Lubricating Company, "Kent" grease. L. H. West. Souvenir, notebook.

*Southern Engineer.* W. R. C. Smith, J. Willett Smith, H. H. Kelley, R. W. Larkin, W. S. Cushion, Charles W. Hill, William Ayres, S. B. Koons.

Mechanical Rubber Company, "Marco" packings. W. E. Sanders, H. T. Fryant, Charles B. Iler, W. A. Frise. Souvenirs, "Marco" pipes.

Crandall Packing Company, Crandall packing. J. M. Chapman, A. N. Beadle,



GROUP OF EXHIBITORS AT NATIONAL N. A. S. E. CONVENTION, COLUMBUS, O., SEPTEMBER 14-18, 1909

J. C. Stout. Souvenirs, watch fob and paper clips.

Chapman Valve Manufacturing Company, standard and electrically operated Chapman valves. W. G. Cummings, Le Roy Gordon. Souvenir, hand mirror.

Allis-Chalmers Company, turbine details and motor-driven air compressor. F. J. Bolles, A. H. Wyman. Souvenirs, post cards

H. W. Johns-Manville Company, packing and asbestos goods. S. M. Hildreth, McKinley, E. E. Skinner. Souvenir, bestos storm mat.

Parmelee Wrench Company, pipe renches. A. L. Feiss, Mrs. A. L. Feiss. ouvenir, pocketbook.

Wright Manufacturing Company, also ustin Separator Company, Wright water lumns and Austin separators. W. M. amberlin, Jr., Charles W. Locker.

VALVE AND PACKING NINES AT N. A. S. E. CONVENTION

DELEGATES AND VISITORS AT OHIO STATE N. A. S. E. CONVENTION, AT COLUMBUS, SEPTEMBER 13, 1909

Detroit Lubricator Company, lubricators. C. H. Crockett.

Strong, Carlisle & Hammond Company, steam specialties. L. P. Strong, Homer Whelpley, J. C. Murdock, A. B. Pinney, F. H. Evans, Charles Camp. Souvenir, pocketbook containing $1000 accident policy in North American Accident Insurance Company.

Adam Cook's Sons, "Albany" grease. G. E. Tanberg. Souvenir, cigars.

Home Rubber Company, "N. B. O." packings. Richard Foley. Souvenir, hard-rubber pencil.

A. C. Judd, packings. C. P. Hock, C. J. Burke.

L. J. Wing Manufacturing Company, turbine fans. A. C. Judd, H. S. Wheeler. Souvenir, engineering notebook.

C. & G. Cooper Company, Corliss engines. F. H. Thomas, M. A. Theil, B. B. Williams.

H. W. Miller Supply Company, "Dodge" pulleys. C. O. Sherwood, W. R. Degner. Souvenirs, "Dodge" calculator and aluminum pocket rule

*Steam*. J. M. Walton, A. D. Ferguson.

V. D. Anderson, Anderson trap and engine-room oil filter. J. H. Meyer, H. J. Meyer, I. P. Lounsbury.

A. W. Chesterton, packings. H. G. Raymond. Souvenir, porcelain match box.

E. C. Squires Company, Squires steam specialties. E. C. Squires, C. E. Squires, Charles N. Siegrist, G. W. McEwen. Souvenir, free auto transfer to exhibit hall.

Fairbanks Company, valves and steam specialties. L. B. Mann, Wallace McCausland, Bertram Richards. Souvenirs, hand mirror for women, "Dart" union watch fob for men.

France Packing Company, packings. A. W. France, J. F. Boreland. Souvenir, scarfpin.

Phillip Carey Company, steam-pipe covering. D. C. Woodward, R. E. Kramig. Souvenir, booklet on asbestos ore.

Heine Safety Boiler Company, water-tube boilers. J. E. Whittlesey.

Manistee Iron Works, valveless feed pumps. W. G. Sims, Mrs. W. G. Sims.

Michigan Lubricator Company, lubricators and oil cups. F. N. Stocking, Robert Davidson.

W. B. McVicker Company, boiler compounds. W. B. McVicker, William J. Schatz. Souvenirs, key ring and leather case.

Crane Company, "Crane-tilt" traps. C. O. Lindahl.

American Radiator Company, "Bundy"

trade "Norwall" and "Simon" specialties. J. W. Rowe, A. S. Mappitt, F. S. White, F. M. Stevens.

John A. Roebling Sons Company, wire cable. H. T. Georges, J. W. Troescher.

Holmes Metallic Packing Company, metallic packing. F. L. Emery.

Erie City Iron Works, "Lentz" poppet-valve engine. S. Rosenweig. Souvenir, watch fob.

Lambert Successful Flue Blower Company, rear end flue blower. S. H. Lambert.

Diamond Power Specialty Company, rear-end flue blower. John Harley, E. W. Nicklin. Souvenir, watch fob.

International Correspondence Schools, engineering courses. J. D. Jones, Misses Tannehall, Casey and Schaffer.

Quaker City Rubber Company, "P P P" and "Ebonite" packings. W. D. Purcell, H. A. Howe, A. D. Thompson. Souvenir, steel rule.

Dearborn Drug and Chemical Works, Dearborn boiler compounds. W. A. Converse, P. H. Hogan, A. W. Crouch, E. H. Ruhlman, "Dan" Delaney, F. Eardly, H. E. Stone, J. G. Beckerleg. Souvenirs, pocket levels for men, perfumery for women.

New York Belting and Packing Company, "Ruby," "Karbonite" and "Salamander" sheet packings and Cobb's "Vulcan" and "Magic" rod packings. Charles A. Wilhoit, Frank S. Ruddell, B. T. Hadley. Souvenir, complete engineering treatise by Wakeman.

Gem City Boiler Company, water softener. H. Russell.

Hartford Steam Boiler Inspection and Insurance Company. Harry Knowlton.

Scioto Valley Supply Company.

Cyrus Borgner Company.

Emer & Hopkins Company, electrical supplies. Mr. Avery.

Ridgway Dynamo and Engine Company, Ridgway engines and dynamos.

## Ohio State N. A. S. E. Convention

Meeting one day before the national convention, the thirteenth annual session of the Ohio State N. A. S. E. was held in the assembly rooms of the Southern hotel, Columbus, September 13.

Discussion of the State license law occupied most of the time of the delegates. Considerable opposition to the present law was developed, and numerous changes were suggested, but after a spirited debate it was voted not to make an effort to have the law changed, inasmuch as the supreme court has declared it constitutional as it now stands and changes might endanger its existence. Among the visitors who took part in the discussion were John Fahrenbach, of Cincinnati, who spoke of his early experiences with license legislation, John W. Lane, of Chicago, W. J. Reynolds, of Hoboken, N. J., Frank Yeager, of Cincinnati, Robert G. Ingleson, of Cleveland, and R. Baumgarten, of Ashland, Ky.

Mr. Baumgarten told at length of the efforts which have been put forth to secure a State license law in Kentucky and expressed the hope for favorable action at the next session of the State legislature.

After a full discussion by the delegates and visitors, Chief Examiner Kennedy, of Columbus, explained the position of the examining board with reference to the recent order requiring the reëxamination of engineers. Assistant Examiner Howles, of Cleveland, also spoke on this subject. Portsmouth and Hamilton both asked for the 1910 convention, Hamilton winning by a vote of 19 to 10.

Officers elected for the ensuing year were: F. F. Brammer, of Ironton, president; Harry Eichhorn, of Columbus, vice-president; Joseph J. Ahler, of Cincinnati, secretary; Volney Weatherhead, of Cincinnati, treasurer; William E. Feik, of Akron, conductor; William H. Moore, of Mansfield, doorkeeper. This year's meeting, by special act of the 1909 convention, had been arranged for national convention week, but next year's convention of the State body will be held on the regular dates provided by the constitution.

## The Efficiency and Fuel Problem

Some interesting observations are made by *The Engineer* (London) on the efficiency of electric-power stations and on the great saving of fuel accomplished by using waterpower where it is available. It appears that in the boiler plants of a street-car company in Cleveland, O., the thermal efficiency was approximately 8 per cent., that is, out of every 100 tons of coal burned the energy of but 8 tons was delivered to the switchboard in the form of electricity. This is a high percentage compared with the average overall efficiency of British steam-electric stations, which is estimated to be from 3.5 to 4.5 per cent. Thermal efficiency is defined as the ratio of the heat unit supplied to the busbars to the heat units in the coal.

In one British station the generation of more than 10,000,000 heat units required more than 18,000 tons of coal, equivalent to slightly more than 4 pounds of coal for each unit of heat. The estimated mean calorific value of the fuel was 12,500 B.t.u., so that the thermal efficiency of that particular station was:

$$\frac{3412.66 \times 100}{4.02 \times 1250} = 6.78$$

per cent.

A three-year comparison applied to a number of distributed power plants in Berlin showed that the overall thermal efficiency the first year was 9.6 per cent.; the second year 10 per cent.; the third year 10.3 per cent.; all higher percentages than those of many other plants, but low considering that there was a marked increase in the output of units each year.

Under the best conditions an efficiency of much more than 11 per cent. cannot be expected. All of these figures are based on the units delivered at the busbars of the station, the losses in transmission to the consumer not being taken into account.

From tests carried out on a large number of generating stations in the United States, the various losses are estimated as follows: Loss in ashes and leakage, 6 per cent.; heat lost in chimney, 22 per cent.; that delivered to auxiliaries and losses from pipes, 7.4 per cent.; main and auxiliary exhaust, 58.7 per cent.; and minor losses, 1.47 per cent., giving a total of 95.57 per cent. Of this loss 5 per cent. is returned by the feed water heater, so that the overall thermal efficiency becomes 9.43 per cent. Different investigators have naturally obtained slightly varying results, but where the discrepancy comes in is generally fairly evident, and, all things considered, the net results are not far apart.

Saving the coal supply by the substitution of waterpower is not as feasible in England as in this country. The 1908 output of the Niagara Falls Power Company, 560,000,000 units, to various large plants, was as much as would have been generated by large central stations from more than 700,000 tons of coal, and if the plants which used this power had been dependent upon their own individual steam plants they would have consumed more than 1,000,000 tons; while if the power now distributed from Niagara were used to replace steam in many plants, a it is applied under average conditions in the manufacturing cities, instead of being used for a comparatively small numbe of large consumers, it would save nearl 2,000,000 tons of coal per annum. Th *Engineering and Mining Journal* edit states that the world's annual output coal is about 1,000,000,000 tons, of whic 80,000,000 tons is anthracite. The Unite States produces annually 450,000 tons all kinds, being about 45 per cent. of th total. The estimated duration of the su ply of bituminous coal is about 300 year of anthracite, about 75 years.

Aside from the saving by means waterpower, there is also promise in th gas engine, the thermal efficiency of whi has always been greater than that of t coal-consuming steam engine; and t output of alcohol and other gas-engi fuels will undoubtedly be very greatly i creased. Meanwhile, some very practi experiments have been made in stea boiler construction, notably by John Nicolson, professor of mechanical en neering in the University of Manchest who has been working on a theory, by means new, whereby the evaporation square foot of heating surface can made at least 10 times and perhaps times as rapid as at present.

# Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

## "Monarch" Boiler Tube Blower

We herewith illustrate and describe the Monarch" boiler-tube blower, manufacred by the Monarch Steam Blower Comany, 187 River street, Troy, N. Y. Fig. 1 shows a side elevation of the device placed in the rear wall of a boiler setting. The apparatus consists of an inlet

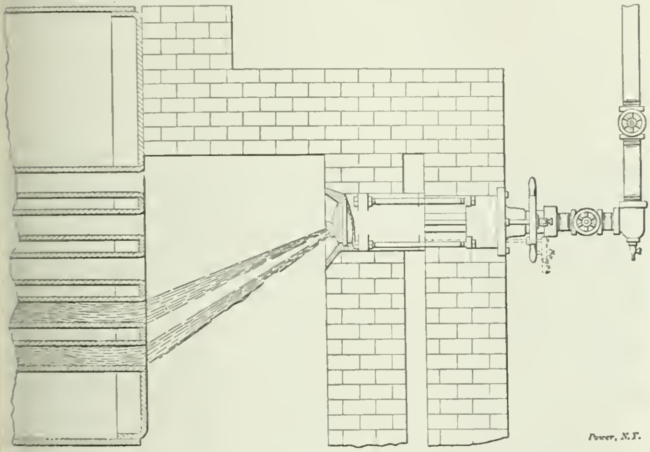


FIG. 1. POSITION OF "MONARCH" TUBE BLOWER IN BOILER SETTING

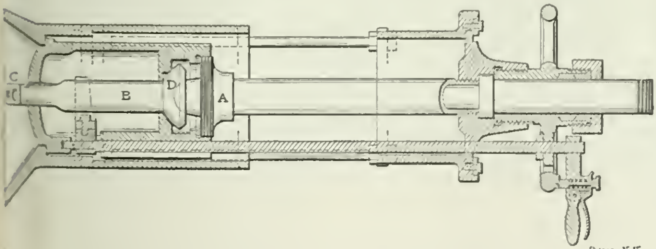


FIG. 2. SECTIONAL VIEW OF "MONARCH" BLOWER

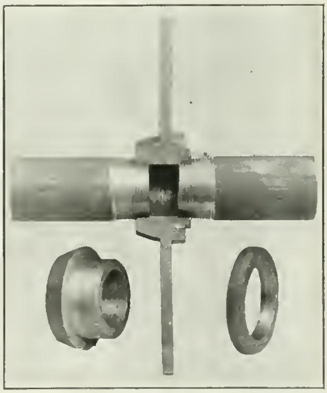
pe, a rear plug connecting the same, a leeve connecting with the rear plug and rovided with a slot in its inner end, nd having a valve seat. It also has a llow valve stem with a cupped rear end rming a steam-tight connection with the alve seat in the sleeve when in operaon, and provided at its inner end with utlet apertures arranged at an angle to e axis of a valve stem.

Means are adopted to swing the inner end of the valve stem radially in the slotted end of the sleeve, also for rotating the valve stem. The shifting device consists of a fork and block operated by a shaft turned by a handle which carries a spring pin engaging at set points with counterborings on the rim of the handwheel, which indicate the particular row of tubes being cleaned.

In operation steam is admitted through the globe valve in the steam pipe, and on to the rear plug *A*, Fig. 2, directly into the valve stem *B*, and out of the aperture *C* into the boiler tubes, as shown in Fig. 1. The impact of the steam when admitted forces the seat *D* of the valve stem against the seat of the cylindrical sleeve, making an absolute steam-tight connection and concentrating the entire boiler pressure through the aperture *C*, and then through the length of the boiler tube. After the operator has set the controller in one of the counterbore holes, the blower is rotated by means of a handwheel, after which the controller is shifted to the other counterbored holes in their order, and the blower revolves at each shift, thus blowing steam through the entire number of boiler tubes.

## Edge Moor Reinforced Screwed Pipe Connection

A type of reinforced screwed-pipe connection, got out by the Edge Moor Iron Company, Edge Moor, Del., is illustrated and described herewith. It consists of a fitting for attaching a pipe to a plate of any thickness, and from either or both sides of the plate, as shown in the illustration. It is adapted for boiler and tank work.



REINFORCED SCREWED-PIPE CONNECTION

The fitting is designed for screwed, expanded pipe or solid connections, and for steam, water, ammonia or gas. As shown, it consists of a thimble which fits in a hole in the plate, and is secured in place by a washer screwed on a thread on the opposite side of the plate from which the thimble faces. The interior of the thimble is threaded, into which suitable-size pipes are screwed, the thimble being threaded with a standard pipe thread. This not only makes a reliable connection for piping, but also reinforces the plate, as is self-evident.

## Modern Science Club Plans

The annual smoker of the Modern Science Club of Brooklyn, N. Y., takes place this (Tuesday) evening. The lecture season will be opened Tuesday, October 5, by an address by M. C. Maxwell, of the department of applied mechanics, Pratt Institute. On October 12 the semi-annual meeting will be held, followed by a chalk talk by F. F. Gennert. On October 19, Snowden B. Redfield, of the *American Machinist*, will talk on "Air Compressors." On October 26, F. L. Johnson, of Power, will talk on "Power."

## Business Items

W. Leinert, mechanical engineer, of New York City, has contracted with Henry R. Worthington, Harrison, N. J., for the manufacture in America of the Leinert liquid weighers.

John W. Good, a well-known business man of Dayton, Ohio, has been elected treasurer of the Lucas Pump Company, of Dayton, in place of R. E. DeWeese, who has resigned and is now abroad.

A recently published statement of the Western Electric Company's business for August last shows that the sales exceeded those of August, 1908, by more than 60 per cent., and represented a gain of 5 per cent. over July, 1909. The three-quarters of the fiscal year which have elapsed indicate gross sales for the year of about $17,000,000. Compared with last year, this represents a gain of $11,000,000.

"Engineers' Handbook" is the title of a 4x6½-inch booklet published for free distribution by the Erie Engine Works, Erie, Penn., whose New York office is in the Hudson Terminal building. The booklet has 89 pages of printed matter and several blank pages for memoranda, and while some space is devoted to descriptions of the company's engines, boilers, feed-water heaters, etc., which are more fully described in a large catalog which is also mailed free, the tables, mechanical tips, etc., make this little publication valuable to the man in the boiler room.

The fuel-testing department of the Arthur D. Little (Incorporated) Laboratory of Engineering Chemistry, 93 Broad street, Boston, Mass., has issued a 16-page copyrighted pamphlet, 4x9 inches, on "The Purchase of Coal." It is, in effect, a plea for the discard of the old-fashioned haphazard way of buying coal, and the substitution of the method adopted by the Government—on a guaranteed analysis, with regular inspections and tests on all coal delivered. Incidentally, of course, it is pointed out that the Little experts, who are under direction of Dwight T. Randall, engineer in-charge, are well equipped to make analyses and tests.

The Burt Manufacturing Company, Akron, O., reports that its last August business was the largest for that month in the history of the company, extending over seventeen years. At the close of August it had unfilled orders on its books amounting to nearly 40 per cent. of the entire output for the month, which is considered a remarkable showing, when in so many lines normal conditions have not yet been reestablished. The company recently received a very satisfying report regarding the performance of its ventilators in the balloon house at Fort Omaha, Neb., where the Government has recently had installed (on a second order) two 24-inch, one 36-inch and three 48-inch Burt ventilators.

## New Equipment

The Hotel Strand, Atlantic City, N. J., will enlarge its power plant.

The Hotel Savoy, Atlantic City, N. J., will enlarge its power plant.

The Penn Iron Company is to install a steam turbine at its mine in Vulcan, Mich.

The power plant of the Owensboro (Ky.) City Railway Company will be enlarged.

Krasin Bros., Tigerton, Wis., will build a cold-storage plant at Marathon, Wis.

The Allenhurst, N. J., Light and Water Company will enlarge its pumping station.

A franchise has been granted Jas. J. Donelson to establish a gas plant at Waverly, Iowa.

The Atlantic Coast Electric Railway Company, Allenhurst, N. J., will enlarge their power plant.

Gorham Bros., Mt. Pleasant, Mich., have built a new engine room and are installing new machinery.

The F. H. White Lumber Company, Bryne City, Mich., has built an addition and will install a new engine.

The Sea Isle City (N. J.) Electric Light, Power and Water Company will increase the capacity of its power plant.

The Miami Valley Knitting Mills is enlarging its plant at Hamilton, Ohio, and intends installing more boilers.

The Hubwelker Provision Company, Hall and Flushing avenues, Brooklyn, N. Y., is erecting a large refrigerating plant.

The Carbondale Machine Company, Simpson, Penn., expects to install a 500-horsepower Corliss engine in its power plant.

The Evansville (Ind.) Ice and Cold Storage Company has rebuilt its boiler room and is figuring on a mechanical stoker.

The Lansing (Mich.) Pure Ice Company will increase the capacity of its plant and will put in a new engine and boilers.

The Breitung Hermatite Mining Company, Negaunee, Mich., is in the market for a boiler house equipment, including two boilers, feed pump, etc.

## New Catalogs

Detroit Lubricator Company, Detroit, Mich. Catalog. Detroit Bullseye locomotive lubricator. Illustrated, 10 pages, 5½x8 inches.

The Trenton Malleable Iron Company, Trenton, N. J. Catalog. Gas engines, gas producers. Illustrated, 16 pages, 6x9 inches.

Marion Machine Foundry and Supply Company, Marion, Ind. Pamphlet. Marion flue blower. Illustrated, 3½x6 inches.

Dearborn Drug and Chemical Works, Chicago, Ill. Pamphlet. Lubrication versus friction. Illustrated, 44 pages, 4x8½ inches.

The Ohio Grease Lubricant Company, Loudonville, Ohio. Pamphlet. A Study in Grease. Illustrated, 16 pages, 3½x6 inches.

## Help Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

WANTED—Good mechanical designers and detail draftsmen for machinery manufacturer located in Wisconsin. Box 98, Power.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," Power.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

AGENTS WANTED to sell Burgmann celebrated engine packings in territories not yet covered. See our advertisements on page 81.

WANTED—Manager, who can obtain some capital, for modern machine works, running day and night, located in Ohio. "Engineers," Box 20, Power.

WANTED—Draftsman experienced in steam engine or turbine work. Write, giving experience and salary required. The Terry Steam Turbine Co., Hartford, Conn.

A VIRGINIA FURNACE wants two competent engineers for power house; should have had experience with blowing engines, hoisting engines and air compressors. Address, "Virginia," Box 30, Power.

## Situations Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

SITUATION WANTED by young man, technical graduate with all-round gas engine and producer experience, erecting, testing and designing. Box 28, Power.

MANAGER, sales manager, department or agency. Commercial engineer, 20 years' experience electrical and mechanical lines. Now traveling, desires change. Harwood, 20 Howard Place, Jersey City, N. J.

POSITION WANTED the year round as assistant engineer in 50 or 75-ton ice-making plant. Fifteen years' experience as engineer in charge of ice-making plants. Graduate of M. E. and R. E. courses of I. C. S. Have charge at present of 15-ton compression machine. Am not employed by the year and desire a change. Can come immediately. Age 30; married. Box 14, Power.

EXPORT—Constructing and commercial engineer, with long domestic and foreign experience, including exporting, selling and constructing of complete hydro-electric plants, steam engines and Diesel oil engines for agents of Westinghouse Electric and Manufacturing Company, desires suitable position, preferably as buyer or office manager with exporting firm; 8 years' practical work in Latin-American countries; proficient in English, German and Spanish and all office routine; excellent references. Box 29, Power.

## Miscellaneous

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

PATENTS secured. C. L. Parker, Solicitor of Patents, 4 McGill Bldg., Washington, D. C.

WANTED—Firm to make boilers with combined water and fire tubes after four new patents on royalty. The boilers have many advantages, are simple and can be made very cheaply. Box 25, Power.

NEED the part-time services of draftsmen and designers? Years of experience on steam and power pumps, gasolene engines, hoists, etc., at your command at reasonable prices. S. S. Engr. Co., Elgin, Ill.

ANY FIRM or engineer in charge of a steam plant that is troubled with scale in the boilers can get absolutely free, the best indicator and reducing wheel made, with velvet lined mahogany case. For particulars, address Great Lakes Chemical Works, Manitowoc, Wis.

## For Sale

*Advertisements under this head are inserted for 25 cents per line. About six word make a line.*

150 HORSEPOWER tandem compound Co liss engine in good order; 16-foot wheel; 2 in. face. F. W. Iredell, 11 Broadway, New Yor

FOR SALE—One 400-h.p. Hoppes feed wat heater, cast iron type; used one month. Cha S. Lewis & Co., Granite Bldg., St. Louis, M

FOR SALE—20x48 Wheelock engine ar two 72"x18' high pressure tubular boilers good condition cheap. Address "Engineer Box 2, Station A, Cincinnati, Ohio.

FOR SALE—Complete boiler, 9 ft. dia. x ft. long, Scotch type; two corrugated furnac 30-in. grate, 110 lbs. steam. Port Richmond I Co., Port Richmond, Staten Island, N. Y.

FOR SALE—250-horsepower Lane & Bo ley Corliss engine, 18x42 cylinder; engine t small for our work and will be replaced so with one of greater power. Wm. A. Coom Milling Co., Coldwater, Mich.

FOR SALE—One 16x36 H. G. Bates Corl engine, 150 to 200 horsepower, in fine con tion; can be seen running; immediate livery if desired. Stephens Engineering C Monadnock Block, Chicago, Ill.

FOR SALE—One 75-horsepower engi slide valve, Nordberg cutoff, in perfect ord

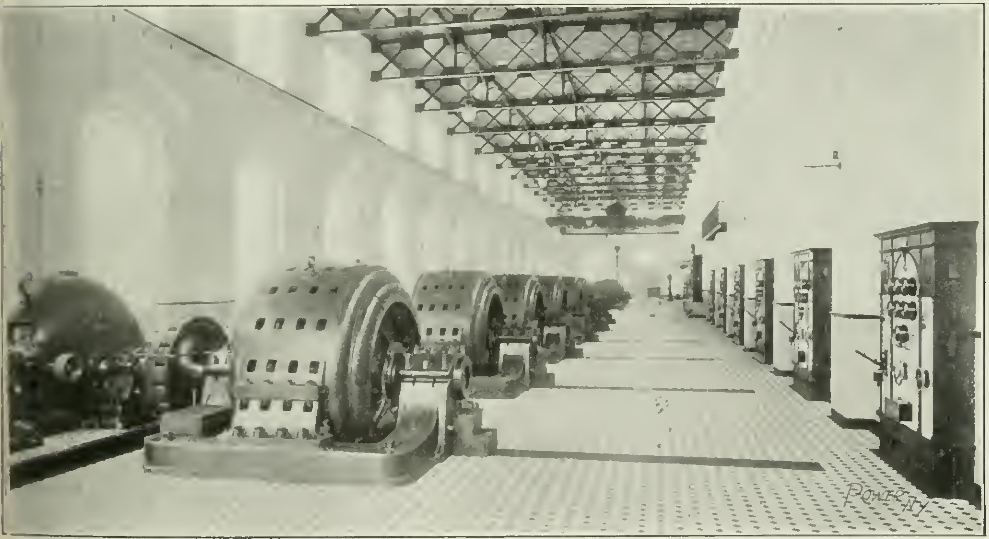
# The Brusio Central Station

## An Interesting Description of the Most Important Hydroelectric Installation in Europe; Surmounting Transmission-line Difficulties

### BY J. B. VAN BRUSSEL

The Brusio hydroelectric power scheme, ently inaugurated at Campocologno anton Griscon-Switzerland) is the t important actually in operation in ope. It is, moreover, the first of in- national character, as the electric rgy produced in Swiss territory is rly all used in Italy.

The water power supplying the plant is ained from falls of the river Pos- vino, which flows from the lake of schiavo. This lake, which has an area about 2,400,000 square yards and a depth of 200 feet, besides being an excellent basin of decantation serves as a reservoir in times of low water; for according to the concessions, the water may be raised 3 feet above and lowered 28 ft below the normal level. The lake is c sed several feet from the outflow by a s ce by means of which the level of the lake can be raised 3 feet.



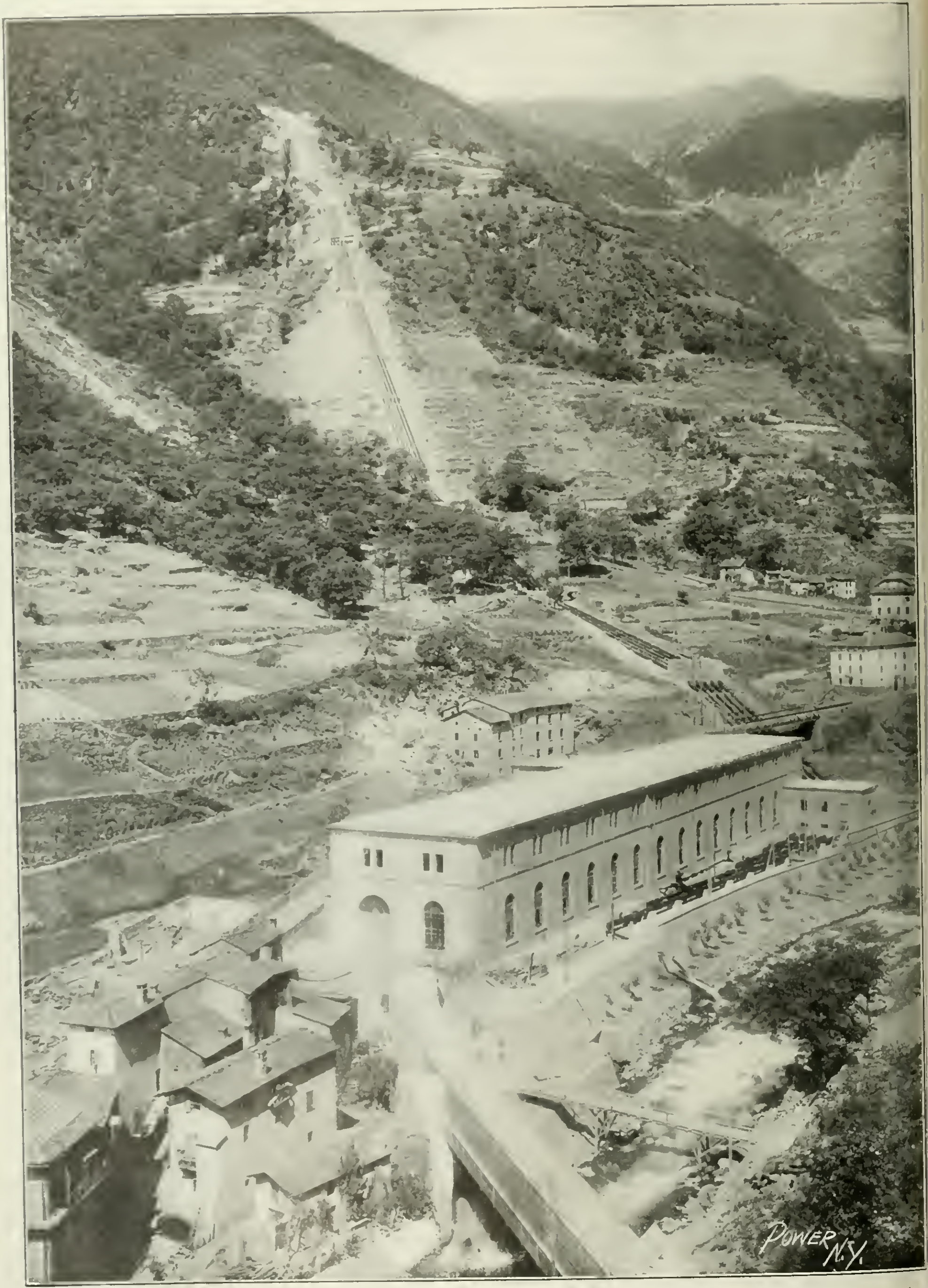
VIEW IN ENGINE ROOM OF THE BRUSIO HYDROELECTRIC POWER STATION

The water, which is taken out of the lake by a siphon, is led through a tunnel c through the solid rock for a distance o over three miles, and delivered to a storage basin 1450 feet above the central station. Six pressure mains about 30 inches in diameter lead the water to a building containing the penstocks and valves to equalize the pressure, and thence to the central station, situated on the Swiss-Italian frontier. The length of each main is about 4500 feet. The mains are riveted pipes for pressures up to 20 atmospheres and welded pipes for higher pressures. The wall thickness ranges from 6 to 23 millimeters, but the exterior diameter of the pipes is kept constant. At every change of inclination the mains are fixed in blocks of concrete, but they rest freely on the foundations, to allow for changes of length due to expansion and contraction. The pressure mains enter the central station at right angles to their axes, and, after having passed a valve chamber, enter the turbines, which are coupled one pair to each main. In the valve chambers all the mains can be connected to a collector. The opening of the intake of water can be worked electrically from the central station. Expansion joints allow slight extension. Along the pressure main is a cable railway worked by an electric motor.

### THE CENTRAL STATION AND EQUIPMENT

The central-station building at Brusio is 334 feet long, 70 feet wide and 48¾ feet high. It is divided in three parts: the generator room, 334 feet long and 52 feet wide; the room for the switchboard and busbars, 334 feet long and 13 feet wide; and the building for offices and feed lines of the valley of Brusio and of the Bernina railway. The generator room has space for twelve groups of turbines coupled to three-phase generators, each of 3000 horsepower; and four groups of turbines coupled to constant-current generators, each of 225 horsepower. The room is spanned by a 25-ton electric crane.

The turbines are pelton wheels regulated automatically. The large ones are of 3000 to 3500 horsepower, running at 375 revolutions per minute; the small ones are of 225 horsepower, at 430 revolutions. They were constructed partly by Escher, Wyss



GENERAL VIEW OF THE BRUSIO POWER SCHEME (CAMPOCOLOGNO)

EXTERIOR VIEW OF PENSTOCK HOUSE

C., of Zurich, and partly by Piccard, ctet & Co., of Geneva. Each turbine is upled to its generator by a Zodel-Voith xible connection.

The three-phase generators are of the volving field-magnet type, with station-y armatures, built in two parts; the h-tension armature coils are placed in lf-closed slots lined with micanite. The tor is of steel in one piece, and the poles rry magnet coils of copper ribbon. The rmal output of each machine is 3000 ilowatts and the normal e.m.f. 7000 lts, at 50 cycles frequency. The e.m.f. an, however, be regulated from 6300 to 800 volts in order to compensate for osses on the line.

The direct-current machines have a ating of 150 kilowatts at 115 volts. Each ne serves to excite four alternators with 5 per cent. overload and 0.7 power factor.

While it is common practice in central ations to concentrate, as far as possible, ll the control apparatus on one switchoard, here the plan is to decentralize, for ach three-phase generator has a switchboard to itself. This is considered as an advantage as to the connections of the switchboard as well as the safety of working, because disturbances on one board do not extend to the others. However, convenience of operation is retained because the entire installation can be seen at a glance from a distributing column located in front of the exciter switchboard, whence the whole installation can be regulated. This central column has a voltmeter connected to each half of the station equipment and an ammeter on which can be read the current of each machine; also an ammeter for the line going to the transforming station at Piattamala. The regulators of each exciter can be coupled, and their voltages can be regulated from the central column; consequently, the voltage of the whole installation is controllable there.

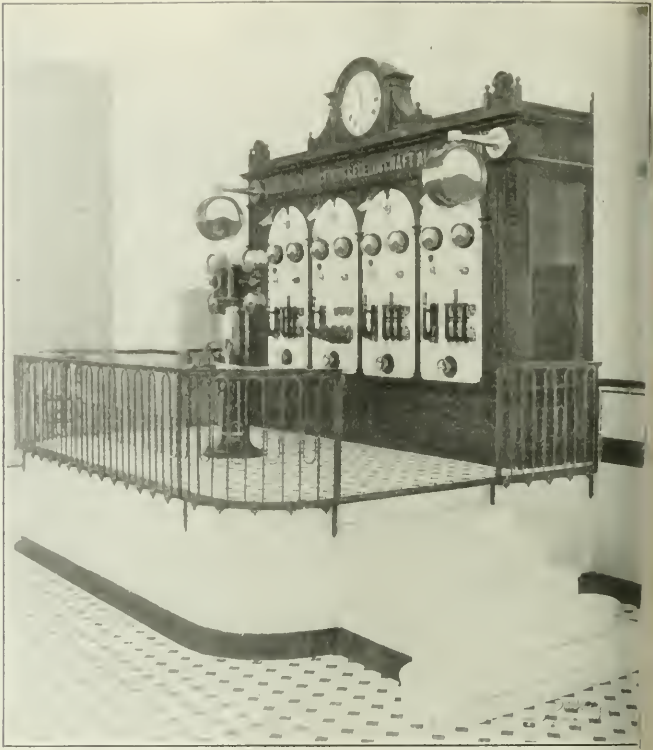
Each generator switchboard contains besides the necessary apparatus for operation and connecting in parallel, an oil switch worked by hand as well as automatically by a relay, and a deëxciting switch, connecting the alternator to a very low-resistance inductive coil. This switch is connected electrically with a high-tension interrupter in such a way that the automatic operation of the latter closes the former. Each switchboard is closed in at the sides by concrete and in front by an iron door. In the space behind the switchboard, the compartment for the high-tension circuits, etc., is separated from the low-tension compartment by fireproof walls. The switchboard apparatus can be entirely disconnected from the busbars, so that examination of the switchboard can be made without danger. In the busbars chamber, which is divided into two floors, are the exciting busbars on the lower level and those for the three phase

GALLERY OF LOMAZZO STATION

current to the upper level. The installation is divided into two equal groups, each consisting of six generators and their exciting dynamos, which can at will work independently of one another or which can always be put in parallel. This division allows one-half of the central station to supply the substation of Lomazzo, while the other half supplies the substation of Castellanza. The first three generators on the left side of the central control column can be connected to separate busbars and excited by a special dynamo; they are intended to supply the energy for the valley of Poschiavo and for the use of the Bernina railway.

### Difficult Problem in Transmission

The step-up transformers are situated in the substation at Piattamala, which is 1070 feet from the central station of Brusio and on Italian soil. The transmission line from the central station to the Piattamala substation was one of the most difficult problems. An aërial line would have required 36 wires for the transmission of about 2400 amperes and its upkeep did not promise too much safety on account of the possibility of falls. The use of underground cables would have involved an enormous cost, and the safety of the installation would not have been insured. The most natural solution, and the one adopted, was a tunnel between the two stations, in which to place the lines; but this solution met with the greatest opposition, because the tunnel crosses the frontier and it was believed it would be used for smuggling. Two

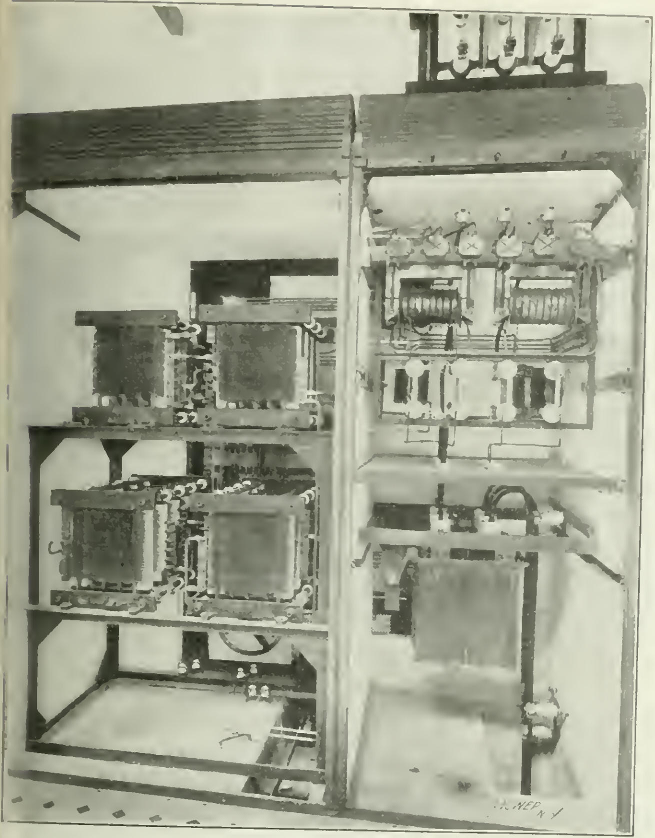


EXCITER SWITCHBOARD AND CONTROL COLUMN, BRUSIO STATION

lines in the tunnel connect with the
sets of busbars of the two sections of
central station. On each side of
tunnel there are three lines of co
bars, one above the other, each
millimeters square. The bars are mou
on triple-petticoat insulators, which
fixed on straight supports between
U-shaped irons and serve at the s
time to support concrete barriers
tween the different phases.

The lines right and left are separ
from the central passage by a trelli
iron wire, so that the passage is al
free from danger. The tunnel is
feet long, 6½ feet wide and 9 fee
inches high, and is watched night
day by custom-house officials. Mos
the tunnel is dry; at one point only
found a spring of water, and this
been utilized to cool the transforn s
The tunnel ends in the basement of ie
substation at Piattamala, to which he
energy is carried at a tension of 00
volts. The substation is designed t e-
ceive 24 single-phase transformers of 50
kilowatts each, which, star-connect in
sets of three, increase the tension om
7000 to 45,000 volts. The transfor rs
are oil- and water-cooled. The b-

TRANSFORMER ROOM AT PIATTAMALA



C PARTMENTS CONTAINING RESISTANCES, ITCHES AND CIRCUIT-BREAKERS IN BRUSIO STATION

st is 180 feet long, 68 feet wide and 2 et high, and has two towers for the e of the lines toward Toriano. Duplex la t characterizes the whole installation, tl equipment being divided in two symm al parts, which can be at any time el ally connected.

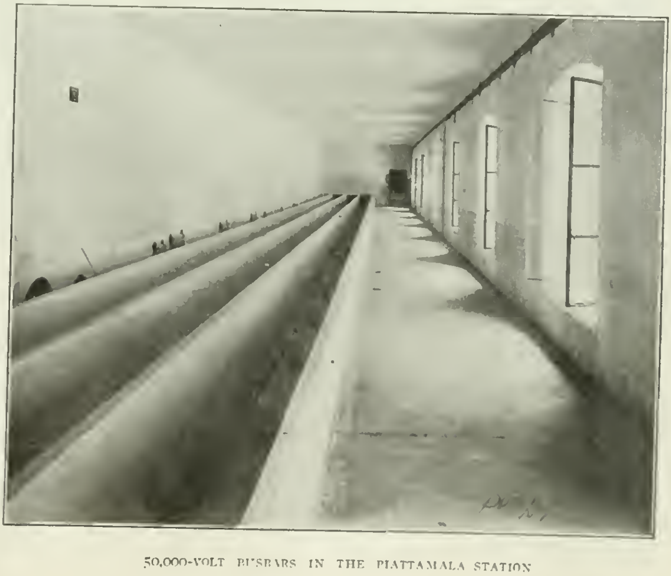
### THE METERING ROOM

lines leaving the tunnel enter a so-ca metering room, where the energy c g from Brusio is measured. Each h is provided for this purpose with h ammeters, one per phase, a comm n voltmeter, a recording voltm r, and two recording wattmeters, of different origin and construction, wired in se . Finally in this room are installed th ammeters and a commutating voltmeter for the two lines, beginning at 50,000 volts, so that the working of the whole installation can be controlled from one po . From the metering room the lines descend to rooms below, situated on the rig and left of the transformer house, and from these pass to the transformers themselves. The high-tension lines from the transformers pass through circuit-breakers to 50,000-volt busbars on the first floor.

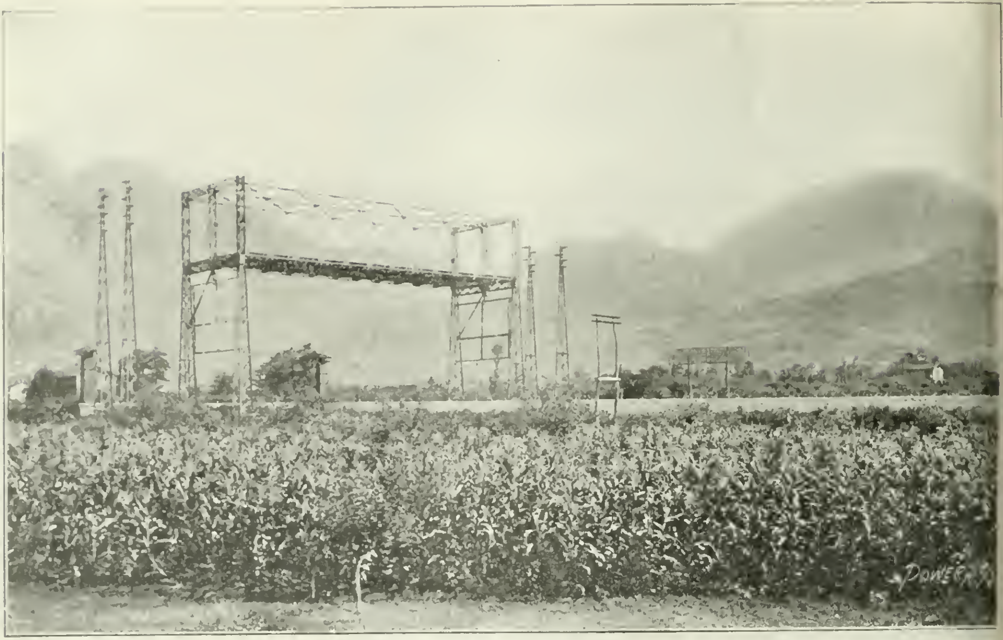
Each group of transformers has a three-pole oil circuit-breaker rated at 70,000 volts, and a single pole oil switch in each phase. All the switches of one group are mechanically connected and can be opened automatically by a retarded induction relay. Each group of three ammeters has small signal lamps to show if a group is connected in or not. In front and behind each transformer are choke coils, and the neutral wires common to the groups are brought to earth after passing horn-type lighting arresters. Each group can be separated on both sides by cut-outs and put entirely out of service. All the lines are separated by walls and also all the apparatus of each phase, except those for 70,000 volts, are located in the compartment with their switches. The transformers are mounted in the central part of the station, the whole length of which can be seen from the metering room. Each transformer is located in a fireproof chamber which can be completely closed, except for a ventilating chimney, which in case of fire acts as a vent of the smoke of the oil.

### THE LOMAZZO SUBSTATION

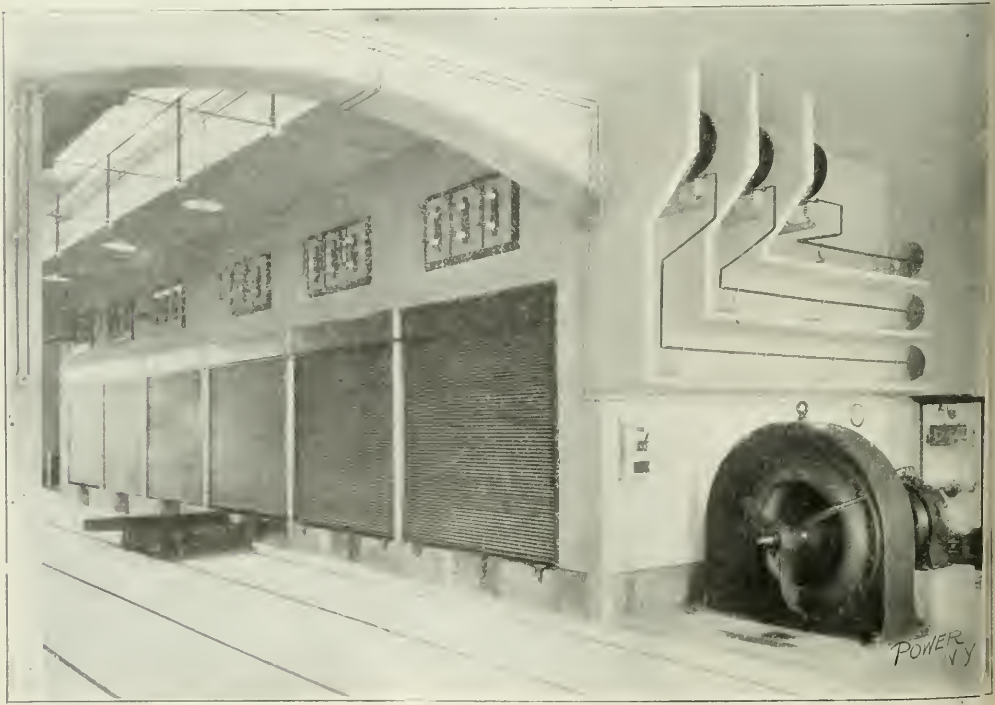
The line from Piattamala to the substation at Lomazzo is 8 [illegible]/3 miles long. From here to Castellanza (near Legnano) it is 11 7/8 miles long. It follows the neighboring mountains in the section Sondrio-Colico and ends across the Val Sesina at Lecco on the lake of Como. The complete line consists of four parallel



50,000-VOLT BUSBARS IN THE PIATTAMALA STATION



HIGH-TENSION TRANSMISSION LINE CROSSING A RAILWAY LINE



TRANSFORMER ROOM AT LOMAZZO

les of three copper cables, 105 square limeters in section, mounted on two allel rows of iron lattice poles, six es on each pole. The rows of poles from 13 to 17 feet apart. In places re they are not so wide apart, from dition of the ground the poles of one are higher than those of the other by eral meters, so that the proper dis- ce between the two lines is maintained. e average hight of the poles is 12 ers (39 feet 4 inches), and they are meters (328 feet) apart. At some es the hight of the pole is as much a meters (98 feet), and crossing cer- ti leys as much as 400 meters (1312 fe apart. Each wire is carried on in insulators tested to 100,000 volts paced 47¼ inches from each other. Th are mounted on straight supports xe on blocks of wood carried on double iro supports. The line current when ru ng without load, measured at the init end, was about 14 amperes for eac line of three wires, at about 50,000 volt potential. For the safety of the line here have been placed at Sondrio, Cor nova, at the commencement of the passage across the mountains; at Lecco, the commencement of the plain, and at Gerenzano, cabins containing lightning protectors and safety apparatus to guard against excessive increases of potential.

The substation at Lomazzo constitutes the starting point for the distribution of the power. It consists of an H-shaped building, 124 feet long, 55¾ feet wide in the middle and 32 feet high. It is arranged for the reception of 6 single-phase transformers, each of a capacity of 1250 kilowatts, to step down from 40,000 to 11,000 volts, and 6 three-phase transformers of 500 kilowatts stepping up from 11,000 to 20,000 volts. At present there are installed three single-phase and three three-phase transformers.

The station is remarkable for the facility of making line combinations. The two lines coming from Piattamala, called A and B, come in there, although generally only the line A supplies Lomazzo, while the line B is intended for Castellanza. A third line, C, connects Lomazzo to Castellanza and the following connections are possible:

Line A supplying Lomazzo and line B (by means of C) Castellanza, line A supplying Lomazzo and Castellanza; line B supplying Lomazzo and Castellanza; line A supplying Lomazzo or Castellanza; line B supplying Lomazzo or Castellanza, and line C supplying Lomazzo.

In the last case the power is supplied by the central steam station of the Società Lombarda at Castellanza, which constitutes the reserve for the hydraulic installations already existing at Turbigo and Vizzola and even for that of Brusio. The last combination can be arranged so that there can be a supply at 40,000 volts, in case of serious interruption, by means of high-tension transformers. Or, when a longer interruption is feared, the supply can be had directly at 11,000 volts from the generators at Castellanza by means of two hydraulic installations. The supply at Lomazzo is thus fully protected.

THE 7000-VOLT LINES LEADING FROM THE BASEMENT OF THE BRUSIO STATION

## Performance of Engine-Turbine Ship "Otaki"

At the recent conference of the Institution of Engineers and Shipbuilders in Scotland and the Northeast Coast Institution of Engineers and Shipbuilders, W. McWisnom presented a paper of some considerable interest. An abstract of this paper, which was entitled, "Notes on the Trials and Performances of the Steamship 'Otaki,' fitted with a Combination of Reciprocating and Turbine Machinery," was published in the *Engineer*, of London, and the results of the trials are presented in the following:

The "Otaki," which was built for the New Zealand Shipping Company, was delivered in November, 1908, and has since made a voyage to New Zealand and back. She is virtually a sister ship to the twin-screw vessels "Orari" and "Opawa," which are fitted with reciprocating engines, the "Otaki" being about 4 feet 6 inches longer. Her principal dimensions are:

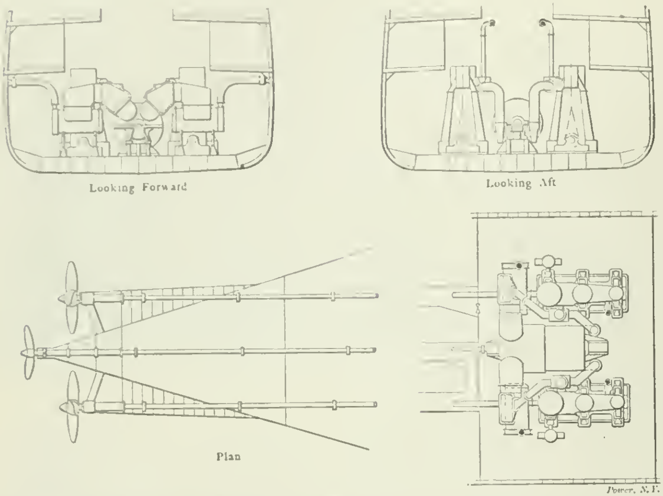
| | |
|---|---|
| Length between perpendiculars | 464 feet, 6 inches. |
| Breadth, molded | 60 feet. |
| Depth, molded | 34 feet. |

Her dead-weight capacity is about 9900 tons on a draft of 27 feet, 6 inches.

The power equipment consists of two sets of ordinary triple-expansion reciprocating engines driving wing propellers and a low-pressure turbine driving a center propeller, as shown in the accompanying illustration. In ordinary ahead working the reciprocating engines exhaust into the turbine which can only revolve in one direction, but change valves are also fitted so that the reciprocating engines can exhaust direct to the condensers. The turbine is automatically cut off when going astern and can be also cut off when going ahead and the vessel manœuvered as an ordinary twin-screw boat. When the turbine is not running, each reciprocating engine exhausts into its own condenser, and when the turbine is running, it exhausts into both condensers. The cylinder dimensions of the reciprocating engines are 24[illegible], 39 and 58 by 39 inches, while the cylinders of the "Orari" and "Opawa" are 24[illegible], 41¼ and 69 by 48 inches. The ratio of high- to low pressure cylinders is thus 1 to 5.6 in the "Otaki" and 1 to 7.03 in her sister ships.

Generally speaking, the "Otaki's" turbine is of the ordinary Parsons low-pressure type. The diameter of the rotor drum is 7 feet 6 inches, and the length of the blades varies from 4¾ inches in the first expansion to 12$\frac{11}{16}$ inches in the last expansion.

The "Otaki" was designed for a continuous sea speed of 12 knots when fully loaded, but the contract provided for a trial speed of 14 knots with 5000 tons of dead weight on board. A series of tests of the "Otaki" were made over the measured mile at Skelmorlie, on which the "Orari" had obtained a mean of 14.6 knots. Under the same conditions the "Otaki" obtained a mean speed of over 15 knots for a total water consumption of 6 per cent. less than that of the "Orari." The total amount of water consumed per hour by the "Orari" was 88,300 pounds, or 16½ pounds per indicated horsepower per hour. The consumption of the "Otaki" on the Skelmorlie route was 82,000 pounds per hour with a speed of 15.02 knots, and at 14.278 knots the consumption was 69,300 pounds. During one of the trials at a speed of 11.7 knots the coal consumption worked out to 1.387 pounds per horsepower per hour, this amount including fuel for all purposes. The coal used was Scotch and had a heating power in pounds of water evaporated from and at 212 degrees Fahrenheit per pound of coal of about 14.



OUTLINE SKETCH OF ENGINES IN THE "OTAKI"

RESULTS OBTAINED IN TRIAL TESTS.

|  | E. H. P. | I. H. P. | Propulsive Coefficient. Per Cent. | Water Consumption. Total per Hour. Lb. | Per E. H. P. per Hour. Lb. | Per I. H. P. of "Orari" per Hour.* Lb. |
|---|---|---|---|---|---|---|
| "Otaki | 3350 | 5880 | 57 | 73,300 | 21.9 | 13.7 |
| "Orari | 3120 | 5360 | 60 | 88,300 | 27.5 | 16.5 |
| Gain per cent. in "Otaki" |  |  |  | 17 | 20 | 17 |

NOTE.—Columns marked * do not take into account the difference of I. H. P. in the two ships; these two methods of comparison should show the same gain.

The proportion of total power developed in the turbine of the "Otaki" was found to vary with the speed. At full power it was about one-third, while at very slow speed the turbine was only doing a small proportion of the work. At 14.6 knots the indicated horsepower of the "Orari" was 5350, and the corresponding power of the "Otaki" was 5880. At this speed the electrical horsepower was 3210 in the "Orari" and 3350 in the "Otaki," the propulsive coefficients being then 60 and 57 per cent. in the two vessels. At full speed the propulsive coefficient of the "Otaki" fell to 54 per cent. The a companying table gives a comparison trial results of the "Otaki" and "Orar for a speed of 14.6 knots on the measur mile.

In actual service the consumption coal on the "Otaki" on the voyage fro Liverpool to Teneriffe was 11 per ce less than the mean for the sister vess "Orari" and "Opawa" under similar con tions. The average speed of the "Otak from Liverpool to New Zealand and ba was 11.09 knots. This speed does n represent the sea speed which the ves is capable of maintaining, nor is it t most suitable for obtaining the low consumption of coal per horsepower-ho It was, however, the speed arranged suit the owner's conditions of service

A careful comparison of the "Otaki coal consumption with that of her sis ships for the round voyage shows an parent gain of 8 per cent., or about tons as a total. As enough coal is c ried from Liverpool for the round t some 250 tons could be spared and ca carried out to this amount. The engi made a nonstop run from Teneriffe New Zealand, a distance of 11,669 kn as logged. The total weight of the chinery of the "Otaki" is about 30 t more than that of her sister ship, an crease of about 3.25 per cent. But all ing for the greater efficiency of the for vessel the boiler power might have b decreased, when the weights would h been about the same.

Since the paper was written the "Ot has completed another voyage to Zealand at a mean speed of 12.35 kn and the anticipations as regards impro economy have been realized. As speed was greater than that of her si vessels under similar conditions it difficult to make comparisons, but gain in coal consumption in the "Ot as compared with similar vessels, was less than 12 to 15 per cent.

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Medical and sanitary authorities in ous centers are introducing restric in regard to the discharge into sewe the effluent from producer-gas plants. constituent in the effluent to which ception is taken is the sulphureted hy gen, but in a report by Dr. Collingr the medical officer of health to the of London, it is stated that if per ganate of potash is added to the was in a settling tank, the effluent ceas be of an objectionable character. Its charge within the city area is, how limited to the hours between 8 p.m. 8 a.m.—*The Engineer-in-Charge.*

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At 11 a.m., Friday, September 24 h American Society of Mechanical gi- neers and the Pennsylvania Sc ty placed memorial wreaths on the F on monument erected by the A. S. M. in Trinity churchyard, New York.

# Measuring Flow of Water by Meter and Weir

## How to Make and Use a Venturi Meter for Measuring Flow of Water in Pipes, the Construction of Weirs and the Theory of Flow Over a Weir

### BY FRANKLIN VAN WINKLE

Employment of the ordinary forms of valves or orifices for gaging the flow of water in pipe lines and closed flumes is frequently impracticable on account of the drop in head and reduction in flow which results from discharging the flow through the measuring aperture. The presence of such obstructions to flow is generally objectionable in water service pipes and pipe lines used for fire protection or in city water-supply lines liable to be called upon at any time for delivery of their maximum capacity. Most forms of apertures are, for the same reason, unsuitable for measuring flow in water-power flumes where ordinarily the sacrifice of two or more feet of head for purposes of continuous gaging would render their employment prohibitive.

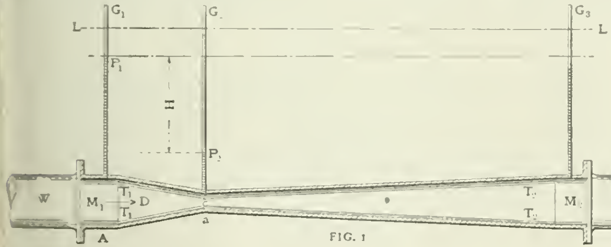

FIG. 1

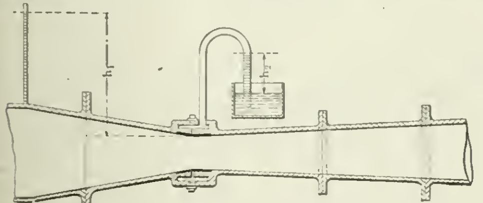

FIG. 2

Power, N.Y.

An aperture in form of the Venturi ajutage[*] can be used with advantage and without objectionable loss of head in a pipe line by employment of an aperture so large in its smallest size of throat as to cause no serious reduction of the total head, and the velocity of flow through the aperture can be based upon the tendency of the jet as it passes through the throat of the aperture to exert a "suction," or less pressure against the sides of the aperture.

This side-sucking action of ajutages is well known, and the peculiar properties of the Venturi tube in this respect were well known to Venturi and may be found detailed at length in the accounts of his experiments made in Modena about 1791, though he does not appear to have suggested the use of this property for any practical purpose.

The Bourdon anemometer, an instrument which has been used for measuring the velocity of air currents in French mines, is founded on the tendency of a Venturi form of tube to exert a sucking action through small holes bored through the sides of its smallest cross-section. The apparatus becomes an anemometer for measuring the velocity of air passing through the narrowest part of a Venturi form of aperture, by determining with suitable form of vacuum gage, the degree of vacuum or "suction" exerted through the small holes, and establishing the relation which the degree of vacuum bears to the velocity of air through the main tube.

The same principle is employed for measurement of flow in the Venturi water meter. In April, 1888, a United States patent was granted to Clemens Herchell on a form of water meter in which the properties of the Venturi adjutage are turned to account in measurement of flow of water, and since that time the Venturi tube method has been developed into the favorite practical method of metering flow through pipe lines. It consists of insertion in a pipe line of a tube of the same form as a Venturi ajutage, and its performance as a meter is based upon the reduction of pressure of the water against the sides of the tube as it flows through the throat, or narrowest part of the aperture, this reduced pressure being taken as an index of the velocity at that point. The size of the throat being known, the quantity discharged in a given time may readily be computed from the drop of pressure at the throat of the aperture, once the coefficient of discharge is established, and without reference to the drop of pressure created beyond the aperture, as usually has to be taken into account when gaging of flow is performed by employment of other forms of aperture. Another advantage over other forms of aperture lies in the fact that the introduction of this form of tube need not result in serious reduction of pressure beyond the aperture for the purpose of obtaining sufficient difference of head upon which to base computations of flow, as the total loss of head in the pipe line, due to the insertion of the aperture, need not exceed 10 to 15 per cent. of the observed head which is used as the index of velocity.

Operation of this form of gaging aperture may be better understood by reference to Fig. 1. Suppose a water-pipe line *W W*, with the flow in the direction of the arrow *D*, to have a short section of its length removed, from $M_1$ to $M_2$ and in place of the removed section a Venturi section be substituted as shown in the figure. The throat, or smallest part of the aperture *c c* is formed at the intersection of two hollow truncated cones united at their smaller ends and each of the same diameter at their larger ends as the original pipe *W W*, but of different lengths; the down-stream frustrum *c c* $T_2 T_2$ being drawn out to a more gradual taper of its sides than those of the upstream frustrum *c c* $T_1 T_1$. The aperture, where the frustrums meet at *c c*, is usually rounded off so as not to present any abrupt changes in velocity of the water in its passage through the tube.

With small standpipes or piezometer tubes $G_1$, $G_2$ and $G_3$ inserted, the hight to which water rises in these tubes will indicate the degree of pressure acting against the sides of the Venturi tube at points where the piezometers are attached. When the tube is filled with water under pressure, but no flow is taking place, water will rise to the same level L L in all of the piezometers. Now, if a draft of water is made from the end $M_2$ discharge will take place in direction of the arrow D, and when flow is established, it will be accompanied by a reduction of pressure in each of the piezometers. The level in $G_1$ drops to some point $P_1$, the drop in head L $P_1$ being the loss of head in the pipe line up to the entrance of the Venturi tube, and the pressure in the piezometer tube $G_2$ drops to a lower point $P_2$, which is the hight H below $P_1$.

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[*] See POWER, Oct. 13, 1908, page 609, Fig. 17.

The same quantity of water that passes the section $T_1$ $T_1$ passes through the throat c c, and in order to do so it must be contracted down to a smaller stream and therefore must have greater velocity than when passing through the larger section; and it cannot acquire this additional velocity unless part of the head presented at $T_1$ $T_1$ has been converted into velocity. From the narrowest part c c to the discharging end, the tube is gradually enlarged from the size of the throat to the same size as the entrance end $M_1$. Therefore when flow is established, the velocity of the water as it passes from the throat to the discharging end of the tube gradually grows less, until the original diameter $M_2$ is reached, where it resumes the original velocity of entrance through the equal diameter $M_1$. Pressure in $G_3$ will not, however, rise absolutely to the original pressure P, because some degree of drop in pressure must always be experienced as loss of head, to greater or less extent, and with any flow taking place, can never be completely restored, although with comparatively slow velocities and favorable form and finish of aperture, restoration to the original head may appear to be complete. If it were so, contraction and reëxpansion of water passing from one end of the tube and through the contracted throat to the other end would be accomplished without any waste of energy, as by loss of heat due to friction, and by setting up two or three Venturi tubes in circuit, one delivering to the other, with flow once established the combination would present an example of perpetual motion.

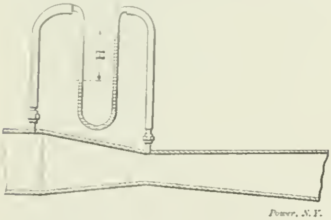

FIG. 3

Neglecting losses of head due to friction in passage of the flow from $T_1$ $T_1$ to c c, the head thus converted into additional velocity would be H, the difference between the pressures $P_1$ and $P_2$. The actual velocity through the throat would be the velocity due to this head H plus the head due to the velocity of approach to the section $T_1$ $T_1$.

Now if

$v$ = Velocity of approach,

$h$ = Head corresponding to the velocity of approach, and

$V$ = Velocity at the throat of the aperture, then, as the velocity $V$ corresponds to the head $H$ + h,

$$V = \sqrt{2g(H + h)}, \qquad (1)$$

but as $h = \frac{v^2}{2g}$,

$$V = \sqrt{2g\left(H + \frac{v^2}{2g}\right)}. \qquad (2)$$

or

$$V^2 = 2gH + v^2. \qquad (3)$$

As the same quantity of water passes through each section of the tube in the same time, $Va = vA$; therefore the velocities $V$ and $v$ are inversely as the areas of cross-sections $A$ and $a$, that is to say,

$$V = \frac{A}{a}v;\ v = \frac{a}{A}V;\ v^2 = \frac{a^2}{A^2}V^2.$$

Substituting this value for $v^2$ in formula (3),

$$V^2 = \frac{2gH}{1 - \frac{a^2}{A^2}}, \text{ or } V = \sqrt{\frac{2gH}{1 - \frac{a^2}{A^2}}}.$$

When the throat diameter is one-third the diameter of the entrance, then $a = 1/9$ of $A$, and the formula becomes,

$$V = 1.0062\sqrt{2gH},$$

or practically

$$V = \sqrt{2gH}.$$

For high velocities, pressure in the piezometer $P_2$ may be reduced so much as to fall to the throat c c, or the reduction in pressure may be so great as to create a "suction." In that case a vacuum-gage column must be employed, as shown in Fig. 2, and the head H of Fig. 1 then becomes $h_1 + h_2$.

For practical purposes a mercury U-tube used as a differential gage is employed, connected as illustrated in Fig. 3. This permits direct reading of the value of H in inches of mercury column, which are readily converted into equivalent feet of water (multiplying inches of mercury by 1.13), or measured by a scale on which the divisions are properly spaced for reading feet of water.

Experiments checked by careful tank measurements have been made to determine the efficiency of discharge of Venturi apertures of various proportions. Tubes in which the throat had one-ninth the area of the large ends of the cones, with the up stream frustrum about two of its base diameters in length, and down-stream frustrum about seven of its base diameters in length, have given discharges of 96 to 98 per cent. of the discharge per the formula, and apparatus of these proportions are found to entail a total loss of head in the pipe line of less than 12 per cent. of the measured head H.

In employing this method of measuring flow through a pipe or closed flume, it is not essential that any particular dimensions or proportions should be adhered to, only that for best results the general form and proportions of the Venturi ajutage should be followed in order not to entail undue loss of head. When the apparatus follows those proportions, the flow estimated by the formula giving velocity at the throat will be correct to within 3 to 5 per cent., provided the proper coefficient of efficiency has been employed. With good mechanical construction and finish of surfaces the actual flow, checked by tank measurements, has been known to be 98 per cent. of the amount computed by the formula, and for very ordinary surfaces in iron and masonry conduits falls as low as 95 per cent. But in any instance where radical departure is made from proportions of the Venturi ajutage or results are required within less than 5 per cent. of truth, the percentage which the actual discharge is of the estimated discharge should be determined by actual test, with values of H coming near to those obtained in the use of the apparatus.

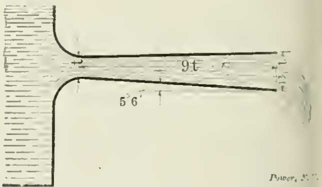

FIG. 4

For measuring the flow in pipes of large size the conical portions of the Venturi tubes are built up of a number of sections of length composed of a number of flanged frustrums of cones bolted together, Fig. 2. In most important meters, the throat section is made of bronze metal, or has a bronze lining to guard against change of diameter from corrosion, and has a surrounding vacuum chamber, as indicated in Fig. 2, the vacuum chamber being connected to the throat by four or more small holes equally spaced around the aperture, each hole being drilled with care so as to make the passages at right angles to the axis of the main tube. Care is also taken that no burs or irregularity of corners are left at the intersection of these holes with the inner surface of the throat, which would tend to create imperfect asperation. Piezometer readings of pressure at the throat are obtained by connecting a piezometer or suitable form of vacuum gage to the top of the vacuum chamber. For most accurate work th interior of the tube is finished smooth from end to end and coefficients of discharge are determined by careful tank measurement, when the tube is discharging under conditions of heads and velocities for which it is intended to be employed. But very reliable results can be obtained where the throat only is measured with care, and it has been constructed with smooth finish of surface. Venturi ajutages are generally supposed to be circular in cross-section but any contracted form of tube can be employed in the same manner for measuring flow, provided contraction and reënlargement are gradual. Square-sectioned tubes have been used with success in large sizes for measuring discharges of water used for power and irrigating purposes, coefficients of discharge having been determined by gaging their flow over weirs, etc.

Before passing the subject of gaging flow by this method, a description of construction and application of a simple form of measuring tube may be of interest. In Fig. 5 suppose *AB* to be a service pipe 2 inches in diameter in which it is desired to measure the flow of water in the direction of the arrow *D*. Insert between flanges $F_1$ and $F_2$ a section of soft brass or copper pipe about 2 feet long, previously flattened down in a vise to form a throat by pressing the sides together between two pieces of wood of the shape *WW*. The forms *WW* should be rounded, as shown in the figure, so as to prevent the formation of too sharp a notch, and should be beveled steeper on one side than the other so as to form a more abrupt contraction of the tube on the inlet side of the throat. Flattening down of the pipe should be done at a safe distance from the inlet end, so as not to spoil the shape of the end $F_1$ for proper threading to receive the flange coupling at that end. To be safe in that particular, it will be best to insert a very short wooden plug in the end of the pipe before forming the throat in this manner.

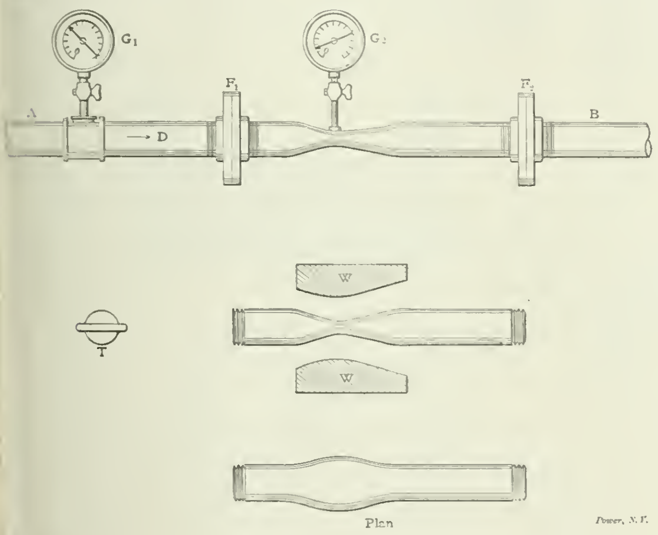

FIG. 5

For metering the discharge of pipe lines the Venturi meters employed are generally provided with elaborate forms of recording pressure gages for recording the differential pressure obtained at the throat and for interpreting the discharge in accordance with the predetermined value of the coefficient of discharge.* The throat diameters employed range from two-thirds down to one-fourth the diameter of pipe lines in which they are employed, the larger proportion being employed for pipe lines of high velocities and the smaller for pipe lines which have such slow velocities of flow that it becomes necessary to increase greatly the velocity at the throat of the meter in order to obtain sufficiently great reduction of pressure for reliable readings on which to base velocity through the throat.

After flattening down the pipe it will look like the plan view, that is, will be broadened out as well as brought together at the throat, with a cross-section like *T* in the figure. It is immaterial for the purpose what the shape of throat may be, so long as it is fairly symmetrical on opposite sides of the center line of the pipe, and the throat is formed by easy bends of the interior surface in gradual contraction to the smallest size of aperture and reëxpansion to the full size of the pipe. For most purposes a throat aperture having an area of about one-sixth the area of the pipe will be found to give good results. For that proportion the pipe would need to be flattened down to a section about 3/16 inch across its narrow inside diameter, spreading out to about 3 inches wide inside. By boring a 3/16-inch hole in the top of the throat, a gage nipple may be soldered in place for receiving a pressure gage. This hole should be cleaned off sharp and square with the inside of the throat. The area of the throat should then be carefully calibrated. This can be done by making caliper measurements of the outside and making due allowance for the thickness of the tube at the throat, as shown by the thickness of the side before soldering on the gage nipple. The rate of flow for several different gage readings should be ascertained by drawing water for a stated period into a barrel or tank and computing the quantity in cubic feet, preferably by ascertaining the weight of water so caught. The flow for any difference of reading of the gages $G_1$ and $G_2$ can be calibrated without going into any calculation of velocity of flow through the throat, thus employing the aperture in the same manner as any other form of aperture could be employed for gaging flow, but with the advantage of much greater range of capacity and less reduction of pipe line pressure. If, however, it is desired to employ the aperture for measurement of velocities through the throat, then three or four calibrations of discharge should be made for different values of *H* (the difference between the pressures at $G_1$ and $G_2$) should be made and the per cent. which the actual flow is of the theoretical flow per formula for velocity through the throat should be determined. With this coefficient once established, a scale of velocities and rates of discharge may be computed by the formula and may be kept in readiness for any observed reduction of pressure on the aperture.

The author has successfully applied the foregoing general methods of making aperture measurements of flow of water and in determination of the rate of flow of steam, air and other gases through pipe lines supplying tenants, etc. In all cases of importance it is highly advisable that the particular apparatus so employed should be calibrated under conditions which are as nearly as possible identical with those which obtain in gaging the flow which is to be measured.

### WEIR MEASUREMENTS

For gaging the flow of water in small streams and open conduits, the method known as weir measurement is a favorite among engineers, because of its convenience and the greater certainty of obtaining conditions compatible with well established theories and experiments. Any kind of dam to check or raise the level of the surface of a stream is called a weir, but considered as an instrument for measuring flow it is usually understood to con-ist of a dam having its back or up-stream side *AB*, Fig. 6, in the form of a vertical plane at right angles to *D*, the direction of flow, and to be provided with a sharp crest *A*, usually horizontal, and formed of a thin metallic plate or sharpened by beveling the down stream side, so that the water in passing over the weir will clear all but the upper edge *A*. The head on the weir is understood to be the hight *H* measured vertically from the crest *A* to the surface of the water 6 to 10 feet up stream from the weir, or beyond a point where the surface forms a falling curve as it approaches the crest of the weir. The crest may be formed of wood or other material, beveled on the down-stream side to an angle of 30 to 60 degrees, but should not be rounded or otherwise shaped so as to form a lip which will cause the water to adhere to the upper surface of the weir, as such forms of crest have the effect of increasing the discharge an indefinite amount.

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*See POWER, August 3, 1909, page 207.

With a weir, like *AA*, Fig. 7, which extends clear across the channel of approach, no contraction of the sides of the stream flowing over the weir takes place at the ends *AA*. Such a weir is called a weir without end contraction, the stream flowing over and beyond the weir the full breadth of the channel, as shown in Fig. 8.

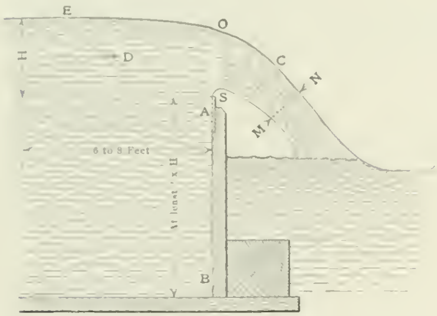


FIG. 6

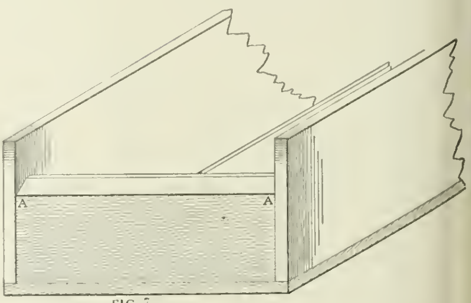


FIG. 7

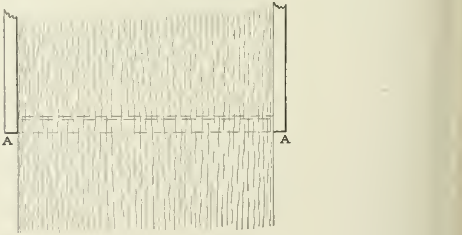


FIG. 8

Power, N.

When, as in Fig. 9, the ends *AC* are any distance, as *CE*, from the sides of the channel, then contraction of the stream flowing over the weir takes place at the ends of the weir, as shown at *C* in the plan view, Fig. 10. This kind of weir is called a weir with end contractions, and for the same head of water and length of weir the discharge is less than over a weir without end contraction.

Diminution of flow due to end contraction increases with the head, but diminishes with increased length *L* of the weir up to a point where the length is about ten times the head *H*, when the effect of end contraction is practically nil; but decreasing the length of the weir in this proportion to the head *H*, causes end contraction to diminish the flow very rapidly. A weir is said to have complete end contraction when the end contraction is practically as great as it can be made by increasing the distance *CE*. This is believed to be true when *CE* is made equal to the head *H*, Fig. 6. Careful experiments have shown that complete end contraction reduces the discharge about 6 per cent. when the length of weir *L* is less than four times the head *H*. The employment of a weir without end contraction is therefore always to be preferred where the head *H* is less than ten times the length of the weir, in order to eliminate the uncertain effect which end contractions have on the discharge. When end contractions are unavoidable in construction of a weir and it is the purpose to make due allowance for their presence, then the ends of the weir should be sharp vertical edges like *AC*, Fig. 9, and beveled on the down-stream side in the same manner as the crest *AA*. The object of sharp edges is to create no uncertain degree of contraction either at the sides of the stream or in its upward curvature in passing over the weir, and that flow may take place nearly as possible as though *AB*, Fig. 6, were the vertical side of a deep reservoir and flow took place into the air, with natural upward curvature of the bottom of the stream in passing beyond the crest *A*. This latter condition would not exist, however, were the bottom filled up against the side *AB*, Fig. 6, to within a short distance of the crest *A*; nor with any conditions present on the down stream side of the weir tending to suppress natural contraction at the crest by drawing the stream downward in its passage over the crest of the weir. For employment of formulas applicable to standard weirs with complete contraction, the vertical up-stream side of the weir should extend above the bottom *B* at least twice the amount of head *H*, and there should be free access of air at the ends of the weir to prevent formation of any degree of vacuum in the space *S*, Fig. 6, for it has a strong tendency to suppress natural contraction of the under side of the stream. The presence of vacuum is usually revealed by an appearance of unsteadiness of flow and the occasional passage of ripples lengthwise of the crest of the weir. The hight of backwater level *J* on the down-stream side of the weir is quite immaterial, so long as it does not boil or back up into the space *S* a sufficient hight to interfere with complete contraction. Backwater, like any other cause tending to suppression of natural contra tion at the crest, increases the flow an u certain amount.

Observing these general conditions, t formulas and coefficients for flow ov standard weirs may be applied with su cient accuracy for most practical purpos The place selected for a measuring w should be at a point in the stream whe the approaching channel is straight a its cross-section is regular and deep possible in proportion to the head so as to avoid presentation to the w of irregular currents of water. Flatten of the curvature of the surface of wa passing over the weir is an indication t suppression of contraction is taking pl from one of the causes mentioned, that the head *H* is too small to be pended on for a lively spouting of stream over the crest. The remedy is increase $H$ by shortening the length of the weir.

### THEORY OF FLOW OVER A WEIR

The fundamental formulas for flow over weirs are based upon the theory of spouting velocity of a liquid, viz., that each particle is projected forward with the same velocity as it would acquire in falling from a hight equal to the head of water acting on the particle.

Supposing $TAB$, Fig. 11, to represent the vertical side of a reservoir, kept filled to the level $FF$, which is at the hight $H$ above the point $A$ in the side of the reservoir, the liquid down through the depth $H$ being made up of horizontal filaments which are temporarily held from flowing horizontally by the presence of the side $TA$. Upon suddenly removing this portion of the side, each of the filaments $p_1, p_2, p_3$, etc., will be urged forward according to its depth $h_2, h_3, h_4$, etc., and this action will continue after flow is established over the side of the reservoir. Neglecting resistance of the atmosphere, friction against the sides of the opening and the tendency to fall in a cascade, the filaments would move across the crest $A$ of the opening in parallel straight lines, each with the same velocity as a body would acquire in falling from a hight equal to the depth of submergence of the filament.

Representing the velocities of successive filaments by horizontal straight lines $v_1, v_2, v_3$, etc., the curve $O c c C$ joining their extremities will be a parabola, because

$$v_1 = \sqrt{2gh_1},\ v_2 = \sqrt{2gh_2},\ v_3 = \sqrt{2gh_3},$$

the velocities being proportional to the square roots of their respective depths. Calling the total depth, or head, $OA = H$ and $AC = \sqrt{2gH}$, the total theoretical discharge in cubic feet per second for one foot length of weir will be that represented by the area of the parabola $OAC$, and this is:

$$\tfrac{2}{3}\, OA \times AC = \tfrac{2}{3}\, H \times \sqrt{2gH},$$

and dividing this area by the hight $H$, the average velocity will be,

$$\frac{\frac{2}{3} H \times \sqrt{2gH}}{H} = \tfrac{2}{3}\sqrt{2gH}.$$

The hight of the whole escaping sheet of water being $H$, and its breadth $= L$, the length of the weir, the cross-sectional area of the stream is $L \times H$, and this multiplied by the average velocity, gives the theoretical quantity $Q$, flowing in cubic feet per second, viz.,

$$Q = L \times H \times \tfrac{2}{3}\sqrt{2gH}.$$

Taking $g = 32.2$ from under the radical sign and reducing, the equation for theoretical discharge becomes:

$$Q = 5.35 \times L \times \sqrt{H^3}.$$

This theoretical quantity is never realized in practice with a sharp crested weir with full contraction, because the filaments, as they approach the weir begin to fall in curved paths $EOC$, Fig. 6, and it is necessary to estimate the head $H$ further up stream, as from a point $E$ rather than at a point like $O$ immediately over the weir, in order to take into account the head $H$ which produces velocity in all filaments approaching the weir. The stream is not only retarded by impingement against the weir, but the velocity of filaments approaching the weir at a lower level than the crest are projected upward and conspire against the direct passage out of the upper layers forming the upward contraction $S$. In this connection it may be observed that the average velocity of the thinnest part of the stream $MN$, Fig. 6, after passing the weir (which corresponds to the *vena contracta* issuing from orifices in thin plate) is very nearly equal to the theoretical velocity.

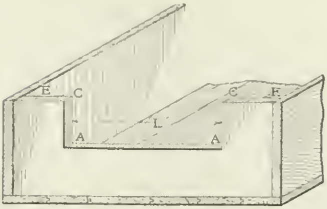


FIG. 9

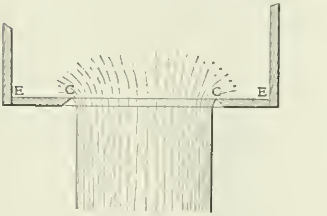
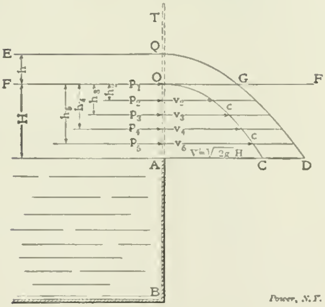


FIG. 10

Power, N.Y.



Power, N.Y.

FIG. 11

Numerous experiments have been made on large and small weirs for the purpose of comparing the actual discharge with that obtained by the formula for theoretical discharge. For sharp-crested weirs of usual proportions, giving full contraction on the crest of the weirs, but without end contractions, James B. Francis, by a series of experiments made at Holyoke, Mass., in 1852, determined that the quantity 5.35 in the foregoing formula should be reduced to about $62\frac{1}{3}$ per cent. of that quantity, making the equation for actual flow:

$$Q = 3.33 \times L \times \sqrt{H^3}$$

for the number of cubic feet per second, flowing over sharp-crested weirs having a length equal to three, or more, times $H$, and without any end contraction, in this respect confirming the experiments of many other hydraulicians of note in this country and Europe.

Francis' experiments were among the most elaborately published series of tests of the flow over weirs made to that time, and as the results announced by him were confirmatory of those obtained by leading authorities, the above equation has come to be regarded as the standard one for computing the flow over sharp-crested weirs without end contraction. The Francis experiments were made on weirs about 10 feet long under heads ranging from 7 to 19 inches, with excellent facilities for determining tank measurements of the flow over the weirs, which was caught in lock chambers whose capacities were carefully gaged and due allowance made for leakage. The experiments are mainly valuable, however, in determining the effect of end contraction with different proportions of lengths of weir to the head $H$, a point on which able hydraulicians had previously disagreed on account of less favorable opportunities for experimenting. Letting $n$ = the number of end contractions, the Francis formula for quantity of water discharged in cubic feet per second is:

$$Q = 3.33 \times \left(L - n\frac{H}{10}\right) \times \sqrt{H^3}.$$

If $H$ is made equal to one-tenth $L$, (i.e. $H = 1/10\ L$) the formula becomes:

$$Q = 3.33 \times \left(L - n\frac{L}{100}\right) \times \sqrt{H^3},$$

so that with $n$ = two contractions the quantity of flow would be reduced only 2 per cent. Therefore, for all practical purposes, when the length of weir $L$ is over ten times the head $H$, the effect of end contraction can be neglected.

### PROPER ALLOWANCE FOR HEAD

As previously stated, it is customary to measure the head $H$ at a distance 6 to 8 feet up stream above the weir, in order to have the elevation of the surface of water approaching the weir at a point where there is no material drop in the surface. When there is velocity of approach toward the point where $H$ is measured, this must be taken into account as productive of a greater effective head than $H$ in creating velocity over the weir. Velocity of approach to the point $E$, Fig. 6, is readily measured with surface floats or wooden rods having loaded ends by observing the distance passed over by the floats in a given time. Converting this velocity into feet per second, the head corresponding to this velocity of approach may be found either from a table of velocities of falling bodies or from the usual formula.

$$h = \frac{v^2}{2g}.$$

In Fig. 11, indicating this additional head by the distance $h$, it will be seen that the total head now acting to produce flow consists of $H + h$, although the depth of filaments passing over the weir remains $H$ as before

In demonstrating the theorem with the head $H$, Fig. 11, it was assumed that the water in the reservoir was at rest; an analogous theorem can, however, be established with reference to the head $H + h$. The original velocities $v_1, v_2, v_3$, etc., of filaments from $O$ down to $A$ are now extended to the parabola $Q\,G\,D$, and the total flow in cubic feet per second for one foot length of weir is represented by the area $O\,A\,D\,G$. This area is the difference between areas of the parabolic sections $Q\,A\,D$ and $Q\,O\,G$, in which $Q\,O = h$; $O\,G = \sqrt{2\,g\,h}$; $Q\,A = H + h$, and $A\,D = \sqrt{2\,g\,(H + h)}$ When there is velocity of approach corresponding to the head $h$, the theoretical flow per second for one foot length of weir therefore becomes:

$$\tfrac{2}{3}\,(H + h)\,\sqrt{2\,g\,(H + h)} - \tfrac{2}{3}\,h\,\sqrt{2\,g\,h} = 5.35\,\sqrt{(H + h)^3 - h^3}$$

and for $L$ feet length of weir the theoretical flow in cubic feet per second is,

$$Q = 5.35\,L\,\sqrt{(H + h)^3 - h^3},$$

and the actual discharge in cubic feet per second with velocity of approach due the head $h$ becomes for 60 per cent. efficiency,

$$Q = 3.33\,L\,\sqrt{(H + h)^3 - h^3}.$$

This formula has been substantiated by Weisbach and other eminent mathematicians and hydraulicians. It has, however, been questioned in cases where there were high velocities of approach, in which cases the observed velocity of approach has in every probability been erroneous and more at fault than the formula. The place for a weir should be selected where velocity of approach is little as possible, for under the most favorable circumstances it is difficult to obtain the velocity with accuracy, especially where a stream is narrow and irregular It is to be observed that the result is effected by the proportion which the velocity of approach bears to $H$ after being incorporated in the formula, and not according to its absolute amount. If the observed velocity, when incorporated in the formula, appears to effect the result more than about 3 per cent., the value of measurements made by weir is very doubtful. Under ordinary circumstances the velocity of approach, when converted into head $h$ for use in the formula, will be found to have so small an effect that it may be neglected, but when the velocity of approach is so great as to effect results more than 3 per cent., as above, employment of the weir as a superiorly accurate instrument for measurement of flow is open to serious criticism.

The arrangement and proportions of measuring weirs placed in open rectangular flumes of iron, wood or masonry should be carefully scrutinized to see that they comply with conditions required for a standard sharp-crested weir before placing dependence upon the standard weir formulas, as conveniences which are availed of for their installation are very liable to result in broad deviations from standard conditions. It is not sufficient, for instance, to apply the standard weir formulas to ordinary gate openings or passages through bulkheads without setting up a weir board or plank so as to present a clear vertical up-stream face not less than twice the hight of head acting on the weir, and to further secure full contraction of the stream at the crest, discharge over the weir should have a clear drop of at least one-half the amount of head acting on the weir. To reduce leakage under and around the weir, it is always advisable to dam up the discharge below the weir, so as to raise the level of the backwater high as possible without interfering with the contraction $S$, Fig. 6.

When the down-stream ends of the weir extend from side to side of the channel, contraction over the weir is liable to be destroyed by formation of vacuum on the down-stream side of the weir. This is the more likely to occur with high backwater on the weir, and should be guarded against by making special provision for admission of air under the dicharging sheet of water, either at the ends of the discharging arch or in some such manner as leading an air pipe back from the receiving bay to the down-stream side of the weir.

For temporary use, a good weir board can be made of 2-inch plank, beveled on the back so as to leave about 3/10 inch breadth at the edge, or the crest may be formed of wood, shod with ⅛- to ¼-inch plate iron, as shown at $A$, Fig. 6. Under any circumstances the construction should be made firm, stiff and strong, so that there will be no tremor or vibration and no change in its dimensions during use. Every precaution should, of course, be taken to make the weir tight as possible for estimates of leakage as a rule are very imperfect. With ordinary good workmanship at joints, leakage can be reduce to a minimum by the use of clay, bran o short stable manure. The degree of tightness of the construction should occasionally be observed with the forebay fille to the level of the weir and the backwate drawn down.

## Measuring the Losses in a Stea Turbine

Professor Rateau, inventor of the tu bine which bears his name, recently pr sented to the Association Technique Mar time, a paper entitled "Mode de Ca des Turbines a Vapeur," in which gives the results of experiments mad determine the internal losses of turb and describes the experiments by w those losses were determined. He experimented upon the subject s fifteen years ago, but these experim lacked precision and were taken up a a few years ago with perfected appar at the shops of La Brosse et Fouch at Nantes, for the purpose of calcul ng with the utmost possible precision the r bine for the torpedo destroyer "Voltig ."

The apparatus used for the pu se is shown in Fig. 1, where $A$ is a c tion of guide vanes guiding the s m upon the section $B$ of the vanes t be

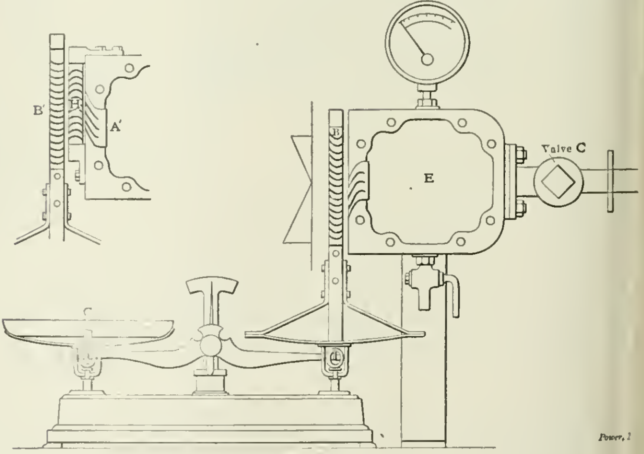


FIG. 1

tested. The section *B* is so mounted as to transmit to one end of a scale beam the thrust which it receives from the steam directed upon it by the guide vanes *A*. The pressure of steam in the chamber *E* is regulated by the valve *C*. The thrust upon the blades is measured by counter-lancing it with weights in the opposite ale pan *G*.

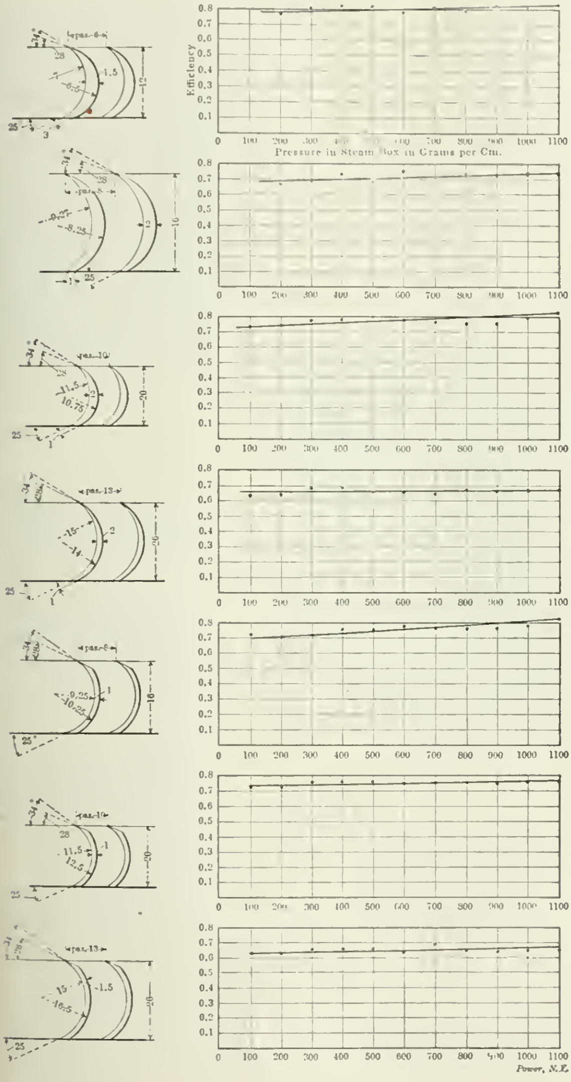


FIG. 2

Another series of experiments was then ade by interposing another section of lades identical with those used in the rmer test between the guide vanes and e vanes attached to the scale, as shown at *H* in the detached sketch of Fig. 1. This resulted in a diminution of the thrust and the ratio between the thrust obtained in the first and second series of experiments is taken as expressing the efficiency of the blade tested.

The losses thus measured are due in part to the minute irregularities of the walls of the blades, to their greater or less thickness, to the form and to the transverse dimensions of the passages, but principally to the shock at the entrance of the buckets. In the case of impact turbines the effect of these losses is to reduce the relative velocity of the fluid in the blades always in the same proportion approximately, whatever the initial velocity of the steam, and whatever the relative velocity of the blades.

The curves given in Fig. 2 show the efficiency of the blades, the respective sections of which are given at the left, as determined by this method. As will be seen, the efficiency varies between 65 and 80 per cent.; for the same blade it is fairly constant, although there is a universal tendency to increase with the pressure; that is to say with the velocity of flow through the vane passages.

In certain publications it has been supposed that the loss of velocity in a bucket acting by impact does not exceed 10 to 15 per cent. Professor Rateau's experiments show that this proposition does not conform to the facts, and he maintains that the loss amounts generally to 20 or 25 per cent. With blades very carefully designed, well polished and having the entrance edges very sharp, these losses may be reduced to 15 per cent., but this will be exceptional and one cannot count upon this value to maintain itself after some use, because the steam, and especially the particles of water which it entrains if not superheated, or which follow upon the expansion of the steam, roughen the surfaces of the blades and reduce the sharpness of their edges.

## Monthly Meeting of the A. S. M. E

The first monthly meeting of the American Society of Mechanical Engineers for 1909-10 will be held in the Engineering Societies building, New York, on Tuesday evening, October 12, at 8 o'clock. A paper will be presented by Prof. R. C. Carpenter, of Cornell University, upon the "High-Pressure Pumping System of New York City." There are two pumping stations comprised in this system which receive power transmitted electrically from several of the electric-generating plants of the city. There are five pumping units in each station consisting of 5-stage centrifugal pumps driven by induction motors. Each pump has a capacity of 3000 gallons per minute and delivers against a pressure of 300 pounds per square inch in the mains.

The first high-pressure pumping system for fire protection was one with steam-driven pumps completed at Detroit in 1888. Besides the New York system there have recently been completed, or are under construction, similar plants at Philadelphia, Brooklyn, Boston and Baltimore.

It is expected that the discussion following the paper will not only bring out information upon these systems but will also lead to a general presentation of the subject of centrifugal pumps.

# The Electrical Transformer

## A Practical Explanation of the Essential Features and Different Types; What They Are Used for, Their Capacity for Work, How Cooled

### BY NORMAN G. MEADE

The transformer is an apparatus for changing alternating current of one voltage to alternating current of a different voltage. It consists essentially of a pair of electrical windings called the "primary" and "secondary" windings, and a closed magnetic circuit interlinked with these two windings. This magnetic circuit is formed by what is known as the "core" of the transformer. The primary and secondary windings are so placed that the mutual induction between them is as great as possible under practical conditions. Upon applying an alternating electromotive force to the primary winding, an alternating magnetic flux is set up in the iron core which induces an electromotive force in the secondary winding in direct proportion to the number of convolutions of wire in the secondary winding. From this it will be evident that the primary winding is that one to which the supply current is applied, and the secondary is the winding in which electromotive force is generated by the magnetism set up by the current in the primary winding.

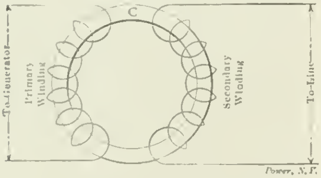


FIG. 1. DIAGRAM OF SIMPLE TRANSFORMER

An elementary diagram of a simple transformer is shown in Fig. 1, in which C represents the iron core around which the primary and secondary coils are wound. There are various types of transformer, but they all comprise the essential parts of a primary and a secondary winding with a laminated iron or steel core.

### Ratio of Transformation

The greater voltage divided by the smaller voltage at no load is called the ratio of transformation and is equal to the number of convolutions in the high-tension winding divided by the number in the low-tension winding. For example, a transformer with 500 turns of wire in its primary winding and 50 turns in its secondary winding would have a transformation ratio of 10 to 1, and if it were supplied with primary current at 1000 volts, the secondary electromotive force at no load would be 100 volts. A transformer of this kind, delivering a lower voltage than it receives, is called a "step-down" transformer. The process is reversible, however, and transformers which deliver a higher voltage than they receive are called "step-up" transformers. Such transformers are used for special purposes; the ordinary apparatus used between local primary street mains and the consumers', or secondary, circuits is of the "step-down" class.

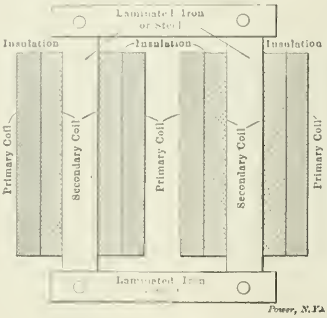


FIG. 2. CORE-TYPE TRANSFORMER

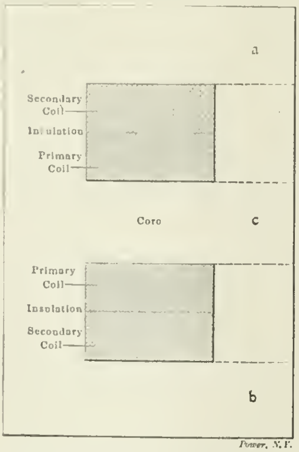


FIG. 3. SIDE VIEW OF SHELL-TYPE TRANSFORMER WITH COILS SHOWN IN SECTION

Transformers differ somewhat in construction, and are divided essentially into two types: the "core" type and the "shell" type. Fig. 2 shows a cross-sectional view of a core-type transformer. The entir core is built up of laminated iron or steel and on each of the "legs" are a primary coil and a secondary coil. The two primar coils constitute the primary winding, an the two secondary coils the secondar winding.

Figs. 3 and 4 show a side view and cross-sectional view, respectively, of shell-type transformer. The main cor laminations are punched in the shape of letter E, as shown by the dotted line Fig. 3, the top, bottom and center of th letter being the arms *a*, *b* and *c*. Th main laminations are laid in place, fir from one side and then from the oth side, and the spaces between the arms a filled with short pieces, so that when com pleted a comparatively solid mass formed.

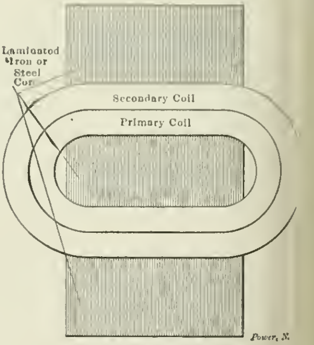


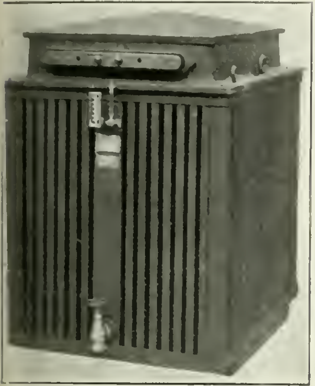
FIG. 4. CROSS-SECTION OF SHELL-TYPE TRANSFORMER

Transformers used on distribution tems are generally made with subdivi secondary windings, and are provided v suitable terminal blocks for connec the sections in series or multiple so either of two secondary voltages may obtained. In large shell-type transform for high-voltage work both the prin and the secondary windings are divided into several sections to facil construction, and to allow for better sulation. By means of this constru on the difference in potential between ie convolutions of any portion of e er winding is reduced to a comparat ly small value.

### Capacity for Work

Transformers for heavy duty, suc as

e used in generating and substations, quire special construction, and some cans for keeping the windings and laminations within a safe temperature, as e of the necessary requirements of any ce of apparatus is that it must be pable of operating for certain periods



5. OIL-INSULATED SELF-COOLING TRANSFORMER

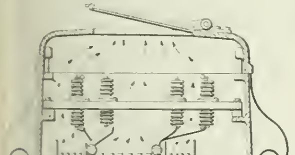


FIG. LONGITUDINAL SECTION OF AIR-BLAST TRANSFORMER

of time at its full load, and in some cases load, without undue heating. In a transformer the capacity for work increases directly as the volume of material, if the densities and proportions remain constant. The volume, however, increases as the cube of any one of the dimensions; therefore, it is evident that the capacity for work increases faster than the radiating surface. Since the losses are also in proportion to the volume, the designer soon reaches a point where it is necessary to provide special means for ventilation or radiation in order that the transformer may run without undue temperature rise.

Self cooling transformers are those which require no artificial means for dissipating the heat developed during operation. These can be divided into two classes: the ventilated or natural draft, and the oil-cooled. The ventilated or natural-draft transformer is one in which the air is the direct means of carrying off the heat, it being designed so that currents of air readily pass through the transformer. Such transformers are not well adapted for outdoor installations, as they require extra housings in order to prevent water or moisture getting inside the cases.

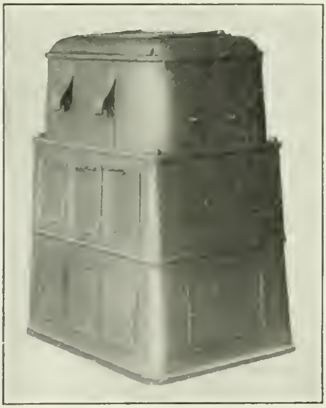


FIG. 7. AIR-BLAST TRANSFORMER

Oil-cooled transformers are those in which the coils and core are immersed in oil, the oil acting as a medium for conducting the heat from the coils to the surrounding case or tank. In addition to acting as a heat-conducting medium the oil serves to preserve the insulation from oxidation, increase the breakdown resistance of the insulation, and tends to "heal" the insulation in case of a puncture. The use of oil in a transformer results in a more rapid conduction of heat between the transformer proper and its case or tank, and the lowering of the temperature prolongs the life of the transformer. The cooling may be further increased by making the containing case with deep vertical corrugations which largely increase the radiating surface, as shown in Fig. 5. Such transformers are used up to about 500 kilowatts capacity.

### AIR-BLAST COOLING

Air-blast transformers are generally of the shell type. As the name indicates, the method of cooling is by a forced blast of air from a fan. One fan or blower generally supplies a number of transformers in the same station, the transformers being placed above an air chamber in which the blower maintains a pressure slightly above that of the surrounding air. The blower may deliver air directly into this chamber, or, if more convenient, it may be located at a distance from the transformers, delivering through a conduit to the air chamber. The core and windings are separately cooled. The air for cooling the windings passes up through the transformer between the coils, which are held apart by spacing strips, and discharges through the top of the case. This opening is provided with a damper for regulating the amount of air passing through the coils. The air for cooling the core passes from the lower housing through ventilating ducts spaced at frequent intervals in the core. The direction of the air currents is indicated by the arrows in sectional view shown in Fig. 6. An exterior view of an air-blast transformer is shown in Fig. 7.

Oil-insulated, water-cooled transformers are built in the largest sizes for the highest voltage that can be maintained successfully on modern transmission lines. In this type of transformer cooling is accomplished by cooled oil passing through ducts between the coils and the core. The oil is cooled by passing water of a comparatively low temperature through pipes

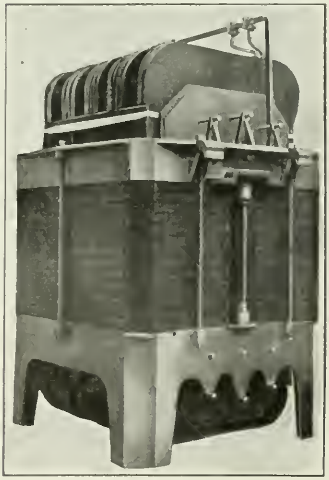


FIG. 8. INTERIOR OF OIL-INSULATED WATER COOLED TRANSFORMER

immersed in the oil. In order to guard against leakage and condensation of moisture on their surface, the cooling pipes are made without any seam or joint within the tank and they are kept wholly below the upper surface of the oil. The complete core and windings of a transformers of this type are shown in Fig. 8. They are inclosed by a heavy boiler-iron case as shown in Fig. 9. The valve near the bottom of the case is for regulating the flow of water.

### TRANSFORMER OIL

Transformer oil should be free from any conducting material and should be sufficiently thin to circulate rapidly when subjected to differences of temperature at different places, and its igniting temperature should be very high. Although numerous kinds of oil have been tried in transformers, mineral oil is now used almost exclusively. It is obtained by fractional distillation of petroleum unmixed with any other substance, and without subsequent chemical treatment. A good grade of transformer oil should show very little evaporation at 100 degrees Centigrade, and it should not give off gases so as to produce an explosive mixture with the surrounding air at a temperature below 180 degrees Centigrade.

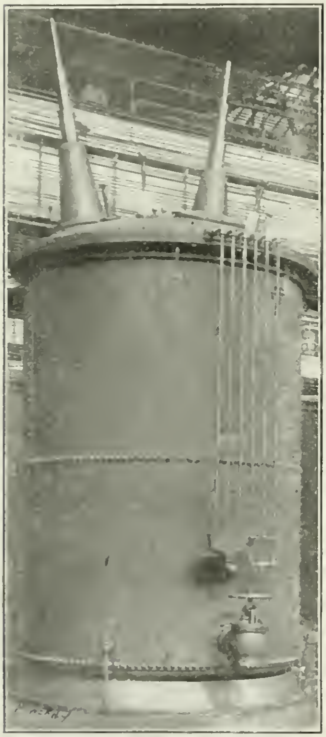


FIG. 9. OIL-INSULATED WATER-COOLED TRANSFORMER

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Recently the fireman of the Waring Hat Factory Company, Yonkers, N. Y., was instantly killed by the bursting of a steam pipe.

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## The Conservation Controversy

By HERMAN B. WALKER

If the United States were wholly dependent upon steam for power, and upon coal to generate that power, the fuel and power problem would be an increasingly difficult one. Fortunately, however, the dawn of the electrical age has made available another element water power. But while the supply of water power depends only upon the rainfall, and is practically perpetual, the stock of water—the available horsepower—is as limited as the coal deposits. The rainfall on the land in the United States averages 200,000,000,000,000 cubic feet per annum, or about the volume of ten Mississippi rivers. About half of this rainfall is evaporated; a third runs into the sea through the rivers and other streams; the remaining sixth is consumed or absorbed. The third which runs into the sea, the volume of a little more than three Mississippis distributed throughout the country, furnishes the water-power potentialities of the future.

The hydrographic branch of the Geological Survey estimates that the amount of water power now available at a cost comparable with the present cost of steam power is 37,000,000 horsepower, while the water power which may at some time be developed, in addition, measures up to 150,000,000 horsepower. The 37,000,000 horsepower classed as now available exceeds the entire mechanical power now in use, and, properly developed and applied, would operate every mill and factory, propel every street car and light every settlement in the country. Its nominal value is computed at $20 per horsepower-year; the price at which it is now sold ranges up to $100 and $150 per horsepower-year.

There is running over Government dams today, unutilized, enough water to produce 1,400,000 horsepower of electricity, according to the chief engineer of the Census Office, while the same authority places the amount of water power in use at 5,350,000 horsepower.

Practically all the coal deposits were once owned by the people—were part of the public domain. In various ways, most of the coal lands found their way into unregulated private ownership; the Government permitting individuals to exploit this valuable natural resource for their own benefit and profit. Today the friends of the conservation movement, which was given its great impetus by the advocacy and support of Theodore Roosevelt, are striving to regulate in the interest of the public the exploitation of the remaining coal deposits, and to save for posterity, through Government regulation of franchise grants and development methods, the recently discovered and priceless heritage of the people contained in the water-power possibilities of the streams.

Clashes of authority and controvers between the Secretary of the Interior, one side, and the heads of the Gove ment forestry and irrigation services the other, recently brought this subj to what seemed to be an acute crisis. C tain acts of Richard A. Ballinger, Sec tary of the Interior, gave rise to critic which amounted practically to charges the Secretary of the Interior has sho himself lacking in enthusiasm, if actually hostile, toward the conservat policies inaugurated under the Roose administration. This controversy, wl seriously embarrassed the Taft admi tration and threatened political con sions in the Western States, where conservation movement comes closer h and is better understood, involves q tions relating to supervision of the for construction of irrigation projects, or leasing of mineral lands, the disp tion of big coal fields in Alaska, regulation of pipe lines through In lands, and the policy to be adopted regard to the disposition or regulatio water-power sites and rights of way pipe lines, conduits, cable lines, etc the public domain.

For several weeks the two point the controversy which engaged most eral attention concerned the title to 000 acres of Alaska coal lands, and secretary's action in restoring to public lands in which water-power are supposed to be located. Gi Pinchot, chief forester, took a stan these questions in which he came sharp collision with the secretary, President Taft ordered an investig of facts involved in the Alaskan troversy, and of charges made by Glavis, a chief of field division i employ of the General Land Office. practically charged that Ballinger ar assistants sought to ignore eviden fraud he presented in connection wi Alaska claims, and that he prevente being given to these fraudulent clai only by becoming insubordinate an ing over the heads of the Land authorities in the presentation facts. The complete story of th troversy is long and involved. enough for the present purpose forth the main facts.

There is a nice constitutional q as to whether the Federal Gover or the State controls the use water power in the streams. The own the water, and the central G ment controls and regulates its u navigation. Most of the big rive streams run through more than one Mr. Taft, when he was Secretary o took the position that the right United States extends to the reg of the use and development of strea purposes subsidiary to navigation. Othe authorities have agreed with hi and Mr. Roosevelt took this view; t is, that any use made of a stream f n it source to its mouth is subsidiary to navigation, and for this reason the Government has a right to exercise a power of regulation over streams even above the head of navigation.

Finding himself opposed by Congress, and hampered in his regulation policies by the difficulty of obtaining laws to promote the conservation program, Mr. Roosevelt simply locked the door against further immediate land, coal, forest and water grabs by withdrawing from entry the remaining coal, mineral, forest and phosphate lands, and the lands containing water-power sites.

Today there is about half a billion acres left in the public domain. In addition, [illegible],000,000 acres, or an area equal to at of Texas and Ohio, is included in the National Forests. The laws provide for the regulation of timber cutting and grazing in the forest reserves; also for the leasing and regulation of water-power sites in this territory. Within the last year the Forest Service has inaugurated policy of leasing power sites and rights of way, limiting the tenure of the grant, exercising a control over the price charged for power by adjustment of the lease price. In other words, a corporation permitted to develop water power and it, and the price it pays the Government for the privilege is mainly determined by the price it charges consumers for its service.

So far as the lands remaining in the public domain are concerned, however, there exists no such power of lease or regulation. Coal and other mineral lands, agricultural and grazing lands, stone or timber lands, may be given away or sold, they may be held by the Government. disposed of, it must be in fee simple. re is no provision in the laws for regulation of development, lease, or regulation of output and price. For the disposition of the water powers, no provision whatever is made in the laws. The of water power, as such, is not recognized. No one had thought of the having a special water-power when the laws were made, and since e has come to be recognized, Congress has refused or neglected to any new laws on the subject. Until years ago water-power sites were away or sold at a nominal price, in perpetuity and without restriction. It had, been the policy of Congress to grant perpetual franchises to anybody who wanted to build a dam anywhere, equally without question.

In addition to withdrawing from entry the lands containing water-power sites, Mr. Roosevelt vetoed, in 1908, a bill passed by Congress giving a corporation the right to build a dam across Rainy river, and to use the waters of that stream, unregulated, for generation of power. In this message the President said:

"We are now at the beginning of great development in water power. Its use through electrical transmission is entering more and more largely into every element of the daily life of the people. Already the evils of monopoly are becoming manifest; already the experience of the past shows the caution necessary in making unrestricted grants of this great power.

"The effect of granting privileges such as are conferred by these bills, as I said in a recent message, taken together with rights already acquired under State laws, would be to give away properties of enormous value. Through lack of foresight we have formed the habit of granting without compensation extremely valuable public rights, amounting to monopolies, on navigable streams and on the public domain. The repurchase at great expense of water rights thus carelessly given away without return has already begun in the East, and before long will be necessary in the West also. No rights involving water power should be granted to any corporation in perpetuity, but only for a length of time sufficient to allow them to conduct their business profitably. A reasonable charge should, of course, be made for valuable rights and privileges which they obtain from the national Government. The values for which this charge is made will ultimately, through the natural growth and orderly development of our population and industries, reach enormous amounts. A fair share of the increase should be safeguarded for the people, from whose labor it springs. The proceeds thus secured, after the cost of administration and improvement has been met, should naturally be devoted to the development of our inland waterways."

After this veto, the Rainy River Company, by an agreement in writing approved by the War Department, secured the rights it wanted, subject to a time limit and a reasonable charge. Last January Congress passed a bill for the building of a dam across the James river, in Missouri, without restrictions of any kind. This, also, the President vetoed. In his veto message he included a report from the Bureau of Corporations, showing that thirteen large concerns then held water-power installations and advantageous water-power sites aggregating 1,046,000 horsepower, where the control by these large concerns was admitted. In addition to this 19 per cent. of the total water power in use held under direct control, the reports of the Bureau of Corporations showed indirect or probable control or interest by these large concerns in other sites aggregating, in all, fully one-third of the total water power in use. In this veto message Mr. Roosevelt said:

"The people of the country are threatened by a monopoly far more powerful because in far closer touch with their domestic and industrial life, than anything known to our experience. A single generation will see the exhaustion of our natural resources of oil and gas and such a rise in the price of coal as will make the price of electrically transmitted water power a controlling factor in transportation, in manufacturing, and in household lighting and heating.

"To give away, without conditions, this, one of the greatest of our resources, would be an act of folly. If we are guilty of it, our children will be forced to pay an annual return upon a capitalization based upon the highest prices which 'the traffic will bear.' They will find themselves face to face with powerful interests intrenched behind the doctrine of 'vested rights' and strengthened by every defense which money can buy and the ingenuity of able lawyers can devise. Long before that time they may and very probably will have become a consolidated interest, controlled from the great financial centers, dictating the terms upon which the citizen can conduct his business or earn his livelihood, and not amenable to the wholesome check of public opinion.

"This astonishing consolidation has taken place practically within the last five years. The movement is still in its infancy, and unless it is controlled the history of the oil industry will be repeated in the hydroelectric-power industry, with results far more oppressive and disastrous for the people. It is true that the great bulk of our potential water power is as yet undeveloped, but the sites which are now controlled by combinations are those which offer the greatest advantages and therefore hold a strategic position.

"It is, in my opinion, relatively unimportant for us to know whether or not the promoters of this particular project are affiliated with any of these great corporations. If we make an unconditional grant to this grantee, our control over it ceases. He, or any purchaser from him, will be free to sell his rights to any one of them at pleasure. The time to attach conditions and prevent monopoly is when a grant is made."

Subsequent events have emphasized the timeliness of the warning given by Roosevelt, and have shown that the growth of the "Water Power Trust"—the further concentration of water powers, developed and undeveloped, in a few hands, is going steadily forward. This has been strikingly impressed upon the country by both official and unofficial investigations. Because of niggardly policy in the matter of appropriations for surveys, maps and scientific investigation, the Government doesn't really know how much it owns, or what is the extent of its resources. Surveyors and other Government employees engaged in mapping the public domain in recent years tell of meeting in the forests and mountains engineers and surveyors employed by private corporations, whose knowledge and maps of the public domain and the water-power sites are more completely than possessed by Uncle Sam. Investigations of claims for homesteads, in some instances, have shown how corporations owning water-power sites, still undeveloped, have craftily secured rights of way for their cables and pipe lines and conduits across the public domain to the nearest cities and towns, by purchasing or fraudulently making homestead or mining claims.

It has been emphasized that every water power site ever secured by individuals or corporations in the public domain has been secured fraudulently. This does not mean criminally. It's the difference between vice and crime. For illustration the corporation which owns the reservoir which supplies Denver with water gained title to its dam site by entering the site as a building-stone claim. The Government sold this claim, now worth many millions, for a few hundred dollars. In southern California, where the water-power monopoly is so complete that already protests are being made against extortionate prices charged for electricity, most of the power sites and rights of way were taken up by the corporations under the guise of entries for building stone claims, grazing lands, timber lands, or even as placer-mining claims.

But Congress adjourned this year without legislating on the subject, and Roosevelt went out of office without having accomplished more than to reserve the water power sites contained in the public lands from immediate entry and occupation. Soon after Mr Ballinger became Secretary of the Interior he restored to entry about two-thirds of the lands of this character which Roosevelt had withdrawn. When a protest was raised, he explained that the withdrawals had been hastily made, many of the lands withdrawn did not contain water power sites, and it was his intention to have the Geological Survey make a complete investigation and a classification of all the water power sites, which would then be properly withdrawn

This was in March I have positive information that no Geological Survey agents went into the field for this purpose until June. So great was the protest against the restoration of these lands, however, that Ballinger began almost immediately to rewithdraw them, and up to the present time about two thirds of those withdrawn under the Roosevelt administration have been rewithdrawn, while other rewithdrawals are being made almost daily. There is a charge that the restorations made in March, and which did not go into effect for thirty days after the order was made, although such orders usually go into effect at once, had the effect of permitting one water company in Montana to secure the lands it wanted and which were necessary to complete its power site and right of way. There is controversy as to the facts in this connection. More important was the statement made by Ballinger, in defense of his action, in which he declared that the settled land policy of the Government was to get rid of the lands by giving them or selling them to individuals, as fast as possible, so that their resources might be developed quickly. This declaration was interpreted as a covert attack upon the Roosevelt policies of conservation, leasing and regulation Followed by a statement from Assistant Secretary McHarg, of the Department of Commerce and Labor, in which he ridiculed the whole conservation movement and said Roosevelt had attempted to do things which only God could do, the effect was produced of two men prominent in the Taft administration, one of them a Cabinet officer, having apparently repudiated the conservation program, to which the President has repeatedly pledged his sympathy and support McHarg resigned at about the time he made his statement, and has since left the Government service.

The principle at stake in the Alaska coal-land cases, around which the most bitter of the controversies has raged, is the same as that involved in the water-power situation. Alaska's vast mineral resources are as yet almost untouched, but are already largely monopolized. Thus, most of the known copper deposits in that country have been secured, in one way or another, by the Guggenheim smelter trust. The coal deposits in Alaska are extensive and will some day be valuable. The laws permit only the outright sale of coal lands in the public domain in Alaska. Failing to secure better laws from Congress, Mr. Roosevelt, three years ago, withdrew from entry all the coal lands there, as he had in the United States.

At the time these withdrawals were made, however, there were about 1300 coal-land claims pending before the Land Office authorities. These claims comprise practically all the coalfields in the Katalda district, in southern Alaska, covering something like 100,000 acres. The coal beds in this district produce a superior quality of steam coal, and the value of the lands in question is estimated all the way up to two billion dollars.

Under the old laws the Government price fixed for the sale of Alaska coal lands is $10 an acre. At this price, an individual may take up not more than 160 acres, an association of two or more persons may take up not more than 320 acres, and an association investing not less than $5000 may have 640 acres. The laws made it illegal for individuals to locate claims for the purpose of selling them to others. Investigation disclosed that there had been extensive frauds in the locating of these 1300 claims. Because of the evidence of collusion presented to him, former Secretary Garfield of the Department of the Interior, hac prevented these claims from going t patent.

It was discovered that about 300 o these claims, which have become know as the Cunningham group, were controlle directly by one syndicate. Land Offic officials testified before a committee o Congress, last winter, as to the extent o these frauds. Henry H. Schwartz, chie of the field service in the Land Office, tol this committee that Glavis, who made th charges against Ballinger's departmen was an honest and careful man. Schwart also went into detail as to the method employed in locating claims in Alask He said his office had evidence at th time to prove that 500 of the 1,300 pen ing claims were fraudulent, and had bee filed with the purpose of securing t entire Katalda coalfield for a single lar interest. This interest was the Gugge heim syndicate, near whose Alaska copp mines the Katalda coalfields are locate Present labor conditions in Alaska, fact, make these coal deposits of lit value to anybody but the Guggenhein although the completion of the Panan canal is expected to give Alaska coal new market and new value.

Schwartz's testimony, last January, p sents details as to the manner in wh lawyers and agents of the syndicate h gone through Western mining and ra road camps obtaining powers of attorn from laborers, whose names were la used in locating coal claims in the Katal district. Through the use of these dum entrymen; the syndicate located hundr of claims, supposed to be for individu but which, if allowed to go to pat would have been at once transferred t single ownership.

Mr. Garfield has not appeared in present controversy as yet, but it is kno from his own testimony before C gressional committees, that he regar all these claims as fraudulent, and ordered them held up. Ballinger at the time, general commissioner of Land Office. Congress interfered in effort to help out the Guggenheims the Cunningham syndicate. In 1907 a was passed in the last day of the sion, permitting an individual to n entry and take patents to 1280 acre Alaska's coal lands. President Roos refused to sign the measure, on the gr that it was intended to aid toward monopoly of Alaska coal. In 1908 S tor Heyburn of Idaho and Represent Mondell, of Wyoming, introduced to validate the fraudulent Alaska cla s, and Congress passed a bill permi pending claims to be consolidated so one person or corporation might 2580 acres. Governor Hoggatt, of Al a, and others, urged upon the comn ee that larger claims were necessary. it was not profitable to work the all claims permitted under the old law. S ary Garfield, however, protested against hrowing the door wide open, and as a esult of his arguments, the bill as passed rovided that only "valid" claims might e consolidated.

Immediately after the passage of this aw, Ballinger resigned from the Land Office, and soon afterward appeared as ttorney for the Cunningham syndicate, leading that the pending claims be allowed to go to patent. His efforts were tile, however, and these claims were till held up when he became Secretary the Interior last March. Soon after at, Glavis, who was still in charge of e cases, was ordered to prepare these laims for patent. He protested, again ging the evidences of fraud and collusion, and the cases were taken out of hands and given to another agent. hen Glavis went to the Forest Service ith his evidence, and the law department Mr. Pinchot's division took up the atter, on the ground that a large part the lands in question were within borders of a forest reserve. This terference brought from the Interior epartment an order for an investigation the claims, and an apparent change policy regarding them. Glavis and Forest Service lawyers urged that Cunningham syndicate and others imicated should be prosecuted for conspiracy Assistant Secretary Pierce, of Interior Department, wrote a decision t there were no grounds on which to se such a charge. His decision was rned up to Attorney General Wickersham, who reversed him, asserted that facts presented made a clear case of conspiracy under the statutes. Glavis called Beverly, presented the facts and evidence in his possession to President Taft, the latter ordered complete records the history of the Alaska claims to be de to him.

pon his review of the records as presented the President authorized Mr. Ballinger to dismiss L. R. Glavis from the service of the Government for "filing a disingenuous statement, unjustly inpeaching the official integrity of his superior officers," and in his letter to Ballinger reviews the accusations as follows:

cannot close this letter without referring to certain other matters connected with your conduct of the Interior Department which have been unfairly used in the public press to support a general charge that you are out of sympathy with the declared policy of this administration, following that of President Roosevelt in favor of the conservation of National resources, especially in connection with coal lands, with water-power sites, and with the system of reclamation of arid lands, which are all within the jurisdiction of the Interior Department.

In the first place, it was charged on the floor of the Irrigation Convention at Spokane by former Governor Pardee of California that you had restored to the public domain for settlement certain lands which had been withdrawn by the last administration for the purpose of conserving water power sites, and that after complaint made thereof you had subsequently withdrawn some of the lands again from settlement; but that meantime, between the one act and the other, an opportunity had been given to the so-called 'Water Power Trust' to file entries and obtain vested rights in valuable water-power sites in the State of Montana.

"When the facts are examined in this regard, it will be found that the persons responsible for the circulation of these charges have done you cruel injustice. The fact was that in January, 1909, in the last administration, executive orders were made withdrawing from public settlement 1,500,000 acres at the instance of the Reclamation Service, for conservation of water power sites. Soon after you became Secretary of the Interior, you brought this order to my attention, and said that it included a great deal of land that had no water-power sites on it, running back many miles from the rivers, and that it included much land which ought to be opened to public settlement; that you had applied to the Reclamation Bureau to know whether it was desired for reclamation purposes, and what their recommendation was in the premises, and that they recommended that it be returned to the public domain."

The order revoking the withdrawal of the 1,500,000 acres was made in April. Sufficient information was procured from the Geological Survey to permit an order withdrawing the land upon which were water-power sites in May, and this withdrawal covered about 300,000 acres instead of 1,500,000. The form of the new order of withdrawal was such that it set aside all filings and entries of any kind which had been made prior to its going into effect; and, as a matter of fact, not one single filing has been attempted on any of the water-power sites since the original order of withdrawal in January, 1909.

"It further appears from a report of the Director of the Geological Survey that the order of withdrawal of January, 1909, was hastily made by townships and by reference to inadequate maps, that it included large areas not within miles of any river or stream, and that it failed to include many valuable water-power sites in the immediate vicinity.

"From the same reliable source it is learned that under the withdrawals made by your department from time to time, beginning in May last, there are now withheld from settlement awaiting the action of Congress, 50 per cent more water sites than under previous withdrawals, and that this has been effected by a withdrawal from settlement of only one-fifth of the amount of land.

"Another instance in your conduct of the department which has been mentioned as indicative of your purpose to block the general plan of conservation of National resources, is your refusal to carry out a contract made in the last administration between the Secretary of the Interior and the Secretary of Agriculture, by which the Interior Department delegated to the Forestry Bureau of the Agricultural Department the power and duty to conserve the forests on the Indian reservations, and to expend under the control of the Forestry Bureau the money appropriated by Congress to be expended by the Indian Bureau for such conservation of Indian forests.

"Your declination to carry out the contract was made necessary by a ruling of the Controller, whose ruling is final and without appeal even to the President, that such an arrangement is a delegation of responsibility and authority for the expenditure of money which the appropriation by Congress for the Indian Bureau did not authorize.

"In my judgment he is the best friend of the policy of conservation of natural resources who insists that every step taken in that direction should be within the law and buttressed by legal authority. Insistence on this is not inconsistent with a whole-hearted and bona fide interest and enthusiasm in favor of the conservation policy. From my conferences with you and from everything I know in respect to the conduct of your department I am able to say that you are fully in sympathy with the attitude of this administration in favor of the conservation of natural resources."

## Wind-Electric Power

An interesting demonstration was recently given in England of an electric-generating plant operated by a windmill. The wind wheel was 16 feet in diameter, and was mounted on a tower 50 feet high. Three tails were provided, one at the side being fixed, and the other two adapted to be rotated on a horizontal axis, so that when they were turned into the vertical plane they would hold the wheel into the wind, and when turned in the horizontal plane, the fixed tail would throw the plane of the wheel in the plane of the wind. The two movable tails were arranged to swing out of the vertical position, automatically, when the velocity of the wind rose above a certain amount. A 2-kilowatt generator was driven by the wheel at speeds varying from 800 to 1600 revolutions per minute. Six switches were provided to control the field circuit by throwing in a resistance when the current generated reached 5, 8, 11, 14, 17 and 20 amperes respectively. The current was used to charge a storage battery, which could be drawn upon as required for operating various electrical apparatus.—*The Roller Mill.*

# An Interesting Small Power Plant

By J. B Van Brussel

The central station recently installed at Chichester, England, is of special interest owing to the fact that the generators are driven by Diesel oil engines. The building itself is a very simple affair, comprising merely an engine house of red brick, lined inside with white, glazed bricks. The floor is of black and white terrazzo with a black border. The interior is spanned by a 5-ton crane.

The plant equipment, which is illustrated in Fig. 1, consists of two Diesel oil engines direct-coupled to two 100-kilowatt 500-volt direct-current generators, which are driven at 250 revolutions per minute. Provision has been made on the generators for the addition of compound field windings, should they be required for traction purposes. Starting up is effected by compressed air stored in suitable receivers, and it is stated that an engine can be started and fully loaded within two or three minutes.

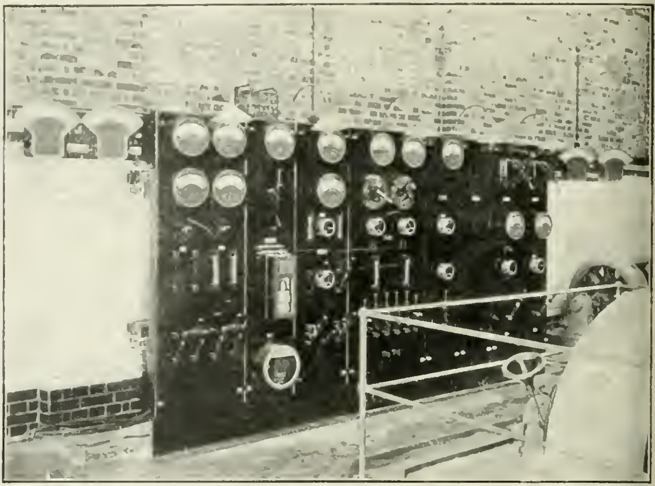


FIG. 2. SWITCHBOARD AT CHICHESTER ELECTRIC WORKS

Water for the cylinder jackets is drawn from a canal adjacent to the works by a circulating pump driven by spur gears from the engine shaft. About 600 gallons of water per hour are passed through the cylinder jackets when the engines are developing full load, and a visible outlet is provided for inspection of the water circulation.

A circular tank 6 feet 9 inches by 12 feet 4 inches, situated near the engine house, provides sufficient oil storage to run both engines continuously for a week. It is worth noting that when the oil ha been delivered to the storage tank n further handling is necessary, so that th labor required is reduced to a minimum.

As a three-wire system of distributio is employed, with 440 volts across th outer wires, a balancer has been installe

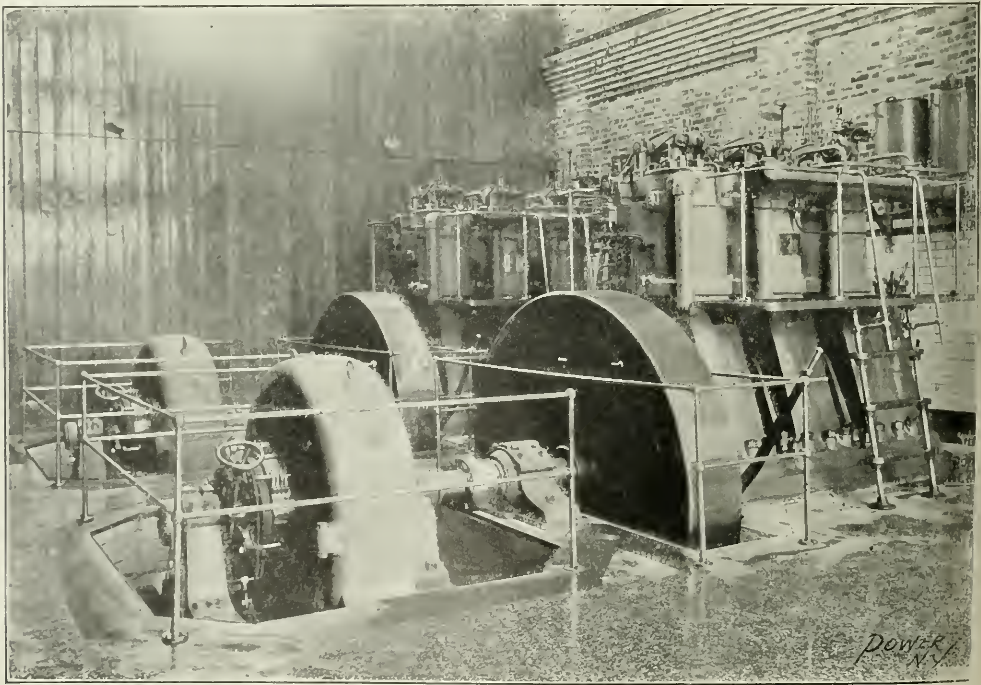


FIG. 1. GENERAL VIEW OF CHICHESTER ELECTRIC WORKS

sisting of two 25-kilowatt shunt-wound hines coupled together on a single bed-p

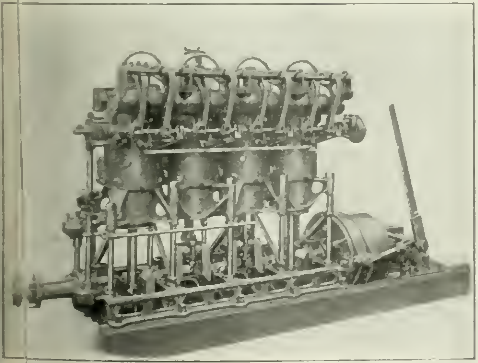
he switchboard (Fig. 2) is of standard gn for a three-wire system. It will oticed from the picture that the board arranged to control three generators, panel being provided for a third ma-ne. The panels, from left to right, for feeders, neutral wire, balancer, ery, motor, dynamo (extension) and two existing dynamos. While pro n is made for the installation of a ery, one has not yet been installed. e feeders are triple-concentric, lead-red cables drawn into Sykes conduits. hree-core cables are used for the buting network. These latter are red with steel tape and laid directly e ground, a board being placed over to indicate their position when future vations are made.

e prospects of success of the under-g are distinctly bright. When the t began operation more than 1200 s had been connected. It is hoped before long a considerable motor load developed.

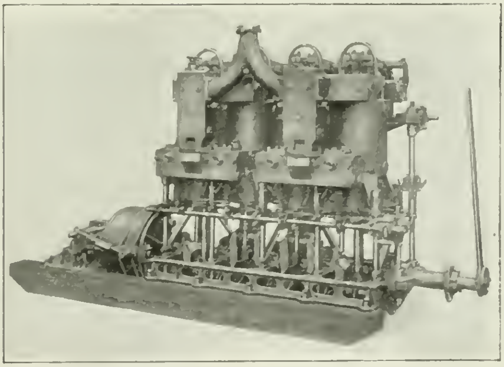
## The Nonmagnetic Ship "Carnegie"

nt and rear views of the engine of nonmagnetic ship "Carnegie" are shown in the accompanying illustrations. The designer and builder is James Craig, Jr., 556 West Thirty-fourth street, New who also designed and built the l combustion engines for the sub-boats "Octopus," "Cuttlefish," etc. "Carnegie" engine is exactly like the , except variations for producer gas of gasolene, and the use of non-tic metal. The hull was designed ry J Gillow, engineer and naval ect, 32 Broadway, New York, who an amateur scientist of ability. The ess was built at the foot of Twenty-th street, Brooklyn, under the supervision of Wallace Downey, vice president and manager of the Tebo Yacht Basin Company, by William H. Payne, constructor. Her displacement is about 600 tons. She combines the seaworthy qualities of an ocean-going vessel with the trim appearance and comforts of a yacht.

For each ton of displacement there is less than one pound of cast iron, and there is no wrought iron or mild steel in her construction. The hull is of wood fastened together with "treenails" (which are wooden spikes driven into bored holes; these treenails are usually made of locust wood) and bolts and spikes of nonmagnetic bronze. Where thin wood and canvas are to be fastened, copper and bronze nails and tacks are used. Every bolt, spike and nail has been tested for magnetism and it is a noteworthy fact that out of the many thousands of metal fastenings used, but *seven* spikes have failed to pass inspection.



FRONT VIEW OF THE ENGINE



REAR VIEW OF THE ENGINE

The mariner, the surveyor and the explorer rely upon the compass or magnetic needle to guide and serve them for their purposes. They must have charts showing how the compass points at all parts of the globe and by what amount it changes from year to year. In the existing charts of the oceans the latitudes and longitudes, the depths, the directions and speeds of currents and variations of the compass, etc., are put down for the mariner's guidance. The variations as set down in these charts are known to be incorrect and the supplying of true magnetic charts and compass data is one of the chief objects of the magnetic survey and incidentally of the "Carnegie."

The magnetic survey is being conducted by the department of terrestial magnetism of the Carnegie Institution of Washington, which Andrew Carnegie endowed with $12,000,000 for the promotion of investigation in widely different fields of inquiry.

The first vessel used for survey purposes was the "Galilee," a vessel which was chartered and adapted as well as conditions would permit. She made a general magnetic survey of the Pacific extending from the Aleutian islands on the north to New Zealand on the south, Asia on the west and the Americas on the east. Her cruises aggregated 60,000 miles and extended from August 1, 1905, to June 1, 1908.

Owing to the fact that iron and steel, both magnetic metals, enter largely into the construction of ships, sensitive magnetic instruments are liable to the influences of such iron and steel parts and accurate readings of such instruments are not possible where such local attraction exists. The "Galilee" was stripped of magnetic fittings wherever possible, but it was obviously impossible to remove all iron and steel from a vessel already built and built without the knowledge that she would some day be devoted to this magnetic research work. The results obtained with her were, however, so satisfactory (errors of 4 to 5 degrees being found in charts) that it was decided to build a vessel as nearly nonmagnetic as possible, and this decision resulted in the launching of the "Carnegie" on June 12, 1909.

The "Carnegie" is equiped with a four-cylinder Craig internal-combustion engine of 150 horsepower. The gas producer consists of a cylinder 6 feet high, with a diameter of 5 feet 6 inches, built of copper with asbestos and firebrick lining and manganese steel grates, anthracite to be used as fuel.

Investigation showed that a gas producer for marine purposes could be built which would generate producer gas for use in internal combustion engines from bituminous coal, anthracite, coke, wood or charcoal, and that such a plant could be constructed almost entirely of nonmagnetic materials. The suction type of producer was adopted chiefly because of its simplicity of construction, and the elimination to a minimum degree of other auxiliary apparatus.

# Practical Letters from Practical Mer

Don't Bother About the Style, but Write Just What You Think,
Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

## Economy in Utilizing the Water of Condensation

Often a great deal of soft water is allowed to go to waste in manufacturing plants, where at the same time considerable sums are paid for water used, and also there is the expense and trouble due to scale-forming matter in the water. If the water of condensation is returned to the boilers it will go a long way toward reducing the water bills, and help greatly in reducing expenses and trouble due to scale.

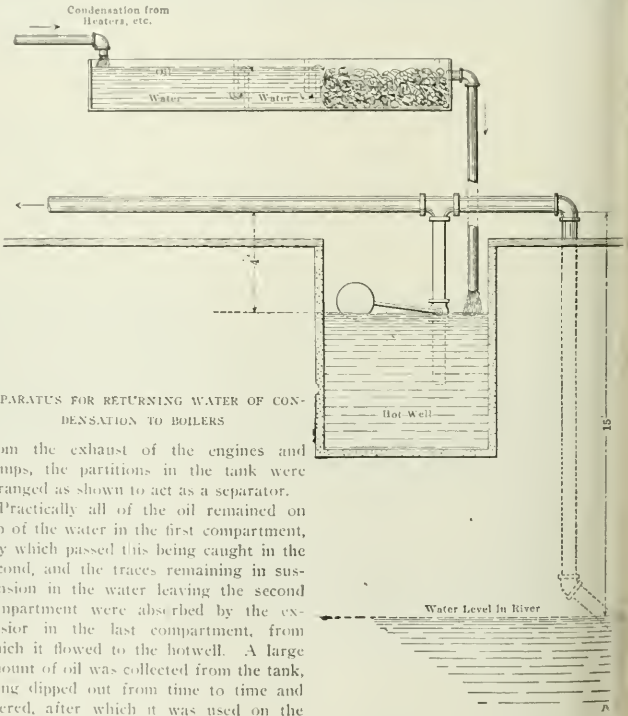
Frequently the reason given for not returning the water to the boilers is that it contains so much cylinder oil there would be danger of burning them, but as it is very easy to separate the oil from the water there is no good reason for wasting either, as both the water and oil can be utilized to advantage in the operation of the plant.

With some kinds of scale-forming matter in the water it is only necessary to add a small amount of soft water in order to neutralize the scale to an extent that will repay the cost; and at the same time reduce the water bills.

In a certain plant there were a battery of six boilers and a Corliss engine which required about the capacity of three of the boilers to operate, the balance of the boiler capacity being required for operating several small engines and steam pumps. The plant covered several acres of ground and these engines and pumps were scattered in different departments, some being several hundred feet from the boilers. A large number of heaters, dry kilns, etc., were used in the different departments, operated with exhaust steam. The feed water for the boilers did not cost anything, as it was taken from a small river which flowed through the company's property. It was very hard, however, and a great deal of trouble was experienced from scale.

More machinery was installed, and things finally got to a point where the boilers would not furnish enough steam, the engineer claiming that more boilers were necessary. Meantime the management had come to the conclusion, that a new engineer was also necessary. A chief engineer was employed who had a reputation for economical operation of plants in this line, and the first thing he did after getting familiar with the plant was to arrange to return all water of condensation to the boilers.

A wooden tank was made as shown in the illustration, being divided into three compartments so that the water flowed from the bottom of each compartment to the top of the next. This tank was placed in the basement and all water of condensation from the heaters, dry kilns, etc., was piped to it. As there was a large amount of cylinder oil in the water from the exhaust of the engines and pumps, the partitions in the tank were arranged as shown to act as a separator.



APPARATUS FOR RETURNING WATER OF CONDENSATION TO BOILERS

Practically all of the oil remained on top of the water in the first compartment, any which passed this being caught in the second, and the traces remaining in suspension in the water leaving the second compartment were absorbed by the excelsior in the last compartment, from which it flowed to the hotwell. A large amount of oil was collected from the tank, being dipped out from time to time and filtered, after which it was used on the heavy slow-running bearings around the factory, which reduced the oil bills.

The boilers had been fed by two duplex steam pumps which were replaced with a geared power pump driven from the main engine shaft; the old pumps being put in good condition, and only used in emergencies. The sketch shows how the water from the hotwell was delivered automatically to the suction of the feed pump by placing a float valve in the pipe. As the water in the river was 10 or 11 feet lower than that in the hotwell, the pump would draw from the hotwell at all tim when the float was in position to adm water through the valve, it being a justed so that the valve was always clos before the water fell below the end of t pipe.

These changes in the plant were ma in the fall, and at this time the boil were badly scaled. Within a few wee after the water of condensation was turned to them the scale began to loos and large quantities were removed at cleaning. By the time cold weather arrived the boilers were practically from scale, and where it had forn been necessary to clean out every weeks, it was now only necessary to about every two or three months. where all six of the boilers had forced to the limit to carry the loa previous winter, only four were no quired to carry a still larger load wi out forcing.

The cost of making these changes was comparatively small, and a large saving in fuel, labor and oil was effected. As there was only a small amount of steam required in the dry kilns in the factory during the summer, a condenser was installed the following spring and the large engine was operated condensing during the months in which heating was not required.

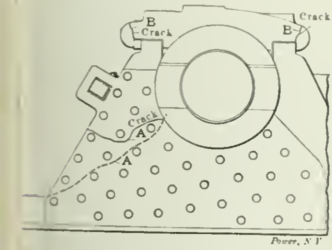
The conditions in this plant were similar o what is to be found in many others hroughout the country, where a small utlay in money and brains would return rofits. As the water did not cost anying in this case the main saving came rom eliminating the expense and trouble ue to scale, while in many other plants e water costs a considerable sum.

S. Kirlin.

Amsterdam, N. Y.

## Engine and Generator Wreck Successfully Repaired

A short time ago we had a very serious reck on one of our 750-horsepower enines. On starting up, water got into the -pressure cylinder, due partly to the ips failing to work on the receiver been the high- and low-pressure cylers, and perhaps more particularly to ew attendant opening the throttle be- the engine was properly warmed up. A piece was broken out of the low-press pillow block, as shown by the lines Figs. 1 and 2, breaking the toes off ap at *B B*, and three spokes of the r were broken entirely off, as shown a *C C*, Fig. 4.



1. SHOWING PATCH AND LOCATION OF CRACKS

he method of repairing the pillow k was as follows: We put a patch inch boiler plate on each side, exing well back and fastened on with t forty 1⅛-inch patch bolts. A bar 4x3½-inch steel, held in place by two extending from patches on either side, two heavy set bolts through the bar screwed up solid against the web on side, took up the thrust of the shaft. A heavy U-bolt *D*, Fig. 3, connected er the center rib and above the cross also helped to close the crack. A new was made with a wedge shown at *E*, F 3. This wedge accommodated the toes of the cap to the pillow block, and when drawn up tight helped greatly to make the job solid. The break across the front was sewed up with 1-inch bolts, cut off flush. This prevented any rocking action that might occur at this point. With a 25 per cent. overload the break shows no signs of weakening.

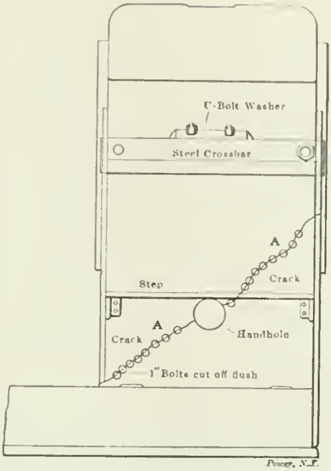


FIG. 2. SHOWING CRACK IN FRONT AND METHOD OF SEWING UP WITH 1-INCH BOLTS

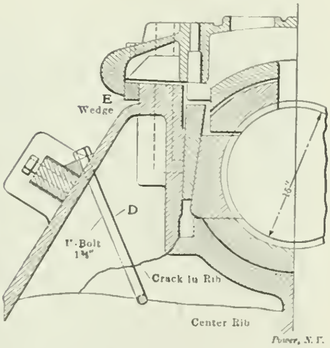


FIG. 3. SECTION; SHOWING U-BOLT IN POSITION ON RIB

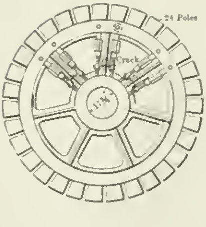


FIG. 4

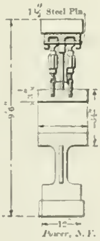


FIG. 5

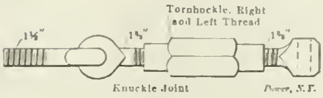


FIG. 6

The rotor was the bigger proposition of the two. At first we thought of putting in filling in pieces, but gave up this idea and decided to put in turnbuckles, there being four buckles to each spoke. The buckle used is shown in Fig. 6. A knuckle joint had to be put in this bolt in order to get it in place. The bolts are screwed into the hub 2½ inches and are 1½ inches in diameter up to the eye and 1⅜ inches from there up. The pins through the rim are 1½ inches in diameter. Those bolts were all tightened up to about one tension and it was found that the cracks had closed appreciably. The rotor is running practically true. The management can see no reason why a new rotor or engine frame should be ordered. The engine is a 20 and 40 by 36-inch cross-compound Corliss running at 125 revolutions per minute, noncondensing. It is direct-connected to a 550-kilowatt alternating-current generator.

F. J. Aldred.

New Aberdeen, C. B., N. S.

## Pump Troubles

Pump troubles are sometimes very difficult to locate, and sometimes quite simple. I was once called to see what was wrong with a pump in a mine when water was up to the cylinder, and went all through the pump and, not finding the trouble, ditched the water out and found a valve that someone had put on in place of a coupling, thus closing an opening.

Another time a Cameron pump gave trouble. It had been running with the large packing ring broken, and not finding anything else wrong except the small rings not fitting the cylinder tight, by peening them with a hammer it worked all right. Another one gave trouble on top. I went all through it and found the slide valve worn. By facing it the pump worked all right.

At another time a pump gave trouble and had to be reversed by hand. It was a Cameron. I took the cylinder head off. Things were all right; the tappets in both ends were right, but acted the same way. I thought something was wrong in the cylinder and someone asked me how it could be there. I took the head off and took out the piston and there found the trouble. Some pump man had substituted a new tappet valve and had pushed the stem of the broken part into the cylinder.

James C. Stewart.

Clovis, N. M.

## Notes on the Pohle Air Lift

The proportions of piping, submergence, etc., may be arrived at mathematically, basing the calculations on the expansion of the air bubbles as they rise to the discharge where the head due to the sum of the water pistons above diminishes, and on the usual formulas covering capacities of air and water pipes; but for practical purposes in the case of small wells the same and often more reliable results may be arrived at from the following:

It is found in practice that the length of pipe submerged below the normal pumping level after the water has fallen should range from 30 to 60 per cent. of the total length of pipe from the bottom end to the top or discharge, the latter ratio of 60 per cent. generally giving the greatest efficiency. The air pressure should vary from three-quarters of the pressure due to the total lift for shallow wells to six-tenths for deep wells. It should be such that it will about equal atmospheric pressure at the point of discharge, unless high velocity is desired at the expense of economy. That is, it should equal the head in feet multiplied by 0.434 plus a few pounds for friction, this latter depending on the length of pipe and friction head. In this connection it should be remembered that where a central air pipe is used in drilled wells, on account of there not being room for the air pipe outside of the water pipe, the friction head is greater. If the compressor is close to the well, the reservoir should be proportioned to reduce all impulses, though in the case of a long air line this will to a great extent take care of itself.

In the case of a large well casing, where the inflow into the well is small, or where the desired amount of water is small in proportion to the capacity of the pipe, the air pipe, if central, should be purposely made large enough to prevent blowing the most desirable proportion, as indicated by practice being about 1 to 2 for small wells and 1 to 3 where the diameter of the water pipe is over 2½ inches; or the area of the water pipe is about six times the area of the air pipe for average cases. If the air is taken from shop air mains, where variable service causes a large variation in air pressure, and the air is not run through a reducing valve, the sudden expansion of high-pressure air at the discharge is likely to cause trouble, if the discharge is into a covered or practically closed tank. This may be relieved by putting a large-sized safety valve at any convenient bend or horizontal pipe at the surface of the ground.

Assuming 60 per cent. submergence, the volume of free air for maximum economy may be roughly taken from the following: For lifts of 25 feet, 13 cubic feet of air for 100 gallons of water; for lifts of 75 feet, 28 cubic feet of air per 100 gallons of water; for lifts of 100 feet, 36 cubic feet of air per 100 gallons of water; for lifts of 150 feet, 57 cubic feet of air per 100 gallons of water, for lifts of 200 feet, 75 cubic feet of air per 100 gallons of water.

With side inlets and ¾-inch air pipes and 1½-inch water pipe, the ordinary capacity will be about 25 gallons per minute, and for larger wells the capacity may be assumed as varying nearly but not quite with the square of the diameter of the water pipe. For example, a 6-inch water pipe will ordinarily give a flow at fair economy of from 400 to 425 gallons per minute. In the case of central air pipe with 3½-inch casing, the output should be about 110 gallons per minute, or 230 gallons with 5-inch pipe, and other sizes in proportion. Generally speaking, from 10 to 14 gallons per square inch of area of water pipe, after deducting the air-pipe area, will be about right, the smaller figure being used for short lifts and the larger figure for lifts of 100 feet or over.

The matter of economy is generally misunderstood and most of the claims of high efficiency should be taken with rather a liberal allowance. While under favorable conditions it may be possible to approach 70 or 80 per cent. efficiency figured from the discharge back to the indicated horsepower of the compressor, most of the tests of ordinary wells where extreme submergence is not possible seem to indicate efficiencies between 20 and 35 per cent.

It should be understood and remembered, also, that the air lift is not well adapted to forcing water horizontally and horizontal discharges of over 40 or 50 feet should be avoided, except by discharging into a tank with a gravity flow the rest of the distance.

W. S. Anderson.

Urbana, Ill.

## Old-Time Portable Engine

Fig. 1 shows a peculiar construction in portable-engine design. Possibly the better part of a century has passed since it was built. This engine was made in England, but of course all the small steam fittings, as well as the steam governor, have been recently put on.

The crosshead is a simple casting, running on a round guide having a flattened top side, with a gib and two set screws for making the adjustment for wear. The connecting rod, as can be seen, has marine end working on a very small cra pin, and the back-end adjustment is ma by a key working against a plunger in t end of the rod. The crank wheel serv as a balance wheel as well as a cra wheel. The main shaft extends thr beneath the boiler and has a band w on the opposite side. It is to be noted t the main spider casting that carries t main shaft has as much metal in its mak up as the entire engine. The eccent is on the straight-line principle, go straight back to the valves. This one po in the construction of this engine a boiler is of much interest because of rare design.

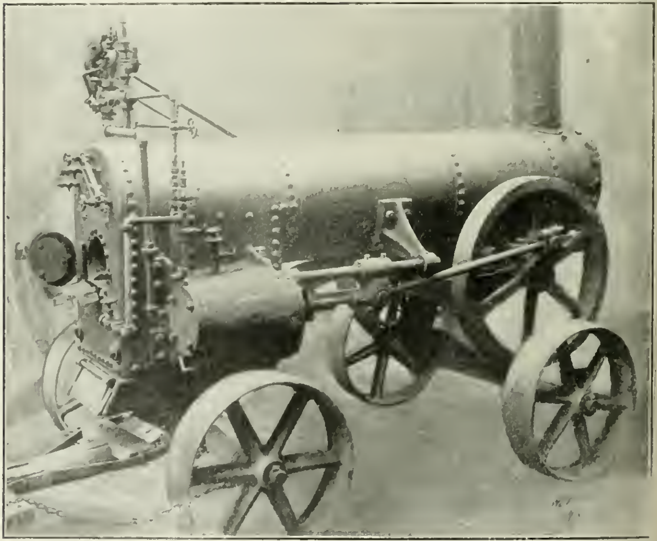


FIG. 1. AN OLD-TIME PORTABLE ENGINE

The flues, as shown in Fig. 2, are inches at the small or firebox end and 2½ inches at the smokebox end, tape st as shown. The flues as well as the ites are made of the best soft iron, hich goes to uphold the theory of less rrosion from old brands of iron than the w-process iron or steel. While some ep pits are in plain sight, as a whole plates have stood wonderfully well. e firedoor is made of the same plate as boiler latch. The rivet pitch is un-ual. The crank pin is about 1 inch in

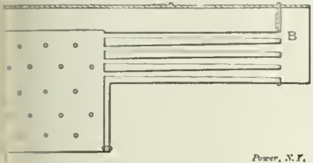


FIG. 2

meter, while the engine cylinder is ap-ximately 7x14 inches.

e design is peculiarly American, ecially the tapering lap-welded flues.

C. R. McGahey.

Richmond, Va.

## A Peculiar Power Plant Accident

ently a peculiar accident happened in the plant of the Sturgis Light and Power Company, breaking the main journal, springing the crank pin and bending the connecting rod on the 10 and 20 by 24-inch tandem compound Corliss engine. The journal cap also broke into pieces. At the time the load was light. There was 1½ gages of water in the boiler, 100 pounds boiler pressure, 5 pounds receiver pressure and 22 inches of vacuum. The speed of the engine was 100 revolutions per minute. The meters showed a load of 10 amperes, or approximately 30 horsepower.

I had just oiled the valve gear all around and then blew down the oil trap connected to the oil separator on the exhaust line. When I stepped to the switch of the horsepower motor that runs the circulating pump on the evaporative surface condenser and pulled it out, about 15 seconds later, the crash came. The motor took about 2 amperes, which would still leave a load of about 8 amperes or about 24 horsepower. The condenser was cool, above 75 or 80 degrees Fahrenheit. The vacuum pump was running well and the relief valve was tight, as the vacuum still stood at 22 inches, when I closed the throttle.

The wreck was caused by water in the low-pressure cylinder. The cylinder is provided with relief valves which operate at [illegible] pounds, but could not relieve it quickly enough to save the journal. The receiver is placed on the crank side of the engine, under the floor, from which the steam rises to the top of the low-pressure cylinder, which exhausts through a 10-inch pipe to the condenser. The exhaust pipe runs down 1 foot from the cylinder, then 3 feet 6 inches to the side of the foundation, turning through another ell and along a horizontal line a distance of 30 feet 6 inches to another ell, where it rises about 16 feet, going through an Austin vertical oil separator to the condenser, which it enters through the side of a 10-inch tee with a relief valve on top of the tee. The receiver is 2 feet in diameter and 4 feet long, steam entering one end at the center and leaving at the top, at the center of length. There is no trap connected to the receiver.

The engine had been in continuous operation for 8 hours at the time of the accident. The governor, governor belt and valve gear were all in good shape afterward, working freely by hand. The load is generally 18 to 19 amperes from midnight till 4 a.m., when it gradually drops to 10 or 11 amperes. I should like to be told how the water got into the cylinder. There is always a little water in the receiver when the engine and opening drain are shut down.

O. J. Lynge.

Sturgis, S. D.

## Babbitting Large Engine Bearings

Main-bearing troubles originate in most cases in improper workmanship, and give no end of trouble, causing constant attention, numerous shutdowns and expense. Every engineer has lost part of his Sunday-school training over hot bearings, and should not forget it when it becomes necessary to rebabbitt them.

The common way of filling the boxes by pouring metal around the shaft and scraping to a fit is the cheapest way, as far as the job is concerned, but not in the long run.

If the engineer is employed by a man of good judgment, he will be permitted to use the best way. Those who are employed by men of no judgment have my sympathy, and I advise them to hunt better quarters, or their beds will be of thorns all their days and their time will be used up at the end of a hose, squirting water on the pet bearing.

In the first place, it is impossible to pour metal in a box casting and keep it snug and tight without peening the surface of the metal with the peen end of a hammer, as this stretches the metal on the surface, causing it to set snug and tight next to the casting and in the anchors.

To peen a bearing it is necessary to use more metal and a lathe or boring machine as the metal has to be enough thicker to allow the peening, which dents up the surface, and such dents must be bored out.

Some bearings are so designed that the bottom will come out by jacking up the crank shaft enough to take off the weight, while a few are so designed as to make it impossible to remove the bottom, it and the frame being cast together. The latter case makes the most expensive operation, requiring the crank shaft to be taken out and the use of a portable boring bar.

In pouring bearings I have found that the metal should be three-eighths thicker than required. A good way is to turn up a wooden mandrel ¾ inch smaller than the required size and 4 inches longer than the bearing. Cut out two circular pieces from 1-inch boards, the circle being the same as the wooden mandrel. Use these pieces to hold the mandrel in place while pouring the metal. Be careful to clamp, putty and weight down the wooden mandrel properly. Peen as explained and set the bearing up on a lathe or boring machine. Be careful to set up perfectly square as this is the most important operation. I would advise the services of a good machinist for this.

Where the bottom cannot be removed babbitt the same way. The only difference is in boring, which must be done on the engine with a portable boring bar.

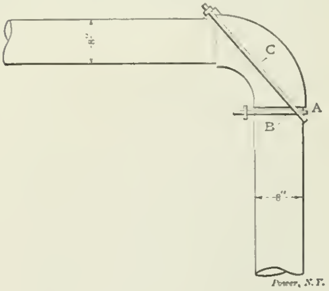
When bearings are made in this manner and properly lubricated they will give no trouble if good metal has been used. They will be much cheaper in the long run.

John S. Van Pelt.

Augusta, Ga.

## Curing a Leak in a Steam Pipe

The accompanying illustration is of a job I did on an 8-inch steam pipe. It is past the experimental stage, having held the joint tight seven months. The leak was at *A*, where there was copper calking. The clamp *B* is a ⅝-inch iron rod, bent to the shape of a horseshoe, with both ends threaded. It was passed through holes in a piece of strap-iron, ⅞ and 2½ by 12 inches, then the nuts were put on and drawn tight. The clamp *C* was put on in the same way, the only difference being in the size of the rod, which was 1 inch. Then the copper was put in and clamp *C* tightened, and the copper calked.



CURING A LEAK IN A STEAM PIPE

E. W. Jackson.

Muddy, Ill.

# Telltale to Show Condition of Spark Plugs

The accompanying is a diagram of the method which I connected to a make-and-break ignition system of a producer-gas engine, with telltale lamps which indicate the condition of the spark plugs. This is a three cylinder engine. To start it the three-pole switch is thrown to the side on which there are five poles (or to the right). This puts the batteries in series with the spark plugs and cuts out the telltale lamps on the switchboard. When the engine is up to speed, I throw the switch to the left, which connects the spark plugs to the magneto circuit, which connects the little telltale lamp in series with its respective plug. When a circuit is complete the lamp lights. In other words, when the engine is running by the magneto there is a continual blinking of the lights, one after another.

The condition of the plugs is detected by the brilliancy of the lights. If a light becomes dim it indicates that the plug to which it is connected needs cleaning. This can be done in this engine while running, by shutting off the gas in this cylinder. Clean the plug, replace and connect up again, after which the light will come up bright. This switch is a standard 25-ampere switch with two extra poles on the middle bar. This bar just short circuits the lamps when the batteries are the source of power to ignite, so that the batteries are not pulled down so fast. The lamps are 4-candlepower, 10-volt.

If this system is installed on an engine there must be a pole on the middle bar (battery side of the switch) for each cylinder.

J. E. Kessler.

Philadelphia, Penn.

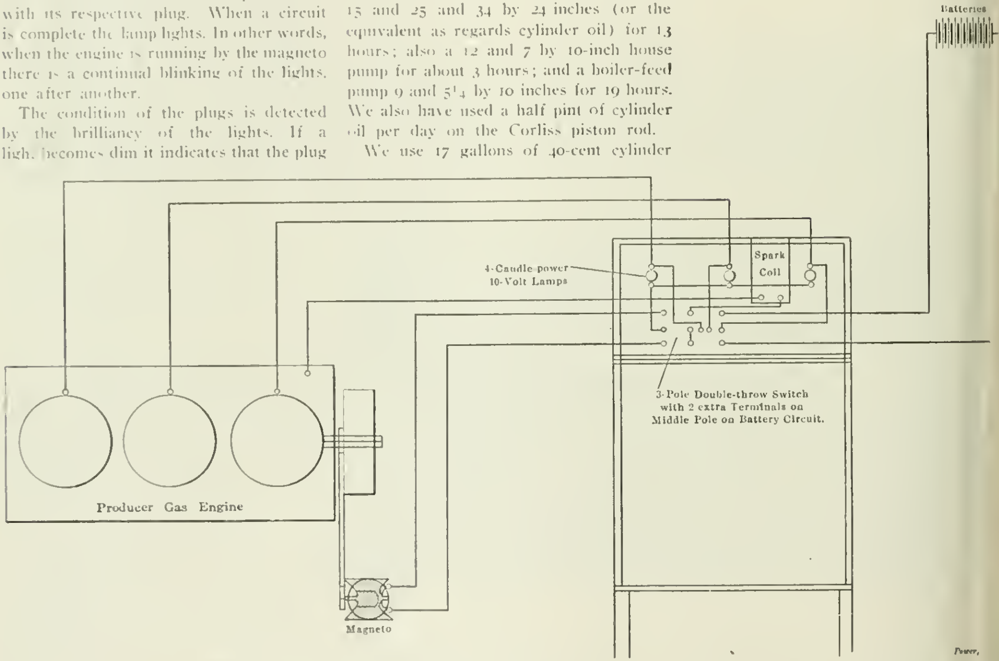

Batteries
Spark Coil
4-Candle-power 10-Volt Lamps
3-Pole Double-throw Switch with 2 extra Terminals on Middle Pole on Battery Circuit.
Producer Gas Engine
Magneto
Power,

DIAGRAM OF ELECTRICAL CONNECTIONS FOR MAKE-AND-BREAK IGNITION SYSTEM

# Oiling Elevator Engines

In our office building, in the course of each day we run three engines, a 10x12 automatic piston-valve engine, running 325 revolutions per minute and doing about 40 horsepower for two hours; an 18x30 Corliss at 125 revolutions per minute, doing about 33 horsepower when started at 7 a.m., and increasing to 300 horsepower, after 10 a.m. on a dark day (this runs ten hours); and a 15½x15 piston-valve automatic at 250 revolutions per minute, doing from 250 down to 15 horsepower, for about 6 hours. In addition we run a duplex, triple-expansion, rotary-valve pump with steam cylinders 15 and 25 and 34 by 24 inches (or the equivalent as regards cylinder oil) for 13 hours; also a 12 and 7 by 10-inch house pump for about 3 hours; and a boiler-feed pump 9 and 5¼ by 10 inches for 19 hours. We also have used a half pint of cylinder oil per day on the Corliss piston rod.

We use 17 gallons of 40-cent cylinder oil per month of 26 days' run. I do not know the composition of the oil. I have never noticed signs of distress in the automatics, no matter how slow the feed, but the Corliss, if the feed is less than one drop to 35 revolutions, shows that it needs more, so I have fixed on one drop to 25 revolutions, giving one drop to 150 feet of piston travel, or five drops per minute. I have made this the rule for all the engines, disregarding the bore. This gives the 15½x15 one drop to 60 turns or 4.2 drops per minute.

The engines are direct-connected units, the 10x12 being belted to the dynamo, and the length of belt being such that giving one drop to 36 passings of the joint in the belt over one of the pulleys (which can be heard) gives one drop to 150 feet of piston travel, or 4 drops per minute.

I do not contend that this is scientific or that we get the utmost from the oil. I have not given the subject special attention, simply adopting this way to secure some consistency in the feeding.

The triple-expansion pump gets on drop to 20 strokes, representing but 4 feet of piston travel, but there are si cylinders. With all the elevators running the pump makes 95 strokes per minut which makes the feed nearly 5 drops pe minute. I have never thought best to g below this, but am not clear but that o the vaporization theory the quantity tha is sufficient for the high-pressure cylin should be enough for all, in which it could be cut down considerably.

The other pumps mentioned have dif ent lubricators, one a down-drop with very small drop, making it difficu compare them with the others. We them a little more than enough to them quiet. All lubricators are si feed (not positive) and are refilled fore they are empty. The oil that esc in drawing off the water, or slops in filling, is caught and goes into strainer with the oil for bearings, w it does not thicken enough to be jectionable.

B. N. Andrev

New York City.

# Subjects Under Discussion

Comment, Criticism and Debate upon Various Articles, Letters and Editorials Which Have Appeared in Previous Issues

BRING OUT YOUR IDEAS

## Armature Winding

In the August 5 number C. W. Hull sked why an odd number of bars is used a commutator. An odd number or an even number of bars may be used, depending on the original design. The number of commutator bars is always equal to the number of inductors divided by $M$, where $M$ is any integer and $2M$ a factor of $Z$, the number of inductors.

Expressing the foregoing as a formula:

$$X = \frac{Z}{2M}$$

where

$X$ = Commutator bars.
$Z$ = Inductors.
$M$ = Any integer.
$2M$ = Factor of $Z$.

An inductor is that portion of the winding that cuts the magnetic field. A coil is usually composed of two inductors, but a coil may have many turns of wire and yet only two terminals; yet as far as the winding connections are concerned a coil is here treated as one turn only. A coil, therefore, is composed of two inductors.

Armature windings are of two large classes, wave and lap. This division is only for the so-called closed-coil armatures.

Further than this, both classes may be classified as to the nature of the winding.

A simple winding represented by Fig. 1, in which the half circles are the coils, is a simplex winding, and said to be singly reëntrant. Singly reëntrant means it enters upon itself once. Fig. 2 shows a winding which is two simple windings placed on top of each other. This is a duplex, singly reëntrant winding. Fig 3 has three separate paths and is known as a triplex singly reëntrant winding.

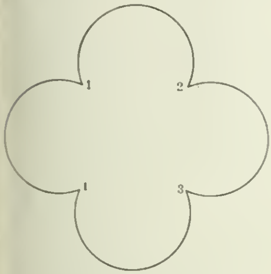


FIG. 1. SIMPLEX SINGLY REENTRANT

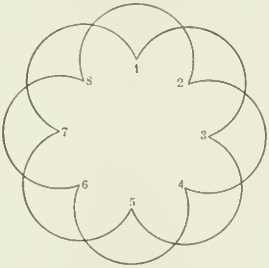
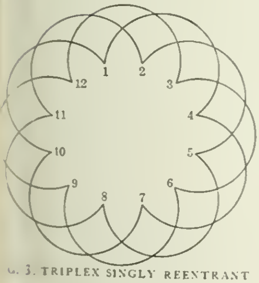


FIG. 2. DUPLEX SINGLY REENTRANT



G. 3. TRIPLEX SINGLY REENTRANT

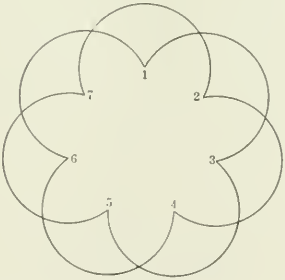


FIG. 4. DUPLEX DOUBLY REENTRANT

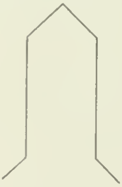


FIG. 6

Power, N.Y.

FIG. 7

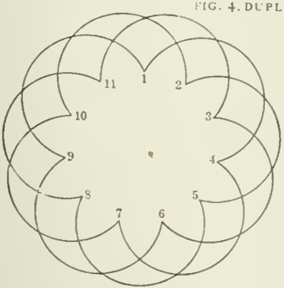


FIG. 5. TRIPLEX TRIPLY REENTRANT

Power, N.Y.

Fig. 4 is different. The first path goes around the armature, but instead of closing upon itself closes on the next commutator bar, and what was the second path in Fig. 2 starts from this same bar. The second path goes around the armature and closes upon the first bar. This winding is one closed electrical circuit, but the winding must be traced twice around the armature to close in upon the original starting commutator bar.

Fig. 5 is more complicated, requiring three turns around the armature of tracing to close the circuit. Fig. 4 is a duplex, doubly reëntrant, meaning to enter in upon itself again, strictly speaking not exactly correct. Fig. 5 is a triplex, triply reëntrant winding.

Now, when the winding is simplex—wave or lap—any number, odd or even, of commutator bars may be used. If the winding is duplex, an odd number of bars will give a doubly reentrant winding and an even a singly reentrant. If the winding is triplex, and the number of bars is divisible by 3, the winding is singly reentrant. If the bars divided by 3 is not an integer, the winding is triply reentrant. This may answer Mr. Hull's question.

G. A. Glick.

Norwood, O.

## Producer Gas Plants for City Buildings

The following is in answer to the letter of Isaac P. Storm, in regard to gas-producer installations in New York City.

One of the main reasons for not installing the gas engine and producer plant in office buildings, apartment houses and the like is that they do not have the exhaust steam which can be used for heating in the winter and an absorption system for refrigeration. The combination of a low-pressure steam plant for heating and the gas producer would make the operating cost higher than with the steam plant.

Another reason is the noise. The gas engine has not yet been perfected so as to keep the noise of the explosion under control. Also, as soon as the engine is worn in a little, the drumming of the poppet valves is noticeable. This of course would be a detriment for the office building or apartment house.

Another reason is that the gas producer itself requires a good deal of head room to work over, and in most of the office buildings and apartment houses now built no provision is made for this contingency. In the case of a building where the noise is not objectionable, and where the power needs to be increased, the installation of a gas engine and a producer would without doubt keep down the cost of operation considerably more than increasing the boiler capacity and using steam power.

In regard to the comparative liability to break downs, the statistics from engine insurance companies give the following ratios: Steam engines, 1 in 8.1; electric motors, 1 in 8.2; gas and oil engines, 1 in [illegible]4. Hence, comparative reliability should not enter the discussion.

The three main points, then, to be contended with in the installation of a gas engine and producer for the office building or apartment house are the lack of heating ability (which, by the way is being gone into now by making use of the hot jacket water and the exhaust gases with some success, but not sufficient to heat a whole building); the noise; the head room needed for the operation of the producer.

The writer also believes that the board of fire underwriters has a few contentions which have to be overcome but which are not very formidable. The place for the gas engine and the gas producer up to the present is in factories, manufacturing buildings, or, under certain conditions, loft buildings.

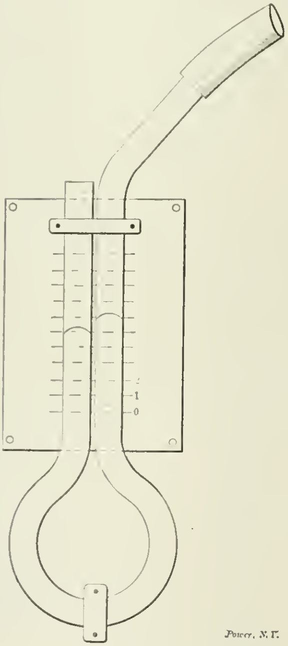
The small high-speed steam engine, taking little floor space and running quietly, has a strong hold on the average office building or apartment.

Rossiter Holbrook.

New York City.

## Draft Gage

I noticed in the August 3 number, an article by William E. Miller, describing a simple and easily made draft gage for the boiler flue. I have had a little experience in this line, and in my boiler testing have used a gage which I made myself, and which I think is not only easier to read but also will give more accurate readings.



A DRAFT GAGE

The reading desired is the difference in level of two columns of water, when one column is connected directly to the flue. Mr. Miller obtains this reading by filling a U-tube to a certain definite mark or hight, then noting how much one column drops when the other is connected to the flue. The filling of a small-bore glass tube to a definite hight requires considerable time and patience, and if repeated often will ruin the paper markings.

The sketch shows what I consider both a more convenient and a more satisfactory draft tube and one at the same time as easily made. Heat a glass tube about 2 feet long and 1/4 inch in diameter over a bunsen burner, blowtorch or common gas jet to a red heat, and bend into a U about 2 1/2 inches between the verticals and one vertical about 2 inches longe than the other. Heat the glass agai just above the horizontal, and draw th two verticals together, leaving about 1/1 or 1/8 inch between them. Bend the en of the longer vertical to about a 95-degr angle, to take the tube. In heating tl tubing, it must be kept revolving in tl flame. After the tube is finished, heat tl tip ends in the same way until their edg are rounded, not sharp as when brok from the longer piece. Take a piece wood about 6 and 3/4 by 12 inches a glue or tack on a strip of paper ruled tenths of the inch. Fasten the tube rectly over this paper so that the rulin projects to eit side, and fasten three strips of thin sheet brass.

Fill the tube with water to any co venient hight and connect the longer by a rubber tube to a 1/2- or 3/4-inch p leading into the flue. Then read amount of deflection in the water colum This is very easy because the two colun are close together. The ruling is hind them. As the reading desired is total deflection, with Mr. Miller's dev all readings must be multiplied by factor 2, which he does not mention, wl with this device the correct reading obtained directly.

C. K. Carte

Chicopee Falls, Mass.

## Trouble with an Exciter Se

Replying to C. L. Greer's query in August 3 number, I should think his switches on feeders or machines w knock out before killing the plant. S plants have no automatic switches on switchboard, as it is preferable to temporary short-circuits burn off tha be troubled with an interrupted ser I infer from the article that nonautor switches are used. As to the real c of the set dying, it would be difficu say. A short-circuit lasting from, three to ten seconds upon a machir from 500 to 1000 kilowatts should cause an appreciable drop in the spe the exciting units.

Seldom if ever do all three legs alternating-current system become s circuited, but even then the alter would stand up for perhaps a minu two. From the information given it appear that the motor-generator set of the low-speed type, the direct-cu end a shunt generator (compoundi cutout since the machine was inst ed, perhaps), or the impedance of the i uc- tion motor is very high. It may b hat the induction motor is overloaded, causing too great a percentage of slip, and when the short-circuit occurs the terminal voltage of the motor is so low, due to the lagging current, that it causes the direct-current exciter voltage to fall, as would naturally be the consequence. Automatic switches in the feeder circuits would cause shorter delays in service than to start up from a dead plant.

L. Earle Brown.

Roundup, Mont.

## Raising Water

Referring to the inquiry of James W. Sherman, in the August 17 issue, regarding the raising of water from a great depth from wells by compressed air, if Mr. Sherman had given the size and depth of the wells, together with the hight the water had to be raised to the surface, and some idea as to the quantity of water required, a more direct answer could be given to his question.

Air lifts are used to quite an extent in this section for raising water and oil from wells, in some cases operating in wells 2000 feet deep or more. In many cases the cost of installation is moderate and in all cases the cost of maintenance is very low, and air lifts, with compressors of any reasonable size, can be operated more economically than ordinary deep-well pumps. There are many situations where they are really the most economical appliances that can be used.

APPROXIMATE CUBIC FEET OF FREE AIR AND WORKING PRESSURE REQUIRED TO RAISE ONE GALLON OF WATER BY "AIR LIFT."

Ratio of Submergence to Lift.

| in | 1 to 1. |  | 1½ to 1. |  | 2 to 1. |  | 2½ to 1. |  |
|---|---|---|---|---|---|---|---|---|
|  | Free Air. Cubic Feet. | Working Pressure, Pounds. | Free Air, Cubic Feet. | Working Pressure, Pounds. | Free Air, Cubic Feet. | Working Pressure, Pounds. | Free Air, Cubic Feet. | Working Pressure, Pounds. |
| [illegible] | 0.428 | 9 | 0.31 | 13½ | 0.252 | 18 | 0.217 | 22½ |
| [illegible] | 0.47 | 13½ | 0.35 | 20 | 0.29 | 27 | 0.255 | 34 |
| 40 | 0.508 | 18 | 0.387 | 27 | 0.325 | 36 | 0.287 | 45 |
| [illegible] | 0.546 | 22½ | 0.422 | 34 | 0.36 | 45 | 0.32 | 56 |
| [illegible] | 0.582 | 27 | 0.457 | 40½ | 0.392 | 54 | 0.35 | 67½ |
| 80 | 0.653 | 36 | 0.522 | 54 | 0.455 | 72 | 0.41 | 90 |
| 100 | 0.72 | 45 | 0.585 | 67½ | 0.512 | 90 | 0.465 | 112½ |
| [illegible] | 0.785 | 54 | 0.642 | 81 | 0.567 | 108 | 0.52 | 135 |
| [illegible] | 0.847 | 63 | 0.697 | 94½ | 0.622 | 126 | 0.572 | 157½ |
| [illegible] | 0.907 | 72 | 0.755 | 108 | 0.675 | 144 | 0.624 | 180 |
| [illegible] | 0.965 | 81 | 0.81 | 121½ | 0.725 | 162 | 0.672 | 202 |
| [illegible] | 1.022 | 90 | 0.862 | 135 | 0.775 | 180 | 0.72 | 225 |

It is necessary, however, to have a proper amount of submergence to get economical operation. The exact amount of submergence for best work varies a little with the lift and quantity of water handled. Ordinarily, for lifts of 40 feet or less I would recommend about 2½ to 1, that is, 2½ times the amount of pipe below the surface of the water in the well when pumping the maximum quantity to the lift above this level. With lifts of from 50 to 80 feet, 2 to 1 generally gives good results. On deeper lifts 1½ to 1 is frequently used. There are situations where sufficient submergence cannot possibly be obtained, and while the pumps may be operated with considerably less submergence, it generally increases the cost of pumping somewhat.

The quantity of air required depends somewhat on the size of the installation, the proper proportioning of the pipes, flow of water in the wells, etc., and it is impossible to give the exact quantities as it is very seldom that two wells will work exactly alike.

I give herewith a table showing the approximate quantity of air required and working pressure for all ordinary cases, but know of a number of installations that are operated successfully with from 15 to 20 per cent. less air than is shown in this table, and a few installations that use more.

In selecting a compressor it is well to allow a surplus over the amount given in the table, as it cannot always be known before testing how much the water in the wells will fall when being pumped; and while some of the better makes of the larger sizes of compressors, with mechanically operated inlet valves, will give a volumetric efficiency of over 90 per cent., there are some of the smaller sizes of compressors, with poppet-inlet valves, that are deficient in inlet-valve area, and some of them will not deliver 60 per cent. of the amount of air that is shown by piston displacement when running at full speed. This, of course, varies with the inlet-valve area and speed.

The size of air pipe is not very important, providing it is large enough to carry the air without undue friction, and the working pressure given is based on there being very little friction.

The size of the pipe in which the water is lifted to the surface is, however, quite important, as there must be a fairly high velocity to work properly, and it is better to err in having the pipe a little too small than too large. The best work is generally obtained with a flow of from 12 to 18 gallons per minute per square inch of section. Smaller pipes will not stand quite so high a velocity as larger sizes.

The arrangement of the air nozzles at the bottom is not a matter of very great importance, provided, of course, the air pipe is somewhat above the bottom of the water pipe. There are a number of different arrangements that give good results.

In some cases, where it is desired to deliver the water at some distance away from and above the well, where sufficient submergence cannot be obtained, air-displacement pumps are used, that is, a cylinder or chamber is lowered into the well below the water line and provided with valves somewhat similar to pump cylinders, being alternatively filled and emptied with air under pressure. What is known as the "dense air" system, by which the air is returned to the compressor under considerable pressure, increases the economy of the compressor and makes a satisfactory and very economically operated pumping plant.

Direct-acting deep-well steam pumps are generally very wasteful in the use of steam and very seldom are any more economical to operate than a good air-lift system, properly installed. All kinds of deep-well pumps, having a long line of rods, generally, are quite expensive to maintain, to say nothing of the trouble and time lost in pulling and replacing rods and buckets. They are good things to keep away from wherever it is possible, particularly where any considerable quantity of water is required from deep wells. However, when operated at very slow speeds and large capacity is not required, their use is sometimes admissible.

G. A. Reichard.

Los Angeles, Cal.

## Cylinder Lubrication

It cannot be denied that engineers have for a number of years been gulled by the chemist, the oil manufacturer and the oil salesman. It has been conclusively proved that viscosity (consistency), flash point (the temperature at which oil vapors ignite) and specific gravity (the weight of a given quantity of oil) are extremely misguiding as factors upon which to base the lubricating value of any oil. In fact, it is safe to say that no external or internal test, apart from the actual cylinder to be lubricated, is of value. Therefore, attention must be confined to the specific working conditions.

It follows that the oil man must have the assistance of the engineer in choosing an oil to suit the local conditions; one cannot possibly do without the other. Both the plant and the oil have their peculiarities, known only to the engineer and the oil man. Therefore, it will be readily understood that in order to select the most suitable lubricant, an oil man must necessarily have an intimate technical knowledge of the various laws which govern steam-engine practice, besides being a master of his own business. It then requires the engineer to be most careful in giving the oil man full details of the plant.

As certain classes of coal meet conditions better than others, irrespective of their heating value as coals, so oils differ in much the same ratio but their differences in quality, or suitability, are extremely wide and difficult to ascertain.

The conditions to be considered in a modern steam plant, for an oil man's guidance, should be as follows: Type of engine, makers, date, horsepower, working pressure, superheat at boiler and at the stop valve, whether the boilers prime; lubricators, where the oil is fed from the lubricators to the engine, whether auxiliary lubricators are fixed, and where; peculiarities of working conditions, feed water (alkaline, soft, hard, etc.). The best results are invariably obtained from blended oils, as no one oil can possibly meet the many conditions perfectly.

The character of cylinder oil should be such that when subject to the conditions of the high-pressure cylinder it will not yield products, or any form of bitumen, but remain a perfect lubricant; in other words, the residue of the oil should be a lubricant. There is a method, but unfortunately a very crude one, of ascertaining the character of the residue after heating to 600 degrees Fahrenheit for a number of hours. Place a measured small quantity of cylinder oil in a thoroughly clean vessel. In another but larger vessel place enough lead for partly immersing the vessel containing the oil. Heat the larger vessel containing the lead until the metal is molten, then immerse the vessel containing the oil and let it remain for a number of hours. Care must be taken to note the loss in evaporation at various intervals for comparison, until finally the oil is past evaporation, or little evaporation is observed. Examine the residue, and if it is found to be tough, leathery, gummy, or of a carbonaceous character, the oil may be classed as unsuitable; if, however, the residue is of a buttery or vaseline nature, it may be classed as a suitable oil. But it is by no means an authentic guide.

The conditions, by the presence of moisture due to condensation, make the task of lubrication very difficult. Whether it is good or bad for an oil to have a soapy ingredient to convert this moisture into an emulsion in order to eliminate rusting and pitting is a matter of opinion. But from the writer's experience, the presence of a fatty oil certainly lends advantage; it must, however, be in very limited quantity. The writer has observed that high-pressure cylinder oils compounded with a small percentage of a fatty oil are better adapted for spreading over hot surfaces, and in engines fitted with Corliss valves a small percentage of a fatty oil in a mineral oil often does that which a pure mineral would never do without practically flooding the cylinders or valves with oil. What kind of a fatty oil, is a secret known only to the oil man. What has been said for the intermediate cylinder applies to the low-pressure cylinder.

A piston reciprocates at so many hundred feet per minute against a stationary surface. Engine manufacturers, however, have designed their piston heads quite in ignorance as to how the slight cone assists lubrication. This convexed piston head serves a double purpose; it allows oil gathered on the piston to creep down and lodge in the clearance space between the junk ring and cylinder walls; whether the cylinder walls are saturated with water or oil, matters very little. The oil is being lashed into the stationary surface and since this surface does not move, there is friction between the stationary surface, the oil and the moving surface; the result is that the oil squeezes by the piston rings and insures a film of oil between the moving and stationary surfaces.

Greases which are composed chiefly of animal oils, fats, etc., and are solidified by means of an alkali, are more liable to decompose and absorb the various forms of calcium which should perchance come over from the boiler and set up friction.

Graphite should be used sparingly and intelligently. The writer saw graphite used at a certain large power house, and the graphite brazed itself to the parts of the valves in such a manner as to reduce their area 25 per cent., and the engine-makers were told that their engine did not come up to specification. Suffice it to say that blended mineral oils are infinitely more suitable for the modern steam-plant. Although much can be said for grease and graphite, these lubricants are unsuitable where high temperatures and superheated steam play prominent parts in the economical running of the power house.

Horatio W. Hutton.

Glasgow, Scotland.

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What is considered good lubrication? Affinity of the iron should first be considered. If the valves and valve seat are of the same percentage of metals, it will require much more oil than otherwise. I have in mind a Corliss engine of an old make. The valve seats bored and new valves were put in, and an abundance of oil seemed to have no effect, on account of the new valves not being of the right composition to correspond with the metals of the cylinder.

An engine valve and face may be as smooth as glass, and no amount of oil seems to relieve the groan, but when examined and the smoothness taken off with a fine file, the parts work right. The filing opens the pores. Oil must have the right viscosity for the temperature of steam, that is, oil for low-pressure steam will not do for high-pressure steam, while oil for high-temperature steam won't do at all for low-pressure steam, as it will not vaporize at a low temperature.

This oil question, as to quality, receives more consideration among stationary engineers than among locomotive engineers, because the former can mor closely watch results. The locomotiv engineer is only allowed a small quantit of oil, of a grade sometimes not suite to the requirements, as railroad companie furnish the same oil for engines carryi 150 pounds of steam as for those wit superheaters in the front end, and at som points they use a water that foams ver badly.

Stationary engineers would think strange to be allowed 5 pints of valve o for a round trip of 260 miles for tw large cylinders using superheated stea and two air pumps, when it takes fr ten to fourteen hours to go one way a five to eight to return. Cylinder oil co from 15 to 35 cents per gallon by t barrel, and using a small quantity wo save a ton of coal. Therefore, there is saving in "economizing" on oil to su an extent.

In some types of valve the reverse le will rattle regardless of the lubricati as the oil pipe leads directly above it, a does not go where needed until shut simply going down the side of the va to the port, and not under the valve. relieve this it should lead to the s of the steam chest or cylinder sadd It is a problem to handle a lubricator cording to theory, because after water tles, one opens the lubricator to oil it a then closes the feeds. The feeds ch being more or less worn and unable produce five drops as required. A lu cator contains just so much oil, 6260 dr to a pint, which is to be fed a drop at a ti but the faster it is fed the larger drops. This is why one cannot han a lubricator as per rating. Take 2 dr per minute and increase it to 4, and e drop in the area will contain about f times as much as the theoretical drop.

Taking a 3-pint lubricator contain 10,500 drops and feeding each cylinder small engine 4 drops per minute, the air pump one drop, would be drops per hour, but as four-per-mi drops contain in area so much more than the single drops, thirty hours w be lost at this rate.

Now, take a large engine using su heated steam, with two pumps. each cylinder 7 drops per minute as ra using 16 drops per minute or 960 d per hour for both pumps. This w be nearly 12,000 in twelve hours, so a lubricator containing 19,000 d is would serve about eighteen hours it could be regulated thus; but in pra we use fewer, larger drops and more minute, and it is a problem to make oil last the required number of h s. Doubling the diameter increases the ume four times, which is the reason the larger drops contain so much more oil.

James C. Stewart

Clovis, N. M.

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My experience, covering twenty years, has been that the number of drops of cylinder oil per minute depends upon the engine being properly lubricated, and it requires no expert to cut down or ncrease the drops per minute to attain he desired result. Of course less good is required than poor oil, but a cylinder oil can be purchased in this vicinity r 50 cents per gallon which is satisactory for from 100 to 125 pounds presre In my opinion it is useless for the erating engineer to try to determine the lity of oil before using it, for in these ys of scientific compounding anyone t a chemist can be fooled.

An upright triple-expansion surface-ndensing engine indicating 1800 horsewer at 165 pounds steam pressure, with t valves on the middle and low-presre cylinders, and a piston valve on the gh-pressure cylinder, used a pint of linder oil every two weeks, distributed tween the cylinders by gravity cups aced on the cylinder heads. A vertical ple-expansion surface-condensing ene, with all flat double-ported valves, 175 pounds steam pressure, the aver- revolutions being 75, and the indited horsepower 2500, could not get gh cylinder oil to stop the high-ssure valve from groaning and squeak This engine was lubricated with a et and plunger type of lubricator, rt size, and I have pumped a quart il in the high-pressure cylinder and ve chamber and it made no impres- on the groaning. By accident it was vered that pure tallow swabbed on high-pressure piston rod stopped the ing. The steam must have taken up tallow and the exhaust deposited some w on the valve and cylinder face. tallow did not show bad effects on ping or cylinder or valve faces. antity used was small, a pound l a week.

A vertical triple-expansion surface-con- g engine, 2500 indicated horse r 175 pounds steam, 80 revolutions, uble-port middle and low-pressure and high-pressure piston valve, no cylinder oil, except a little ed on the piston rods every half The cylinder rings were tested six months. The heads were taken and steam admitted by an auxiliary under the pistons and if steam through, the piston rings, which re of a patent make, were taken out, anded and made steam-tight. I tched these cylinders for nearly two rs and repeatedly tested them with a scope gage and they did not show wear and had faces like glass. It st be remembered that these vertical marine-type engines have no friction due to a heavy piston.

A 12x15 horizontal flat D valve engine, 175 revolutions, 100 pounds steam, will not run without distress under 14 drops of cylinder oil per minute. The rings and valve face are in good condition.

In a plant in an office building in this city, cylinder lubrication of the elevator pumps and high speed engines is achieved by placing a cup containing graphite and cylinder oil between the sight feed lubricator and the steam pipe.

Harold James

New York City

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Observation by one of the oldest engineers in active service, of the quantity of cylinder oil generally used in Corliss engines, has led to the conclusion that there is frequently great waste in this item of running expense. For quite a number of years I have had charge of several engines, one of which is a double-tandem-compound with high pressure cylinders 22 inches in diameter and low-pressure 42 inches, with a stroke of 60 inches and running at 61 revolutions per minute. Dry steam at 130 pounds and superheated about 15 degrees is used. This engine is eighteen years old, the cylinders have not been rebored, and it is in test condition today. We use one quart of cylinder oil per day per cylinder, or one gallon per day for the engine. The oil is fed by Rochester lubricators.

We have one cross-compound Corliss engine 22 and 40 by 60 inches, running at 63 revolutions per minute, with steam from the same boilers. This engine is twenty years old and in good condition. The cylinders have not been rebored. We have for years used only 2 quarts per day. There is another cross-compound Corliss, 24 and 48 by 60 inches and running 77 revolutions per minute, on which we use 5 quarts per day, including the independent air-pump engine. These three engines have been lubricated with the same quantity and grade of oil during these years, and their condition today proves that they have had all the oil necessary.

I have no doubt that there are Corliss engines using less cylinder oil, but I have not considered it prudent to go lower.

In regard to the quality of the cylinder oils in the market, I have found that price is no criterion. I am positive that strictly mineral oil will not lubricate an engine cylinder satisfactorily. There must be 3 or 4 per cent. of animal fat thoroughly incorporated with it, to make it adhere to the walls of the cylinder.

We pay 21½ cents per gallon for our oil, which makes the cost on the tandem driving 1400 horsepower 21½ cents per day and on the small cross-compound driving 700 horsepower 10.7 cents per day, while the larger cross-compound driving 1400 horsepower costs 26.9 cents per day. The cost of cylinder lubrication on these three engines taken together is 5.14 cents per horsepower per year.

A. B. Corcoran.

New York City.

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I am glad you have asked for contributions on cylinder lubrication. This is a subject I have long been interested in. I have been feeding cylinder oil to an engine twenty-five years without knowing, for certain, if I was using the proper amount. For the last ten years I have been running a Sioux Corliss, 18x42, making 105 revolutions per minute, 90 pounds gage pressure, and developing about 175 horsepower. I took charge of the engine when new, and for seven years fed a drop to every 65 revolutions of 600 W cylinder oil, which amounted to a quart to every twenty-four hours, the oil costing 60 cents per gallon.

On account of the high speed of the engine the valve gear made a great deal of noise, and sometimes for twelve hours I would double the amount of oil without lessening the noise of the gear. I use a Michigan sight-feed lubricator. To see if the engine was getting plenty oil I would see that the feed was kept regular for twelve hours before shutting down, and then I would take off the cylinder head and examine both the cylinder walls and valves, and never failed to find a good coating of oil on both. For the past three years I have been using about three pints of the same oil, but I don't see that I get any better results. I use no trap on the steam line.

E. M. Frost.

Conshohocken, O

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Our engine is a 16x36 Harris Corliss, running at 100 revolutions per minute, steam pressure 65 pounds. It has been running two and a half years. The cylinder oil used is A. W. Harris standard grade, fed through Rochester automatic lubricators at the rate of 1½ pints per day of ten hours. The results are excellent.

While this may be more than the average feed, I believe oil cheaper than coal and repairs. I also use a Webster open heater but the boilers show no trace of oil.

H. E. Lemon

Fitchburg, Mass.

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The writer knows of a steamship having engines of 7000 indicated horsepower, in the cylinders of which no oil is used. The piston rods are swabbed about every forty-five minutes and in this way some oil finds its way into the cylinders. The internal wearing surfaces are in excellent condition. Smoother running and greater economy of operation are rarely excelled in actual practice.

Frank H Williams.

New Haven, Conn.

# Rhode Island Coal for New England?

## A Hard, Graphitic Coal That Is Practically Incombustible in Its Natural State Is Said to Ignite and Burn Readily after Chemical Treatment

That coal deposits actually exist in the State of Rhode Island has long been known. Various excavations and expert inspection throughout the Narragansett basin have revealed this fact and the product of a small mine near the village of Portsmouth, half way between Fall River and Newport, has confirmed the truth of this assertion beyond all question of doubt. Some 30 or 40 years ago, coal was taken from this mine and used for smelting copper ores. It has also been tried for domestic use, but its hardness and lack of volatile matter made it extremely difficult to ignite, and to keep aglow even after the fire had been started. For this reason New England, notwithstanding its indigenous supply, has continued to ship its anthracite from Pennsylvania. The mine was abandoned and up to a very few months ago no serious attempt was made to revive interest in this coal.

About August 1, of the current year, Boston and New York papers came out with glowing accounts of the new process by which this coal could be burned and of the Rhode Island Coal Company which had been formed, with Henry M. Whitney, of Boston, as president, to promote the mine. Giving the coal a bath in a 5 per cent. solution of sodium nitrate and calcium chloride, it was claimed, would cause it to kindle with great readiness and burn at an intensely high temperature. This process, invented by Newell W. Bloss, was to revolutionize New England industries, for by the first of the year, heat, light and power were to be supplied by home coal.

Recent editorial comment in these columns relative to Rhode Island coal was met with strong objection on the part of Mr. Whitney, and an urgent invitation to visit the mine was extended. The invitation was accepted and the conclusions formed from personal inspection and data obtained are embodied in the following paragraphs.

It appears that the Rhode Island Coal Company has secured mining rights on about 4000 acres of coal lands, which include two shafts driven about one-third of a mile apart by the former operators of the mine, and a building at the mouth of each shaft. These structures are rather dilapidated, and their boiler and hoisting equipment are in much the same plight. It is the intention, however, to use the boilers simply for pumping out the mines which had become filled with water while idle, and to remove the old equipment and buildings as soon as a new plant has been erected.

For the South shaft, as it is called, there are two 80 horsepower locomotive boilers, supplying steam to the hoist and two mine pumps. The North shaft has five 100-horsepower vertical boilers and the same equipment in pumps as the South shaft. Both shafts are 1600 feet long, the South shaft having been sunk at an angle of 35 degrees, which would mean a vertical depth of over 900 feet. The North shaft is more precipitous, and the decline varies from 40 to 70 degrees, with an average of about 45 degrees for the entire distance. Passages worked underneath the 800 foot level connect the two shafts. Below 600 feet there is no appearance of water. The springs are all above this level, and the water is diverted to a large reservoir from which it is pumped to the surface.

Little timbering is noticeable in the mine, and on the lowest level the vein of coal last worked is about 5 feet thick. The basin is reported to be rich in coal, however, and it is said four new veins have been determined by the diamond drills now at work on the property, and these are 6½ to 8½ feet thick. The track down either shaft is in bad condition, and before coal in any quantity can be removed from the workings, it will require a new track, new cars and new equipment all the way through, and any level through which coal will be taken must be cleared of the rocks and rubbish now strewing the path. In the present condition of the mine it is impossible to get out enough coal, without more trouble than it is worth, to run the boilers supplying steam to the pumps. This is one reason given for burning soft coal instead of using the product of the mine, the other being lack of sufficient grate surface to burn enough Rhode Island coal to make the desired amount of steam.

As soon as the diamond drills, four of which are at work, and the surveying which was started on the morning of the visit of our representative, September 8, have located the center of the basin, it is the immediate intention, as expressed by James W. Dennis, vice president of the company, here to locate the plant, consisting of a breaker, treating tank, conveying machinery and 1500 horsepower in producer-gas units to furnish the power for the mine. The breaker and a Zwoyer briquetting plant of 150 tons capacity per day of 10 hours have been ordered from the Traylor Engineering Company. On September 8 the make of gas engine and producer had not been decided upon, practically nothing had been done toward putting the mine in shape, or erecting the building to house the power equipment, yet it was confidently asserted that the mine would be in operation by January 1, turning out 150 to 200 tons of coal per day, this quantity to be gradually increased after the first month, and when the vertical shaft, which is to be sunk at the center of the basin, is ready for service, it is fully expected that the capacity of the plant will run up to 250 tons.

In the near future it is also planned t erect a large generating plant, using ga producers and engines, and transmittin the power to neighboring cities and towns in which it is claimed there is a marke for 600,000 horsepower. The mine is t be fully equipped to ship by tidewate or by rail. W. F. Sekol, now with th Delaware, Lackawanna & Western, a Scranton, Penn., has been secured as mining engineer, and on January 1 will tak charge of the mine at Portsmouth.

Of the entire output, it is expected th 40 per cent. will be in lump size. Th will be given the treatment, and instea of revolutionizing New England industrie according to early predictions, . will l limited to domestic use. Coal of pea si will be used in the producers, and t coal below pea size will be made up in briquets. These are to be $1\frac{13}{16}$ inch square, coming down to a sharp edge all four sides, and swelling out to a thic ness of less than an inch at the cent Twelve briquets to the pound is the e pectation, and with a special binder a the sharp edges of the briquet, ready co bustion is to be obtained. As in the ca of the lump coal the briquets are to sold for domestic use.

In the accompanying photograph a shown samples of the coal of practica the same size as the original, but h the graphitic character of the coal is apparent, and the general appearance much better than the coal actually p sents. Coal of the size of the smal lumps was burned, for the benefit of writer, in the cook stove of a nea resident. The coal was reported to from the mine at Portsmouth and trea with the solution previously mention and was burning intensely with a reddish flame.

Evidently, the success of the vent depends largely upon the chemical s tion, and its ability to make the coal bu

RHODE ISLAND COAL

What the Rhode Island Coal Company xpects this coal to do is clearly exressed in a report by Henry J Williams, hemical engineer and analytical chemist, f Boston, and subsequently printed in an ight-page pamphlet issued by the comny. The following quotations will be i interest

"Rhode Island coal contains in its atural state a considerable percentage f graphite, which prevents it from burng satisfactorily It contains, moreover, h a very low percentage of combustible latile matter, which escapes very quickwhen the coal is first heated, that the al is quite incapable either of kindling readily or of producing any permanent fire. Simple treatment of this coal with a very small amount of crude Chile Saltpeter (Sodium Nitrate, $NaNO$)*, the [illegible] solution originally suggested by M[illegible]ss, or better, with crude Calcium Chloride $CaC$)† gives the coal the remarkable property, when fired, of setting free continuously, under the influence of its high temperature and the draft, combustible gases, chiefly Carbonic Oxide (CO), which burn above and through the fire, kindling it with great readiness and with production of an intensely high temperature.

"The materials which are used to impart these remarkable properties to the coal are of such exceedingly low cost that the process is readily applicable to Rhode Island Coal at slight cost Crude Sodium Nitrate costs, at present, about $56 per ton, i.e., 2.8 cents per pound, while the fused Calcium Chloride in 500-pound drums, which I used in my experiments, actually cost only 1¼ cents per pound, and in larger quantities can be bought still lower The process of applying the solution is exceedingly simple: either a mere sprinkling of the coal, or better, immersion of the coal in the solution, best followed by simple air drying, is all that is required to treat the coal properly At a conservative estimate the total cost of the chemical treatment, even if the coal required to be artificially dried, could not exceed 10 cents per ton, and it may be much below this figure.

"When the coal is once treated it retains for years its properties of burning readily. Experiments have been made with treated coal which had remained exposed to the elements for nineteen (19) months, and which in that time had been frequently rained upon. This coal burned with exactly the same readiness as coal which had been freshly treated. We can, therefore, feel reasonably assured of the permanency of the treatment. The experiments which I have conducted prove that a very small quantity of chemicals is all that is necessary to impart to the coal its good burning properties. The treatment may necessarily be more or less superficial, but, inasmuch as a very small amount of chemicals produces the desired result, every fresh shovelful of coal fired into the furnace is quite sufficient to maintain in the fire a sufficient quantity of chemicals to insure, without cessation, the proper burning of the coal."

These paragraphs agree closely with what Mr. Dennis had to say on the subject during the visit to the mine, with the exception that the chemical was to be a 5 per cent. solution of both sodium nitrate and calcium chloride, and that the cost of treatment per ton of coal would be five cents at the most and probably less, this including the cost of labor as well as material. It would be difficult even to guess what purpose the calcium chloride serves, unless perchance to lend an orange-red color to the flame, which in mingling with the yellow flame of sodium nitrate would produce the appearance of intense heat. The sodium nitrate would also crackle, and add to the illusion of a vigorous combustion.

It is true that sodium nitrate, when

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* Evidently $NaNO_3$. † $CaCl_2$.

formed, will give off its oxygen readily, and [illegible] theoretically. The [illegible] of sodium nitrate, obtained by passing the coal through the 5 per cent. solution, would be of no appreciable value. For example, let us suppose that the sodium nitrate is to supply one-twentieth of the oxygen necessary for combustion, the balance being taken from the air. Ten per cent. or even a larger proportion would undoubtedly be required to give satisfactory results, but the smaller figure is simply taken for the purpose of illustration.

In sodium nitrate, $NaNO_3$, there is one part of sodium (Na), one of nitrogen (N) and three of oxygen ($O_3$), the atomic weights being 24, 14 and 16, respectively. This would mean a total weight of

$$24 + 14 + 48 = 86$$

for the salt, and consequently it would require 86 pounds of sodium nitrate to supply 48 pounds of oxygen, that is, providing all the oxygen is given off as a free gas, and this would rarely be the case.

Taking 80 per cent. fixed carbon as a fair average for Rhode Island coal, and neglecting the small amount of volatile matter contained, this would mean 1600 pounds of carbon for a ton of 2000 pounds. Burning this carbon to carbon dioxide ($CO_2$), would require 32 parts by weight of oxygen to 12 parts of carbon, or $2\frac{2}{3}$ pounds of oxygen to burn one pound of carbon, and to burn 1600 pounds of carbon would require 4267 pounds of oxygen. If the sodium nitrate is to supply but one-twentieth of the oxygen, this would mean

$$4267 \div 20 = 213$$

pounds of oxygen, and this would require

$$213 \times \frac{86}{48} = 382$$

pounds of sodium nitrate. At a cost of 2.8 cents per pound for the sodium nitrate, the cost of material to treat a ton of coal would be $10.70, to which should be added the cost of the calcium chloride used.

At this cost for treatment it is evident that the solution won't do, and as a smaller amount of the salt would be of no great assistance, it is difficult to see how the coal in lump form can be profitably sold for domestic purposes. The low and irregular draft and the small bed of fuel in the ordinary stove do not offer conditions suitable to a coal of this character. It requires the strong, steady draft of the blast furnace, and with its low percentage of sulphur might here be used to advantage. To burn the coal in a gas producer would perhaps be possible. It would require a hot fire, and to avoid excessive clinkering a low ash content would be necessary. According to the report of Mr. Williams the average coal used in many tests contained 17 per cent. of ash, although in one case the coal showed as little as 6 per cent. The average figure given shows too much ash for successful use in the producer, and a selection of the better coal would be necessary.

Briquetting the coal, with a binder containing sufficient combustible matter, sounds more reasonable, but before purchasing any of the 400,000 shares of stock offered in the pamphlet previously mentioned, investors would do well to make a thorough investigation, visit the mine and form their own conclusions.

## National Exhibitors' Association Officers

The accompanying halftone shows the new officers and executive committee of the National Exhibitors' Association of the National Association of Stationary Engineers. The photograph was taken at the recent N. A. S. E. convention at Columbus, O., and was received too late to be incorporated with our report of the convention which appeared in last week's issue.

THE NEW OFFICERS OF THE NATIONAL EXHIBITORS' ASSOCIATION OF THE N. A. S. E.

## James Watt Association Entertainment

The twenty-fifth annual entertainment and smoker of the James Watt Association No. 7, Stationary Engineers, will be held at its meeting rooms, 307 West Fifty-fourth street, New York City, Saturday evening, October 30. "The Bunch" and their talented performers will assist in making the evening a pleasant one. The usual good things in the way of refreshments will be served.

## Dynamo and Motor Conversion

On page 503 of the September 21 issue an inquiry signed R. H. L. reads "How can a shunt-wound dynamo be changed to run as a motor," etc. This should have read: "How can a shunt-wound motor be changed to run as a dynamo." The answer is correct for the corrected question but exactly inverted for the questior as it was printed.

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The eighteenth annual (1909) editio of Hendricks' "Commercial Register the United States for Buyers and Sellers' has just been issued. This valuable busi ness directory contains in its 1220 read ing-matter pages more than 350,000 name and addresses of American manufacturer under 35,774 classifications, representin nearly every machine, material, appara or specialty required in the architectu engineering, mechanical, electrical, ma facturing, railroad, mine and kindred dustries. It is published by the S Hendricks Company, 74 Lafayette str New York City, and costs $10, exp charges prepaid.

## Monster Dry Vacuum Pump Performance

In the account of this pump, in September 7 number, page 420, it stated that this pump condensed "4[illegible] pounds" of steam. It should have r "75,000 pounds." This pump was by the Manistee Iron Works Comp Manistee, Mich.

# Inquiries

*Questions are not answered unless they are f general interest and are accompanied by he name and address of the inquire*

*The Eccentric and Valve Setting*

If the diameter of an eccentric should e reduced one-half inch, what change ould be made in the valve setting?

A. A.

None at all. The valve design and opration depend on the eccentricity and not n the size of the eccentric.

*ap on a Slide Valve*

For what purpose is lap put on a slide lve?

L. E. T.

In order that steam may be cut off from e cylinder before the end of the stroke d allowed to do some work by exsion.

*ength of Connecting Rod*

How can the length for a new concting rod be found?

P. C. P.

Put the piston and crosshead in the act center of travel and measure the stance from the center of the crosspad pin to the center of the crank shaft.

*use of Pounding in Air Pump*

What causes the pounding in a bucket pump?

F. L. L.

t is caused by the water striking the er or discharge valve deck. This noise be reduced if not entirely cured by admission of a little air above the ket on the downward stroke. This bove the water opens the discharge s on the upward stroke and fur a cushion between the water and valve deck.

*Lap on a Putnam Engine*

w much lap have the valves on a nam engine?

A. T. Q.

is usually defined as being the nt that the valve overlaps the edge team port when the valve is in ddle position, and the term cannot rrectly applied to poppet valves. The f lap in poppet-valve engines is ed by allowing the valve to resed during a part of the revolu f the eccentric, and is measured s.

*ig Weight of Governor Balls*

weight of the balls of a flyball r was reduced, how would it afe speed of the engine?

M. M. H.

t were possible to concentrate the t of all of the revolving parts of the governor in the balls and the other ng parts had no weight, the change f weight of the balls would make no hage in the speed of the engine. But as his is not possible a reduction in the weight of the balls would cause an incase in the speed of the engine.

*Effect of Lengthening Low Pressure Cutoff*

In a compound engine with a cylinder ratio of 5 to 1, would a lengthening of the cutoff on the low pressure cylinder from 1/5 to 1/4 of the stroke lower the steam consumption of the engine?

H. E. L.

That would depend entirely on conditions other than the point of cutoff alone. Carrying its rated load and expanding in the high-pressure cylinder to receiver pressure, a lengthening of the low-pressure cutoff would cause a drop from the high-pressure terminal to receiver pressure, reducing the back pressure in the high-pressure cylinder, and allow it to do more work. This would shorten the cutoff on the high-pressure cylinder and reduce the apparent and probably the actual steam consumption per horsepower-hour.

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# Book Reviews

INDUCTION COILS; DESIGN AND CONSTRUCTION. By A. Frederick Collins. Published by Munn & Co., New York, 1909. Cloth; 395 pages, 6x9 inches; 155 illustrations; numerous tables. Price, $3.

Those parts of this book which are compilation are excellent; the few places where the author has indulged in original explanation or presented his own ideas of things are weak. The chapters on practical construction are highly meritorious, the one on the theory of operation is unscientific and inadequate. The tables in Chapter XX appear to have been collected rather indiscriminately, and without much consideration of their relation to each other.

Taking the book all in all, however, it should be very useful to anyone concerned with the manufacture or repair of induction coils; but the user should have sufficient fundamental knowledge of electricity and magnetism to be independent of the technical instruction which the author tries to impart.

HIGH SPEED DYNAMO ELECTRIC MACHINERY. By H. M. Hobart and A. G. Ellis. Published by John Wiley & Sons, New York. Cloth; 526 pages, 6x9 inches; 355 illustrations. Price, $6.

Like all previous writings of Mr. Hobart, alone or in collaboration, this book is thorough, practical and in the main clear. It covers every phase of the design and construction of high-speed dynamo-electric machines, both alternating-current and direct-current. The choice of symbols is not always happy and sometimes confusing; for example, $n$ = number of phases and $i$ = amperes per armature conductor, while $ni$ = total ampere-turns per pole in the armature winding. Again, $B$ = angular displacement of air-gap flux by armature reaction; also $B$ = flux per unit area of armature surface, further, $B$ = flux density in the magnetic circuit. Another minor disadvantage is the use of metric units throughout the book.

The figure of merit of the book as a whole is extremely high. Even if one does not wish to follow Mr. Hobart's methods in detail, the data presented make the book valuable to anyone interested in the design of high speed generators.

HYDROELECTRIC DEVELOPMENTS AND ENGINEERING. By Frank Koester. Published by D. Van Nostrand Company, New York, 1909. Cloth; 454 pages, 8x11 inches; 500 illustrations. Price, $5.

This book is uniform with "Steam-Electric Power Plants" by the same author. In his latest work the author has made a careful selection of data most desired and valuable to the hydraulic engineer. Reports, maps and charts of rainfall, evaporation and runoff have been omitted, as these may be readily obtained from the various governments, and as it was the opinion of the author that a good illustration will tell more at a glance than a long discussion, the book contains a large number of cuts showing the present standing of American and European hydroelectric engineering. It is fortunate that such a number of good illustrations are incorporated with the text, for the book is divided into three parts, so that a comparatively limited space can be devoted to each.

Part I, on the Transformation of Water Power into Electrical Energy, is given considerably more space than is taken by the other two sections on the Transmission of High Tension Electrical Current and Modern American and European Hydroelectric Developments. The first part covers 211 pages and is subdivided into chapters on Preposition, Dams, Headrace, Penstocks, Power Plant, Mechanical Equipment, and Electrical Equipment. A few of the new features made obvious in this section are air shafts and equalizing chambers in connection with pressure tunnels; seamless, welded, flangeless, telescoping penstocks to facilitate shipment and to eliminate expansion joints; impulse wheels with draft tubes and multiple, nonwater-wasting nozzles; compound turbine on single shaft, the supply of one being the discharge of the other, and numerous other features representative of the latest practice.

Part II is devoted to the transmission line, substations and line protection. Special attention is given to steel towers and the chapters on Substations and Line Protection are of unusual interest. Part III describes briefly a number of the largest plants in North America and Europe.

To the student or engineer in practice the book should be of service, and the nontechnical man interested in the subject will find it a comprehensive treatise.

# POWER AND THE ENGINEER

DEVOTED TO THE GENERATION AND
TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

John A. Hill, Pres. and Treas. Robert McKean, Sec'y.

505 Pearl Street, New York
355 Dearborn Street, Chicago.
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of Power solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "Powpub," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During* 1908 *we printed and circulated* 1,836,000 *copies of* Power.

*Our circulation for September*, 1909, *was (weekly and monthly)* 141,000.

*October* 5............ 42,000

*This paper reaches* 12,000 *separate readers each month and* 33,000 *each week.*

*None sent free regularly, no returns from news companies, no back numbers. Figures are live net circulation.*

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## Cylinder Lubrication

Recently we asked readers to send us data concerning the use of cylinder oil, and it is gratifying to note that a number of responses have been received. As quickly as possible after receipt these data will be published in the discussion columns of the Practical Letters department, and since we agree not to publish names and addresses, when so requested, we anticipate a more general response. This is a subject of vital interest to engineers and we hope to see it thoroughly threshed out.

The data desired should include the style, size, horsepower and speed of the engine, the rate of feed in drops per minute, the gallons used per month, the kind and price of oil, etc.

## Marine Producer Gas Power

As was pointed out in the interesting paper read by Mr. Straub at the Washington meeting of the American Society of Mechanical Engineers, the problem of producer gas power for marine service has received considerable attention abroad, and a good deal of experimental work on a respectable scale has been done in Europe. On this side of the Atlantic some interest has been manifested by a few, but the subject has not received as much effort as its importance merits. So far as we know, only three attempts have been made to build and operate a producer-gas boat; the first craft of this kind was a 40-foot cabin launch built for H. L. Aldrich, publisher of *International Marine Engineering;* the second was a converted steam cabin launch, equipped by Stephen A. Hasbrouck, and the third was the magnetic survey boat "Carnegie," described in this issue. The last-named boat is not old enough to have yielded any performance records. Mr. Hasbrouck's boat has been in almost daily use on the Hudson river for several months, but we have no data on its power plant performance.

Mr. Aldrich's launch has made a number of runs in and around New York harbor and recently made a trip up the Hudson to Albany and back. The round trip of 275 miles was made in 41 hours 25 minutes, actual running, and the fuel consumption is reported to have been 636 pounds of pea coal costing five dollars per ton. The producer is rated at twenty-five horsepower and the engine is capable of about eighteen on producer gas. These figures are interesting, though a little vague, but the fact that such a trip was made by a producer-gas boat is not insignificant in the present backward state of this branch of engineering. It would be a valuable contribution to the cause, however, if Mr. Hasbrouck or Mr. Aldrich would have a run made of, say, 100 miles and complete power-plant records taken. Marine producer-gas power i
bound to come, and its development wil
of course, be most rapidly accelerated b
systematic experiment and thorough ana
yses of the results obtained.

## Sparking at the Brushes

It is at least ten years since the know
edge of direct-current dynamo and mot
design reached the stage of developme
where the process of commutation w
so well understood that any engine
familiar with established principles co
design a direct-current machine which
solutely would not spark at the brush
in spite of that fact, manufacturers
high standing and years of experience
building every day dynamos and mot
which run sparklessly only when caref
nursed and protected from rude and ru
less load vagaries. Railway motors natu
ly give the most trouble in the
of brush sparking and commutator
terioration, because they work un
severe conditions which cannot be c
trolled by the motorman to any c
siderable degree. But we fail to find
good reason why railway motors are
built to stand their conditions of op
tion, just as rock crushers, steam lo
motives, automobiles and other mec
isms are built for the rough usage
must get. The bad commutation of
way motors is so general that opera
companies accept it as an unavoid
evil and calmly submit to having
motor commutators turned off once e
week or so; in one plant in Texas
master mechanic is quoted as stating
a lot of 50-horsepower motors sel
ran longer than ten days without ha
to have the commutators turned off.

In a good many instances the pra
has developed of cutting away the
between commutator bars for a short
tance below the surface of the barrel
many operating superintendents hav
in special tools for doing this work
course, this is a mere makeshift
would be unnecessary if the motors
so built that they could not spark or
over under any permissible condi
Why are they not built so? That
conundrum of more than ordinary
There is no lack of knowledge o
part of the designers; no lack of fa
or money to build the right sort of
It can't be that the purchasing com
will not pay enough for the equipm
justify the extra expense necessary t
out sparkless motors; no man with e
sense to butter a slice of bread
balk at any rational increase in p
do away with the ridiculous repair
now endured.

In the case of dynamos and moto for
ordinary service, keen competition re-
sponsible for narrowing the commutation
margin. No such excuse applies t rail-

way motors. The restricted space under surface cars is an obstacle in the way of increasing diameters and decreasing lengths, which would go far toward a cure, but are street-car dimensions like the laws of the Medes and Persians?

## The Rash Mixture of Electrical Circuits Again

A few weeks ago we cited an accident at Greenwich, Conn., as a demonstration of the unwisdom of hanging high-tension electric circuits on the same poles with other circuits. In that case, fortunately, no one was injured, though that happy result was due to sheer good luck. At Olginate, near Como, Italy, another disaster due to similar conditions occurred recently, with much more deplorable results. In Olginate there was a high-tension power feeder on the same poles with low-tension distribution circuits. The feeder was broken in some way not described in the press despatches and the ends fell on the low-tension wires, putting the latter at a deadly potential. Some of the fittings in the residences became overheated sufficiently to cause fires and in trying to extinguish these the customers came in contact with lamp sockets and other metallic fixtures, with the result that ten persons were killed and more than double that number were seriously shocked and burned.

It is to be hoped that the authorities will wake up within the next century or so and pass stringent laws against the installation of circuits of dangerous voltages on the same poles with harmless distribution circuits. Such procedure is even more hazardous to public safety than the indiscriminate sale of poisons, which has long been prohibited by law.

## Then and Now

Three hundred years ago Henry Hudson sailed up the river which bears his name, and today thousands are celebrating the event. Then the banks were wooded. Manhattan island was a forest. Today Manhattan island is covered with a wonderful collection of stately buildings, some of them the highest in the world. The streets are honeycombed with subways, gas and water mains, and conduits for electric-light, trolley, telephone and telegraph wires. And yet 135 years ago these things were unknown, the first wide water system being constructed in 74, when skyscrapers were unheard of. The vast advancement in civilization and architecture has been the development of the last two generations. One is forced to use his imagination to a large degree before the full significance of the development of the country since Hudson sailed away is realized.

The discoverer finds the field for the inventor, and the inventor produces. Hudson found the river, Fulton produced the steamboat to sail upon it. One hundred and three years ago the methods of ship propulsion were the same as used by Hudson—wind and sail. One year later Fulton's "Clermont" opened the way for a new power—steam.

Following the "Clermont's" first voyage the development of steam navigation was rapid. It was but sixteen years later, or in 1818, that the "Savannah," smaller than the "Clermont," being but 100 feet long, crossed the Atlantic ocean in twenty-seven days, the first steamship to accomplish this feat. Today the "Mauretania" is known as a four-day boat. She is 600 feet longer than the "Clermont," has 75 feet more beam and has a gross tonnage of 33,000 tons, with 70,000 horsepower to propel her. The limit of size has not been reached, for sometime in 1911 the White Star steamship "Olympic" will be launched, having a length of 890 feet, beam 92 feet, plated depth 64 feet, displacement at 37½ feet draft 60,000 tons, and she will be driven by 45,000 horsepower of steam turbines at a speed of 21 knots per hour.

The first warship to be built by the United States was launched in 1815, Fulton having to obtain the assent of Congress to construct such a craft, the distrust in the feasibility of such application of steam power being at that time almost universal. Today there float on the bosom of the Hudson river warships of the latest type and development, costing millions of dollars and representing the naval forces of the leading nations of the world. Hudson had the honor of a discoverer, but Fulton's achievements are honored every day by coming and going monuments of marine architecture.

A published account of the gradual advance in steamship development would make a volume in itself, but one of the greatest productions of the nineteenth century was practically developed during the past sixty years, which applies not to speed and size so much as to method of economy.

The "Great Eastern" was launched in 1857, and made her first transatlantic voyage in 1861. Strange to say, the "Great Eastern" held the record for size until the building of the "Oceanic," which was launched in January, 1899, or forty-two years later. The "Great Eastern" was a failure, but not so much on account of size as experiments.

Change after change has been made since the time of the "Clermont;" the single-cylinder engine has been displaced by the compound, triple- and quadruple-expansion engine, and the steam turbine taking their place in two of the fastest transatlantic steamships in the world. Not only have the engines changed, but the design of the boilers has been improved, and the steam pressure has been increased from two or three pounds per square inch, as carried on the boilers of the "Clermont," to 200 pounds per square inch of the present day, although fifty-five years ago a pressure of 54 pounds per square inch was considered the limit. Wooden hulls have given way to those of steel.

What this advancement in steamship design means to each individual cannot be estimated, but it affects all to a greater or less degree. This applies not only to passenger transportation, but also to the cost of shipping freight from point to point. From statistics it is shown that the modern freight steamer will, at a speed of 10 knots per hour, transport 1000 tons of freight for a distance of 10 knots for $1, with coal delivered on board costing $5 per ton.

Small wonder that the State of New York and visitors from foreign shores are paying tribute to the achievements of Robert Fulton. A more fitting tribute would have been to make this celebration national.

## Turbine versus Combined Reciprocating and Steam Turbine Sets

Sir Christopher Furness, M. P., recently had the machinery of his British steam yacht "Emerald" converted so that the three-turbine three-propeller system was changed to a combined high-pressure reciprocating engine and low-pressure turbine plan. It has been rumored that the reduction in the steam consumption was just one-half. Although there was a marked reduction, the saving is hardly as large as rumor has suggested. The following table supplied by Sir Christopher Furness himself, is intended to give figures for comparison. It will be seen that in the first part of the table the steam pressure varied, whereas in the second it was constant at 150 pounds. This makes comparison somewhat difficult, but it is safe to point to the top line in each set of figures, namely, that relating to a speed of 10 knots, when, with a steam pressure of 150 pounds, the consumption figures are 18 and 13 tons. Thus with the converted machinery the steam consumption was rather less than three-fourths the consumption with the three-turbine system. Generally speaking, the other figures are of the same order, although the comparison is not in every case quite so pronouncedly to the advantage of the cited combination plan:

BEFORE:

| Speed. | Consumption. | Steam Pressure. |
|---|---|---|
| 10 knots | 18 tons | 150 lb. |
| 11 " | 23 " | 145 " |
| 12 " | 25 " | 140 " |
| 13 " | 28 " (?) | . |

AFTER:

| Speed. | Consumption. | Steam Pressure. |
|---|---|---|
| 10 knots | 13 tons | 150 lb. |
| 11 " | 16½ " | 150 " |
| 12 " | 20 " | 150 " |
| 13 2 " | 22 9 " | 150 " |

# Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

## Oil Gas Producer

Following are a description and illustrations of a method and apparatus used in utilizing residuum or crude oil for making gas. The process consists essentially in mixing oil with air and vaporizing and gasifying the mixture, which results in a perfectly fixed, colorless gas of from 700 B.t.u. upward per cubic foot. The operation of manufacturing this gas is as follows:

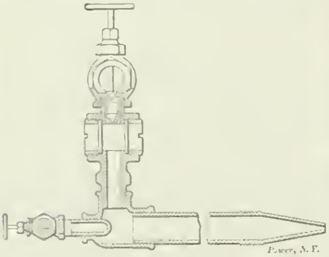
Power, N.Y.

FIG. 1. SECTIONAL VIEW OF NOZZLE

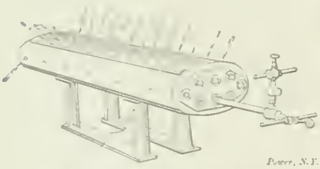
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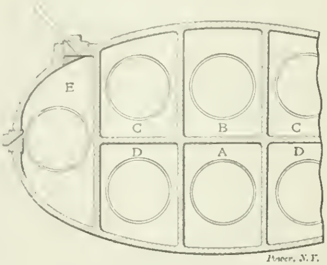
FIG. 2. BURNER AND NOZZLE



Power, N.Y.

FIG. 3. COMPARTMENTS OF BURNER

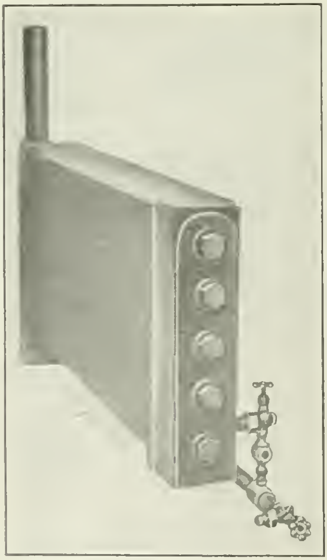


FIG. 4. RETORT WITH NOZZLE IN PLACE

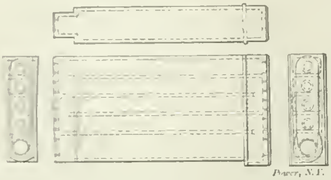

Power, N.Y.

FIG. 5. INTERIOR CONSTRUCTION OF RETORT

An air-and-fuel-mixing nozzle is made to deliver a mixture into an iron burner, where it is heated, and thus gasified, the gas being let out through small holes in the burner where combustion takes place. This burner supplies the heat necessary to vaporize the oil fed to the retorts in which the gas is made. Fig. 1 shows a sectional view of one of the nozzles. The oil is fed in through the upper needle valve and air through the lower. Both oil and air are under equal pressure; the hole through which the mixture passes is but 3/16 inch in diameter, the air hole being 1/8 inch.

In Fig. 2 is shown the burner with the nozzle attached. It is made of an iron casting, cored so as to form eight compartments running the entire length of the burner. These compartments are arranged so that the mixture enters the bottom center, shown at *A*, Fig. 3, passing th length of the burner, enters *B* back t the front end, entering through the com partment *C* and down into *D*, forward in to *E*, whence it passes out through series of holes shown in Fig. 2 an where it is ignited, being supplied wit necessary air from the opening in th firebox. The holes in the side of th burner are arranged so as to direct th gas downward for the purpose of kee ing the burner hot. The two upper row of holes direct the gas upward again and between the retorts which are place 2 or 3 inches apart in the frame so as t present as much heating surface as po sible.

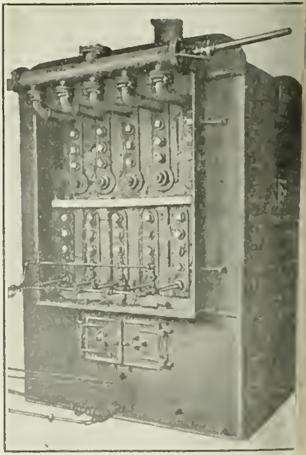


FIG. 6. FRONT VIEW OF OIL GAS PRODUC

In Fig. 4 is illustrated one of the torts with the nozzle in place. The terior construction is shown in Fig and is similar to that of the burner self. After the mixture passes thro the various channels of the lower ret it passes through similar channels in upper one. By the time it has pa through these retorts, the oil has bec thoroughly gasified, and no raw oil is lected in the settling tank unless an cess is fed through the nozzle. If is should happen no harm is done, as surplus oil simply settles in the t where it is drawn off and used aga

Fig. 6 is a front view of a ten-r oil-gas producer, with the iron fron moved. The burner is situated below the firebox, and the retorts are arranged above in pairs, one over the other. The oil enters the lower one at the bottom and gas leaves from the top of the upper one of each pair, where it is collected in a manifold, carried over through two settling tanks and piped to a storage tank.

Fig. 7 shows the rear end of the pipe connection between the retorts of each pair. This end is covered by an iron front when in operation. In order to

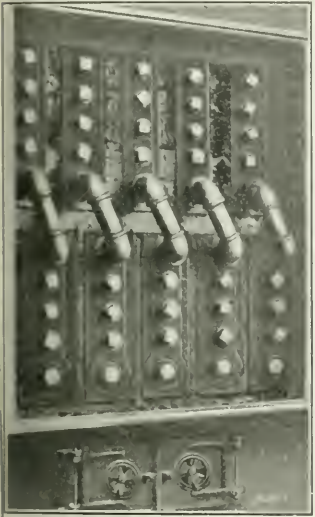


FIG. 7. REAR OF A TEN-RETORT PRODUCER

tart the apparatus, it is only necessary to t the burner to a dull red, admit the and the air to it and allow the retort reach the same temperature, when the nd air are admitted to the retort and e gas is at once generated. This process manufactured by the Gas Power Pro- g Company, Lima, O.

## Economy Grease

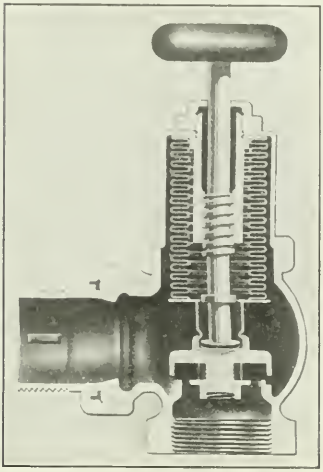
A new kind of grease has just been put he market, known as "Economy" se. It is a prepared pure-oil lubri- , and is said to have a high melting consistent with safe lubrication.

is claimed for it that it does not n resin, resinous oils, talc, powdered . clay, tallow, etc., is not affected by ic conditions and that the same ty is used both summer and winter; that it does not harden, become id or gum up.

It is also claimed that it remains in the me condition in the cup as found in the kage, and that it retains the same con- tency after being placed in the cup in hot place. This grease is manufactured the Economy Lubricating Company, rst and L streets, South Boston, Mass.

## "Sylphon" Packingless Radiator Valve

The features of this type of valve are shown in the accompanying illustration. It is made with a patented metallic bellows inclosed in the bonnet of the valve; the valve stem and stem support being located inside the bellows. When the valve is opening and closing, the bellows merely contracts and expands in length without disturbing the steam-tight connection between its upper end and the top of the valve bonnet, which is connected with the disk holder at the bottom of the bellows. As a result the valve is automatically sealed at all points around the stem and remains so as long as the bellows lasts, which it is claimed will be as long as the life of the valve itself.



"SYLPHON" PACKINGLESS RADIATOR VALVE

The entire valve stem and valve support, being located inside of the bellows, are not exposed to the action of the steam, or to the wash of the system. Therefore, it is claimed that they do not corrode or become clogged with sand, scale or grease and remain practically frictionless.

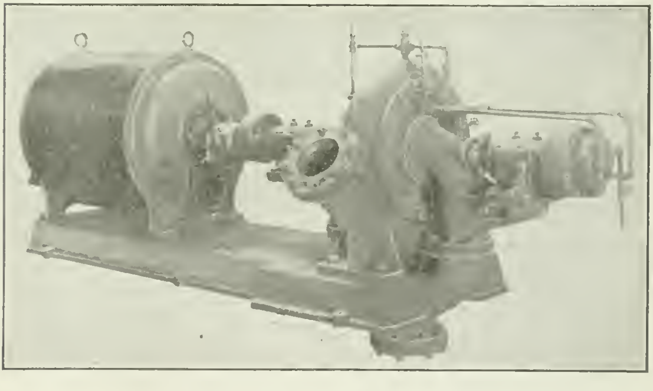
The "Sylphon" bellows is made of steam brass. It is claimed that it is not affected in any way by heat or corrosion of steam or water. The folds of the bellows are sufficiently close to act as capillary cells which retain the water of condensation and prevent sediment from lodging in them so that the action is free and unobstructed.

Some of the features of this type of valve are that it has no packing of any description, and has no valve stem or supports exposed to the steam, and its working parts do not come in contact with the steam and wash of the system. It is manufactured by the American Radiator Company, 282 Michigan avenue, Chicago, Ill.

## Buffalo Centrifugal Pump

The accompanying illustration shows a "Buffalo" centrifugal pump, direct-connected to a Kerr steam turbine. It is a 6-inch horizontal-shaft single-stage double-suction volute machine, and the pump and turbine are mounted on the same base, and connected by a special leather-link flexible coupling, having a ring-oil bearing between the coupling and pump gland.

The pump is fitted with dustproof, double-ring oiling bearings and water-cooled single collar thrust. The runners are of bronze and are finished all over, and the glands are brass lined. The suction glands are on each side of the pump, and are provided with water seal to prevent leakage of air to the interior of the pump. A recent test of this pump showed an efficiency of between 74 and 75 per cent., it is claimed. The pump shown is connected to an 18-inch seven-stage 50-horsepower Kerr steam turbine, which operates noncondensing under 125 pounds'



BUFFALO VOLUTE PUMP AND KERR TURBINE

steam pressure. The weight of the complete unit is about 800 pounds. The pump is built by the [illegible] Steam Pump Company, Buffalo, N. Y.

## "Lip Lock" Self-adjusting Cylinder Packing

The "Lip Lock" cylinder packing, which is suitable for marine, stationary engines, locomotives, automobiles, pumps and gas engines, is also applicable to air, oil, water or ammonia pumps. It is manufactured by Redner & McCoy, 128 and 130 East Forty second Street, New York City. Owing to the fact that this packing has never been pushed to any great extent it is practically unknown to steam users and the following description should therefore be of interest.

The "Lip Lock" cylinder packing can be used in all kinds of cylinders. It is set on pistons provided with grooves for the reception of the packing rings which are L-shaped, having extensions, the rings being substantially circular in form, with the two ends separated from each other a slight distance to allow for contraction and expansion. One end of each ring is provided with an integral projection, or key, which is smooth on one side, and comes in contact with the other end of the ring and overlaps it a sufficient distance to prevent the passage of steam, or liquid in the case of pumps.

Each groove in the piston head is provided with an offset groove constituting a keyway for the projection of keys. These rings are placed at the outer edge of the piston, and between the two, or in the middle of the piston, is a heavy flat ring set out by a corrugated brass spring, which carries the weight of t piston, thereby allowing the piston rin to be practically free of weight and form a steam-tight joint whether in contracted or extended position. A stea tight joint is also formed by the plan surface of the lip or key and the oth end of the ring. By making the surfa planed and the key integral with one e of the ring it is apparent that there slight possibility of the ring getti caught.

Fig. 1 shows a section of a piston w the rings in place. It will be seen tl two steam rings are placed on the ou edges while the center ring which su ports the piston head is in the cent This type of piston is suitable for stea engine use. Fig. 2 shows the locomot type of piston, and also gives a good i of how the rings overlap the count bore of the cylinder. The details of t sketch also show the piston cut away admit the key or lip riveted to the ring.

Fig. 4 shows the design of piston s able for pump use, while Fig. 3 sh

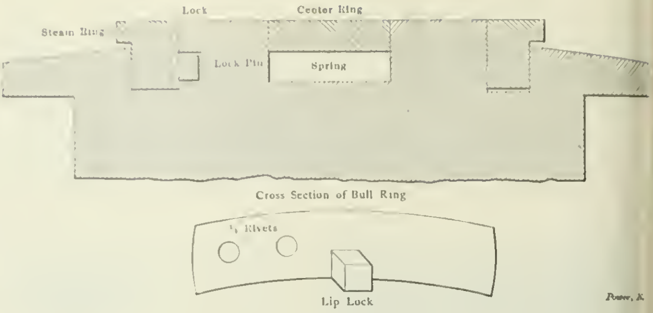


FIG. 1. RINGS IN PLACE

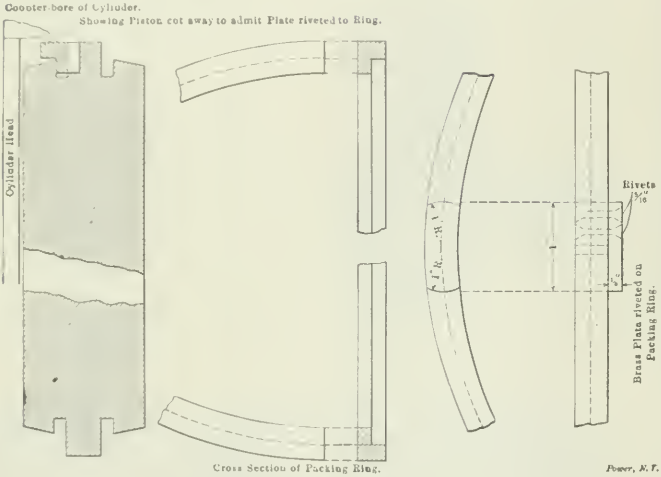

Counter-bore of Cylinder.
Showing Piston cut away to admit Plate riveted to Ring.
Cylinder Head
1" R.
Rivets
3/16"
⅛"
Brass Plate riveted on Packing Ring.
Cross Section of Packing Ring.
Power, N. Y.

FIG. 2. LOCOMOTIVE TYPE

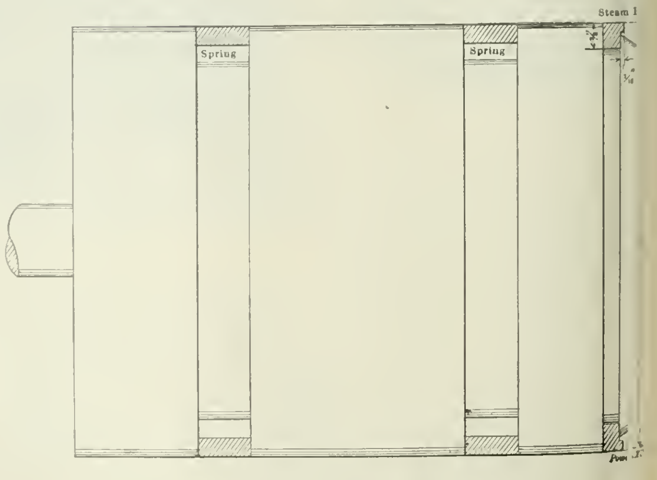
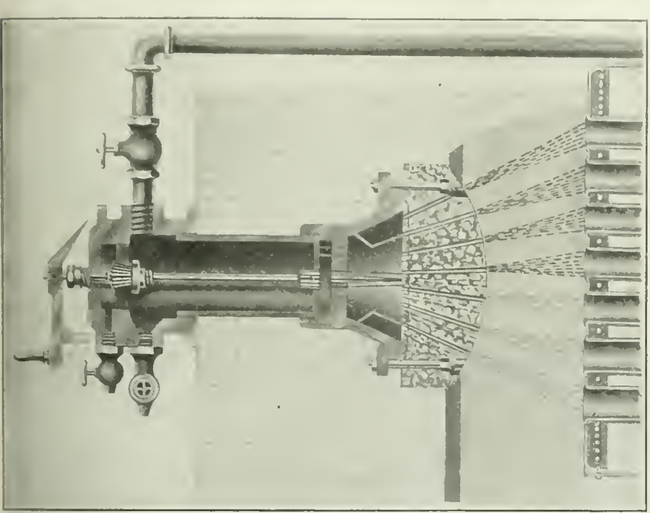


FIG. 3. PISTON FOR GAS ENGINE

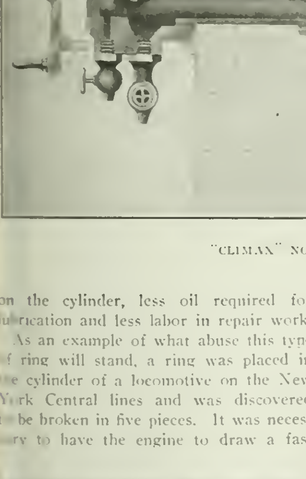
that designed for a gas engine. It will be noticed in this case that the packing ring is at the extreme end of the piston, while the supporting rings are placed equidistant from each end, thus supporting the weight of the piston itself.

The advantages of this type of ring are claimed to be less friction, less wear on the cylinder, less oil required for lubrication and less labor in repair work.



“CLIMAX” NO. 3 TUBE BLOWER

As an example of what abuse this type of ring will stand, a ring was placed in the cylinder of a locomotive on the New York Central lines and was discovered to be broken in five pieces. It was necessary to have the engine to draw a fast heavy train, as no other engine was prourable. The rings were put back in place and the engine ran for one week fter the broken ring was discovered, when it was replaced by a new ring. An xamination of the cylinder disclosed that it had not been injured in the least and was apparently as good as new.



Power, N.Y.

FIG. 4. PUMP PISTON

## “Climax” No. 3 Tube Blower

The Goodfellow “Climax” No. 3 boiler tube blower is illustrated and described herewith. The blower head has six chambers, each chamber having a series of independent jets arranged to cover a corresponding series of tubes in the boiler head. Each chamber has a valve port covered by a valve with one port and controlled by a balance valve at the opposite end of the steam cylinder. Drip-cocks are provided to drain the cylinder of condensation.

Each time the operating handle is moved to the indicating mark a certain series of tubes are blown, every tube in the boiler being blown alike with a concentrated force of steam, and of equal duration. The cleaner may be operated from the front, rear or side of the boiler in the direction of the draft. The blower head is made of iron or firebrick material and is attached to the back-chamber brickwork. This blower is manufactured by John H. Goodfellow, 36 Ferguson avenue, Buffalo, N. Y.

## Textile Master Mechanics and Chief Engineers

The New England Textile Master Mechanics' and Chief Engineers' Association was organized on September 21 at Fall River, Mass.

The preamble states the objects of the association to be the advancement of the art and science of textile mechanics and steam engineering, to promote social intercourse between master mechanics and chief engineers of the New England textile industries, and to maintain a bureau of information and employment.

To become a member one must have served as a master mechanic or chief engineer in a textile mill at least one year. The Association is purely educational and social in character and we wish for it an abundant success. Henry G. Young, 868 Second street, Fall River, Mass., is secretary.

## Personal

Adolph W. Gilbert, lately president of the Pratt & Cady Company, of Hartford, Conn., has assumed the presidency and general management of the Chapman Valve Manufacturing Company, bringing with him as works manager Robert Shirley, designer of the Shirley gate valve and of the 108 inch gate valve in use at Niagara, probably the largest gate valve in use in this country.

H. H. Stoek, for many years editor of *Mines and Minerals*, has been appointed professor of mining engineering at the University of Illinois. This announcement is made under the authority of Dean Gross and it is to be eccepted as evidence that the new department of mining engineering of the University of Illinois is to be as efficiently manned as are its other departments of engineering.

T. Commerford Martin, for more than a quarter of a century editor of the *Electrical World*, recently resigned that position to accept the general secretaryship of the National Electric Light Association. The responsibilities of his new duties will be very great, but Mr. Martin is well equipped to cope with them, owing to his natural gifts and his experience in matters electrical. No man is more widely and favorably known in his field of work.

In a power station situated not far from Glasgow, writes a correspondent, there was a station superintendent well known as a splendid engineer, and as a very difficult man to get on with. On one occasion a greaser, while adjusting a sight-feed lubricator, was badly damaged about the face by the bursting of the lubricator glass. After the chief engineer had attended to the man's injuries, he went to the station superintendent's office and reported the matter to him, expecting that he would express some little sympathy for the man. You can therefore imagine how much he was taken aback when all he got was, “Was there much oil lost?” —*The Engineer-in-Charge.*

Shortly after the night shift at the Buffalo Steel Company's plant at North Tonawanda, N. Y., started to work on September 10, the flywheel burst and caused considerable damage to the plant.

## Business Items

C. A. Bell [illegible] of Pittsburg has been appointed manager of the mechanical departments of the W[illegible] Manufacturing Company, and the [illegible] Separator Company of Detroit, taking the place of H. H. Humphrey, deceased.

The Chapman Valve Manufacturing Company has furnished to the United States Government a number of 10-inch brass valves for use in dry-docks [illegible] in salt water. These valves weigh 2580 pounds and are built entirely of the yellow metal.

The Orvis Economy Furnace Company, 21 Park Row, New York City, has been granted permission by the Supreme Court to change its name to the National Power and Economy Company, the change going into effect September 22.

The R. & J. Dick Company of Glasgow, Scotland, manufacturer of composition leather belting, has bought five acres of land adjoining the Passaic, N. J., cotton-duck factory, and will at once begin the erection of a building 300 feet long and 180 feet wide. To this will be added other buildings as the development of the business demands.

The Hoppes Manufacturing Company, Springfield, Ohio, is just issuing a new 40-page catalog of Hoppes live-steam feedwater purifiers, exhaust-steam feedwater heaters and purifiers, steam separators, oil eliminators and exhaust heads. It is fully illustrated and clearly describes the Hoppes machines and methods. A copy will be sent free to any reader addressing the company.

The Roché Engineering Company, Charles G. Wilfong, general manager, has just opened offices in suite 812 Weightman building, Philadelphia, Penn., and is putting on the market the Evans automatic feedwater regulator, the "Pennsylvania" smoke preventer, the "Philadelphia" internal-combustion marine engine and the "American" boiler-feedwater purifier. Charles S. Wood is president of the company and Frank E. Roché, secretary and treasurer.

"A Study of the Open Hearth" is the title of an expensively-bound 92-page booklet, 4¼x6¾ inches, with flexible leather covers and gilt edges, which is sent gratis upon request by the Harbison-Walker Refractories Company, Pittsburg, Penn. Originally prepared for the use of its own operating department, so much interest in it was shown by a number of open-hearth superintendents, who suggested it as being of interest to iron and steel men generally, that it was published in this form. It describes fully the process of making open-hearth steel.

The Diamond Rubber Company, manufacturer of "Indian Red" sheet packing and mechanical rubber goods, has in course of construction a large addition to its present works at Akron, Ohio. The new building will be five stories high, 100 feet wide and 100 feet long, with a ground floor 165 feet in width, and will afford facilities for a large increase in business. Starting eleven years ago with a floor space of two acres and 200 employees, the company now furnishes employment for 3600 men and has a floor space covering 34 acres. Tires, hard rubber specialties and insulated wires and cables are also among the products of the company. The laboratories of the company are said to be the largest in the world devoted to the chemistry of rubber.

The American Car and Foundry Company has installed a 500-kilowatt General Electric low-pressure turbine with a 250-volt direct-current generator in its Detroit plant. This turbine takes the exhaust steam from several vertical single-acting steam engines and exhausts into a surface condenser placed directly underneath the turbine. On account of the small supply of circulating water available, a cooling tower has been placed on the roof of the power house and no difficulty is experienced in maintaining a good vacuum. The entire layout is very compact. The turbine has been run for several months, showing very smooth operation and excellent commutation, and is said to develop a kilowatt for every kilowatt developed by the engines. The results obtained in actual service have been so satisfactory that three additional units of similar design have been ordered.

The Ridgway Dynamo and Engine Company announces the opening of a district office at 1311 Schofield building, Cleveland, Ohio. H. C. Hale, who has been the Cleveland sales agent for "Ridgway" apparatus during the past two or three years, will be in charge of this office as local manager. Mr. Hale is well and favorably known in Cleveland as an able engineer and has been connected with several of its important engineering and manufacturing enterprises. While his experience has thus been varied, he has had special opportunities for observation and study of the many problems connected with the mechanical and electrical equipment of coal mines in the bituminous fields of Ohio, Pennsylvania, West Virginia and Kentucky. The Ridgway Dynamo and Engine Company supplies a large proportion of such power-house equipment for the mines in these districts and considers itself fortunate in having Mr. Hale on its staff. He will be glad to have prospective purchasers of power-plant machinery for any service confer with him in regard to their needs.

The claim to having the largest plant in the world for the manufacture of machinery for the mechanical transmission of power is made by the Dodge Manufacturing Company, Mishawaka, Ind., whose buildings cover nearly 40 acres in a 60-acre location on the Lake Shore & Michigan Southern railway. The consumption of raw materials, the production of finished goods, and the capacities of the power and mechanical equipment are evidence of the extensiveness of the factory. There are annually consumed 20,000 tons of pig iron, 7,000,000 feet of lumber, 900 tons of steel and structural iron, 6200 tons of steel shafting and 9000 tons of coal. There are annually produced 250,000 "Independence" wood split pulleys, 100,000 "Dodge Standard" iron split pulleys, 90,000 solid-iron pulleys, 95,000 hangers, 150,000 bearings of all types, 4000 friction clutches and more than 2,000,000 pounds of bearing metal. The steam boilers have a capacity of 1500 horsepower, and the steam engines 1500 horsepower, with electric generators of 250 kilowatts. The steel shop in which the "Eureka" water softener and purifier is made has a capacity of 52 fully equipped machines per annum.

Several large orders for direct-current apparatus have recently been received by the Crocker-Wheeler Company, of Ampere, N. J. Among these is one from the Southern Iron and Steel Company, of Roger, Ga., calling for two 250-kilowatt, engine-type, 550-volt, direct-current generators and 275 horsepower in 500-volt, direct-current motors. This is in addition to a recent order for 1450 kilowatts in engine-type generators and 1200 horsepower in slow-speed motors for the same concern. The Republic Iron and Steel Company, Youngstown, O., placed an order for a 600-kilowatt engine-type 250-volt, direct-current generator, which will be added to a plant consisting of two 300-kilowatt Crocker-Wheeler generators. Another order has been booked from the Nonquit Spinning Company, New Bedford, Mass., covering 375 kilowatts in 250-volt Crocker-Wheeler type D direct-current generators. One 250-kilowatt, 250-volt, engine-type, direct-current generator and two 50-horsepower motors are to be installed in a woolen mill for the Southwark Mills Company, of Philadelphia. Two 75-kilowatt, engine-type, 125-volt, direct-current generators will be installed in the factory building of Goodman, Loeb & Co., Philadelphia.

A new method for calculating drying equipments is described in "Drying in Industrial Plants," a brief treatise just published by the Green Fuel Economizer Company, Matteawan, N. Y. The first part of the book discusses the elementary theory of drying and then describes drying equipments as used in various industries, such as tenter frames in textile plants, leather driers for tanneries, thread, laundry, baking powder, blue, lumber, malt driers, etc. The latter part of the book contains a chapter o drying engineering and gives an original metho for calculating the amount of air and stea required for drying a given material unde prescribed conditions. The method here outline does not require an elaborate system of specia tables, as does that proposed by Housebran and others, but the calculations can be performe with the aid of the ordinary steam tables an a table of humidity, both of which are include in the present book. Further, in order to kee down the complexity and number of the table Housebrand has assumed one heat of vaporiza tion for all drying temperatures, whereas wit the method herein described the correct valu can be taken in each case. The book shoul be of interest, not only to manufacturers wh have drying work to do, but also to engineer who design and construct plants of this cha acter. The booklet will be supplied gratis o request.

Five 6-inch Blackburn-Smith feedwat filters have been installed in the Marion pow station of the Public Service Railway Compan of New Jersey to eliminate the oil which ha heretofore reached the boilers in considerab quantity. At this plant there are twenty-fiv 625-horsepower boilers, arranged in five ba teries and carrying a pressure of 200 pound Each battery is served by one filter which ha sufficient capacity for handling 150,000 poun of water per hour. The exhaust steam fr Curtis turbines and the auxiliaries is condens and used again as feedwater, but it was foun that the open heaters did not catch the present in the condensed exhaust steam fro these auxiliaries. The new filtering arrang ment, as provided by the Blackburn-Smi filters, now passes all the feedwater throu two separated layers of linen terry at the la point before the water enters the boilers. this way both makeup water and condensati are given a final classification. The wat reaches the filters at a pressure of about 2 pounds and at a temperature of about 2 degrees. The filtering surfaces are kept cle by renewing the media on the cartridges wh they are replaced by spares. The operation quickly performed as the swing bolts whi hold down the cover of the filter are eas loosened, and the cover is swung to one si by means of a crane which is furnished as p of the filter. The oil retarded in this instan is plainly noticeable by the discoloration the cloth of the two foul cartridges rest against the foundation, in comparison with t spare one which is being put into place. Th foul cloths are afterward boiled out in so and kept in readiness for the next cleani Blackburn-Smith filters are made by Jan Beggs & Co., 109 Liberty street, New York, w will send further information upon request.

## New Equipment

The Red Bank (N. J.) Water Works is enla ing its power plant.

The Paine Lumber Company, Oshkosh, W will build an electric power plant.

The Superior (Wis.) Water, Light and Po Company will install additional equipment.

The Middleport (N. Y.) Gas and Electric C pany will install two additional oil engines.

C. A. Straubel, 409 North Washington str Green Bay, Wis., will erect a cold storage pl

The Leader Iron Works, Decatur, Ill., build a new boiler room and install two boilers.

The Menasha (Wis.) Paper Company is re to receive bids on pumps, condenser, ele generators, etc.

# Supernatural Visitation of James Watt

## He Brings Fulton, Stephenson and an Anarchist with Him; Over a Game of Seven-up They Institute a "Fulton Night" and Hear Robert's Story

### BY WARREN O. ROGERS

The midnight visits of James Watt ew more and more frequent as the ks passed, and the subjects discussed re many, but usually of an engineerg character. On one occasion he brought ero with him, but as I could not undernd his language we did not get on very ell together. On another visit Watt ught Branca, whose mind continually verted to the steam turbine, and it

THE FOUR WERE SEATED AROUND THE LIBRARY TABLE, PLAYING A GAME OF "SEVEN-UP"

I ot seem strange when I state that I claimed to be the father of the machine wind in successful operation today. The conversations I enjoyed with these inbitants of the spirit world showed that ty had a keen perception of the value of steam for their day, although to us, with modern usages, it would seem alnst too elementary to notice.

One evening I had been detained at the club a little later than usual, and upon entering my residence was surprised to hear voices, raised in loud controversy, issuing from the direction of the library. Suspecting that Watt had brought along some of his kindred spirits and that they were making themselves at home, I quietly seated myself in the adjoining room to listen to what was said. From the conversation it was at once apparent that my visitors were no others than Watt, Fulton and Stephenson, the reputed fathers of the steam engine, steamboat and locomotive, and one other, who later proved to be an anarchist. The four were seated around the library table playing a game of "seven-up."

The argument was as to which of their inventions had accomplished the most good for civilization. It was evident that they had but just started, and were indulging in personalities and "mud throwing," much after the manner of mortals.

Seeing that they could not agree in any kind of a ghostly fashion, I made myself known and suggested that Fulton tell about his early difficulties, and bring out all the points as to his work benefiting the public, to be followed by Stephenson, and in that manner to get better acquainted. I therefore got the cigars—and other things—and leaned back in a rocker to enjoy the treat I knew was to be mine.

After Fulton had lighted his cigar to his satisfaction he said:

"I was born in a little Pennsylvania town called Little Britain, in 1765. My parents were Irish, and I don't give a 'dom' who knows it," and Fulton lapsed into a little of the brogue of the "ould sod." "I was christened Robert Fulton, and have never had reason to be ashamed of my name, neither of my actions, which is more than I can say of some I have known." And as Fulton looked at Watt as he was speaking, that worthy turned a slight crimson, as he evidently recalled the condition in which he had left my house some weeks before.

"My father died when I was three years old," went on Fulton, "and as I gave up schooling early in life my education did not amount to much, seeing that I was forced to go out into the world to make my own way. When I was seventeen years of age, I was quite an artist, dabbling in portrait and landscape painting, but there wasn't any more money in it then than there is now for the general run of artists. My inclinations also led me to study mechanics, and I devoted much of my time to mechanical drafting, etc., while living in Philadelphia."

"Gee, but that was a slow town!" interrupted Watt.

"By the time I was twenty-one," went on Fulton, disdaining to notice Watt's slur upon his home city, "I was able to make a home for my mother and also visit England to study art."

"Art—art—what is that?" again interrupted Watt, with a sneer. "Art," continued Watt, answering his own question, "art is to most people what a dish of molasses is to hungry flies; they go to it in swarms. If a man is a failure he turns to art; if he kills a man, and is acquitted, he studies art. Of all the art freaks I have seen in my circle, not more than one in every thousand knew enough to earn three square meals a day. They are the skinniest-looking lot I have ever seen among our shadows. Don't talk any more about art to this crowd."

"Well," rejoined Fulton, with a sparkle in his eye, "I wasn't that kind of an artist. I was a success, and let me tell you, if I had remained with my art the world would have had something to show for it. However, I gave up art because mechanical and scientific investigations were a greater enjoyment to me. That was when I was about twenty-five years of age. I then went to Birmingham to live, and it was there I met Watt. So you see," resumed Fulton, turning to me, "Watt and I are old acquaintances. He had just succeeded in his great improvement in the steam engine, and you may be sure I soon became familiar with it."

"Is that the reason you became interested in navigation?" I asked.

"Smoldering ashes, no! That didn't come for some years later, although it might have been the seed sown. No, I was busy with many other things before I began to experiment with steamboats. The strange part of it is that thousands of people living today do not seem to know that I ever invented anything beside the steamboat. Why, I used to manufacture lead pencils, when but ten years of age, and I had a boat fitted with paddlewheels when I was a boy. While in Birmingham I was engaged in the construction of canals and received notices from several societies for my work. Why, I invented the idea of the canal lock, such as they will use in the Panama canal that I am hearing so much about lately. I also published a treatise on the subject in 1796, invented a method of sawing marble and was honored by a British scientific society."

"Regular society man, wasn't you?" broke in Watt, "and an author. I don't wonder you died suddenly. I don't see how you stood it for fifty years."

"Oh, that didn't cause my hat to pinch," rejoined Fulton. "I invented a machine for spinning flax and making rope and also a kind of a power shovel. About a year later I began to experiment with submarine explosives, which later on enabled me to perfect a torpedo."

"Fulton was a regular anarchist," said Watt, as he looked at me. "Don't look it, does he?"

"It was these experiments that drew my attention to the submarine boat. Finally the French government came to my assistance, and with their aid I was enabled to construct a boat that could stay under water for several hours and travel for a number of miles. I could control the boat very easily, making it sink, rise, turn around, go forward or backward. The Frenchmen lost interest in it, however, and did not do anything with it."

"Those Frenchmen are slow when it comes to new inventions," remarked Stephenson, as he idly stacked the cards. "Now if you had taken your invention to England you would have received attention right smart."

"England nothing!" replied Fulton. "I did take my boat to England, but they were satisfied with getting me away from France, I guess. They wanted me to give them the exclusive right to my invention, but I was an American, by heck, and couldn't see it that way. Well, I came back home and got my own Government interested to the tune of $5000, but they soon got cold feet or something and the thing fell through."

"Gee, but you're a long-winded cuss!" exclaimed Watt, as he spun a couple of poker chips on the table. "You haven't said a word about your steamboat. Cast off your line and get on your course!" and Watt clicked his bony knees together with impatience.

Taking no notice of his remark, Fulton resumed, "I was not the first to dabble with steam navigation by any means, but I was the first man to make a practical and commercial success, but it wasn't the work of a day, I can tell you. I had planned and thought matters over many times before I imported one of Watt and Boulton's engines to run the 'Clermont.' I knew there was money in the thing, as Livingston had obtained a monopoly o steam navigation in New York water: which was transferred to Livingston an myself in 1803, when we had a monopol that was extended another twenty years

"Down with monopoly!" growled tl bewhiskered skeleton as he drew a bon from the bosom of his red shirt an lighting the fuse, placed the bomb und Fulton's chair. That individual calm put his icy foot on the burning fuse ar extinguished it with a spit and splutter

When I got an opportunity to talk Watt alone I gave him strict orders nev to bring anarchists with him again, as did not care to have my house blown splinters.

After the "red" had calmed down as to be rational, Fulton continued l narrative:

"The 'Clermont' was 133 feet long, 1 feet wide, 7 feet deep and of 160 tons d placement. The Watt engine was doul acting and had a vertical cylinder 2 f in diameter and 4 feet long. The boi was 20 feet long, 7 feet deep and 8 f wide, constructed something after the t of the modern locomotive boiler. boat had two 15 foot paddlewheels wh were 4 feet broad, and the piston connected to the shaft by side levers outside connecting rods which connec to the crank gear on the wheel shaft

"The boat was run successfully, but insults I received were enough to h caused most men to give up in des and disgust. I was called a fool, cr idiot and I don't know what. Those refrained from these epithets looked tl which was just as bad.

"Well, we started for Albany and there, too, although there were many laughed and jeered at us when we sta and when we stopped for a slight ad ment in midstream we could hear people hooting from the shores of river."

"How long did it take you to g Albany?" I asked, as Fulton seeme have become engrossed with memori the past.

"Just thirty-six hours," was the pr response. "It took from six to ten to make the trip by other means, a can say that there has been stean travel between New York and A from that day to this, winter month cepted."

"Very interesting," I said, stret one leg out over the other.

"Interesting? not a bit," contrad Stephenson. "You ought to see h locomotive can get over the groun tween those cities now! Why ——"

"I rise to a point of order," interr te Watt, while the anarchist reached f another bomb. "This is Fulton's nig sand your rails."

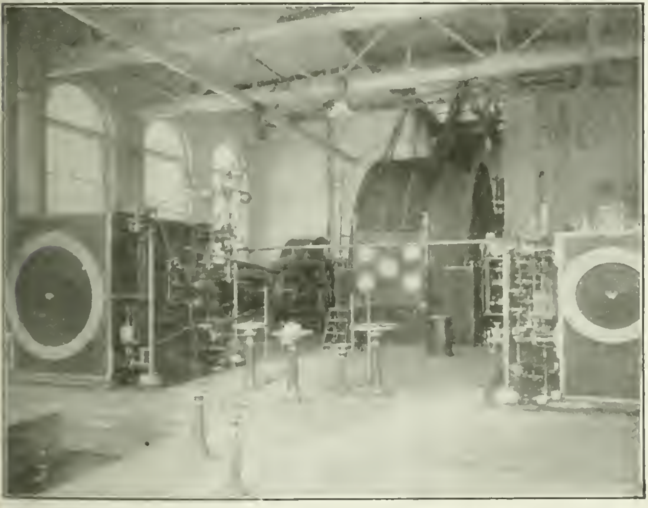
"There isn't much more of inter to tell. I constructed the first steam w ship built for the United States Goveri ent. I also built the first steam ferryb t to run between New York and Jersey City and New York and Brooklyn; and furnished plans for the first Mississippi steamboat."

"A regular first-nighter in everything," chuckled Watt, as he relit a cigar stub.

"I was married in 1808," went on Fulton, "and died February 24, 1815 of pneumonia or consumption, I forget which."

As he sat there in the semi-lighted room I could catch glimpses of what kind of a picture Fulton must have presented, with his tall, straight figure, attractive face and eyes, high forehead and dark, curly hair. The four visitors had stopped talking now and were playing a last hand of "seven-up," while I pictured the advancement made in steam navigation since the first run of the "Clermont," with which all of us are familiar today. How unconcerned that man of genius, as he t there playing his hand of cards! How he seemed to realize the vast imrtance of his invention, or its benefits ankind! How little he seemed to ape the magnitude to which steam vigation has been carried; how little he w of those mighty ocean steamships t plough through the waves regardless the elements, or glide through the th sea, mighty in themselves, wonderand majestic!

I gave a sigh, as I was awakened from reverie by the step of the maid deending the stairs to begin the duties f another day; and wishing to see what w visitors would do with others of the ortal world bestirring, I turned, but e chairs were empty and all that indiated that visitors had been present were e remains of partly consumed cigars, d the scattered playing cards on the brary table.



PE DRIVE DELIVERING 2500 HORSEPOWER WITH THIRTY-SIX 1 [illegible]/8-INCH COTTON ROPES

## Belt, Motor and Rope Drive

By H. D. Jackson

I have noticed in one or two papers extracts from a paper presented by Harrington Emerson on leather-belt transmission, in which he frankly and freely states that the leather belt is for all mill purposes superior to any other method of drive; and makes the statement that the installation of electric drives, rope drives and chain drives has been mainly on account of the persuasive arguments of the sales agents and lack of enthusiasm in the belt manufacturer.

It seems to me that Mr. Emerson has been somewhat over-enthusiastic on the belt, for the same reason that the manufacturers of other types of drive are over-enthusiastic regarding their products; and that he has rather overestimated the value of the belt and underestimated the value of other methods of drive.

The use of leather belts for transmission purposes requires the use of long lines of shafting; shafting which is very much heavier than is required simply to transmit the power for use of a single floor or for a single line of work; as this shafting has not only to carry power which it delivers to machines on this floor, but also the power which has to be delivered beyond this floor. In setting up the shaft, it is necessary that it should be very carefully installed and exceedingly well lined up, and it is equally necessary that it should be carefully watched in order that it be maintained in line. Where vertical drives are necessary, there is considerable loss in vertical belts even without the use of idlers; and in most cases, in order to make the transmission possible, idlers are necessary, adding to the loss.

### Installing and Operating Cost

The statement is also made that in most mills and machine-shop installations, the leather belt will prove least expensive to install, operate and maintain. In a properly laid out plant, the cost of an electrical installation will not exceed the cost of a belt operated installation, as the shafting and bearings will be much smaller, and the total cost of both very materially decreased. The quantity of shafting will be very much less, and as no belts are required except from the machines to the shafting, the belt cost is very low. This is of course offset by the increased cost of the wiring and the motors; but in most cases the costs will be practically equal.

As for operating expense, there should be little if any difference in the cost of operating the machinery alone, and the same is true of maintenance, depending, of course, on conditions of operation and care; but we are assuming that both are equally well cared for, which as a rule means that both are to a considerable extent neglected; and as a matter of fact, the motor drive can be neglected to a far greater extent than the belt drive, without suffering material injury.

It must not be taken that I mean that in all cases the electric drive is superior to the belt or rope drive, for such is far from the case. There are conditions and there are mills where a belt drive is superior to a motor drive; but in most machine-shop practice and much of the mill practice, there is a decided gain from the use of the motor drives if properly installed. One of the greatest difficulties of a motor drive has come from lack of knowledge in the method of installation and, as Mr. Emerson says, from the enthusiasm of the salesman rather getting the better of him, and his recommending the installation of too many motors, or motors of a character not suited to the purpose. If a competent engineer is employed for the installation, the motor drive will equal the belt drive in first cost, operating cost and maintenance cost in almost every plant, and win out against the belt drive in operating and maintenance cost in very many plants. The great objection to belt drives is that the losses in friction are cumulative, that is, if we start at the farthest point from the engine, we have a power load and a friction load. The next piece of shafting has to carry not only the load which it delivers to the machinery, but also the friction and the power load of the shafting beyond it, and this piece of shafting has to be made heavy enough to carry this load in addition to its own natural load. This holds true from shaft to shaft until we come to the main engine; the friction load, therefore, being cumulative, until on reaching the engine, the friction load of the mill or plant may be a very considerable factor. In a number of plants that have been tested, both old and new, the friction load has been considerably exceeds 50 per cent. of the total power generated by the engine. In machine shops it frequently rises as high as 75 per cent. The belt manufacturers may claim that this is due to faulty construction. This may be so, but the fact remains that in many plants this condition remains.

### OTHER BELT DRIVE TROUBLES

Other great troubles with the belt drive are the throwing around of dirt, dust and oil, the possibility of fire from friction of the belt, in belt boxes and elsewhere; the amount of light that belts obstruct; and troubles incidental to making changes in the speed of various tools and machines. Further, unless the plant happens to be laid out with an idea of increase in capacity, it is often awkward and inconvenient to make additions without entirely replacing a line shaft. It is difficult and sometimes expensive to arrange for the shutting down of any particular portion of the factory. Mr. Emerson says this can be done through the use of belt-shifting devices, etc. While this is true, belt shifters in large sizes are seldom satisfactory; and further, this shutting down may also close a considerable portion of the factory which is dependent on this piece of shafting.

I quite agree with Mr. Emerson that the motor-drive shop is attractive, but hardly agree with him that it is not business. The use of individual electric motors depends on the purpose for which they are used. The running of a long line of shafting for the express purpose of operating one tool which is only required semi-occasionally, is, to bring in an expression of Mr. Emerson's, "just as poor business policy as to keep a race horse to drag a farm team." On the other hand, the use of an electric motor for operating this machine would be quite as good business policy as "the keeping of a racing horse for racing purposes."

Individual motors have their application, but few of us believe in the installation of an individual motor drive, unless there is reason for it. If one will go back far enough, it can be readily shown that in many cases the prime mover necessary to operate a plant through electric drive, especially a plant having many machine tools or tools intermittent in operation, will be much smaller than that required to operate through belt drive. This is because the friction losses are materially reduced and the load of the intermittent-operating machines fluctuates from one machine to the other, allowing the use of a smaller prime mover.

### MOTOR DRIVE LESS EXPENSIVE

The result, therefore, is that the actual cost of the installation of the power plant and equipment is less than that of a belt-driven plant. If the mill plant happens to be one of considerable extent, with buildings somewhat detached, the advantages of the electric motor are even more obvious, although rope drive has in the past done exceedingly well under these conditions. If on the other hand the plant is a very compact one, where the main drive from the engine can be made by means of either rope or belt drive, with various line shafting on each floor, and not transmit it to a main jackshaft and thence from floor to floor, the belt or rope drive will show an economy in first cost, operation and maintenance over any other form of drive; but as soon as additional apparatus is put into the plant, requiring an extension, just so soon does the advantage of the belt or rope drive begin to diminish, and sooner or later the electric drive becomes advisable.

In a properly laid out electric drive, the shafting losses should be very slight, as the shafting is usually short and carries comparatively little load. The motor losses are as a rule rather small if the motors are suited to the work. The transmission losses between motors and generator can readily be made small and the efficiency of the generating unit is usually high. The efficiency of the motors, transmission and generator remains practically constant, whereas in the belt drive there is a continually increasing loss unless the belting and shafting are very carefully watched.

### KNOWLEDGE MEANS ECONOMY

It is quite true, and is to be regretted, that many plants have been given electrical equipment which show very poor results, and the operation of these plants has been taken as a criterion upon which to base the comparative merits of electric drive and belt drive. It would be much more logical to compare the poorest type of belt drive with the failures of the electric drive, than to compare the best of the belt drives with the poorest of the electric. Many installations have been made, particularly those using alternating current, where through lack of knowledge of the motors used, the results obtained have been exceedingly poor. The motors have been installed on the basis of direct current, without any attention being paid to the fact that there is in all alternating-current work a difference between the actual power used and the apparent power generated at the dynamo. It has frequently been found, owing to the lack of appreciation of the fact that there is a lagging current in alternating-current circuits, that the generating unit was overloaded long before the engine had come up to its capacity, and that two engines were necessary to operate the plant, where one should do it without difficulty. This is no fault of the electric drive, but is rather the fault of the man who installed the drive. It is foolish to say that such difficulties are inherent in the alternating-current plant. They are not. They can be and are avoided in well laid out plants.

In direct-current plants no such troubles exist, but it frequently happens that the wrong type of motors are installed and troubles are experienced on this account. The use of shunt-wound motors where compound-wound motors should be used, or *vice versa*, has caused trouble, but the most prominent difficulty of all has arisen from the advocates of the electric drive being so narrow-minded as to insist on the installation of the largest number of motors possible and the use of individual motors on all types of machine The result has been a tremendous in crease in the cost of installation, an in crease instead of a decrease in powe losses, and an operating expense as wel as maintenance expense far in excess o what it should be. This has occurred ver largely through the desire of the plan owners to have an uptodate plant, and th willingness of the salesman to sell every thing he can, regardless of whether or nc it is necessary. Of course, where a mi owner goes to the manufacturing compan and tells them he wants motors to driv certain machinery, the manufacturer ha little or no option as to what to sell, far as the number of motors is concerne but where the manufacturer is called to suggest what should be done, it n infrequently happens that his salesma anxious to make a good sale, suggests far greater number of motors than is ne essary, and sometimes of types of moto which are not suited to the purpose. Th is strongly to be deprecated, and can on be avoided by hiring a competent eng neer. The fact that such things are do is one of the reasons for the existen of consulting engineers.

### POINTS ON ROPE DRIVE

In comparing the rope drive and t belt drive, there is much to be said favor of both. For drives on very sh centers, for angle drives, for verti drives or drives on very long centers, rope is far superior to the belt, particula with the use of cotton rope and the sin loop or English system. The belt ma facturers claim that the rope drive not last as long as the belt drive, that it is expensive to install and erate. Experience abroad has been to contrary. Mr. Kenyon, in an article the *American Machinist* of July 8, gives some very interesting data on r drives under conditions in which belt dr would be impossible, and gives infor tion regarding the life, which leads to believe that the belt drive is superior to the rope drive when the dr are put in by those who know how.

The photograph on page 601 shov rope drive delivering approximately horsepower with thirty-six 1⅞-inch ton ropes. These are divided so that ropes run to each of four floors, thro a rope tower. In the photograph, no of the ropes were installed, as the p required at the time was considerably than that estimated for the final development. The speed of these ropes is approximately 6000 feet per minute, and the lywheel or driving wheel was slightly over 10 feet wide. Had belts been used for this transmission, it would have required a flywheel 30 feet wide. It is in- resting to note that the ropes do not al have the same tension, nor is this re- uired, it having been found that the ower automatically divides between the ropes, and that these ropes will carry ap- roximately the same power even al- ough the tension may be slightly differ- t. This type of drive has been and is rfectly satisfactory in a number of in- allations in this country, and in very ny installations abroad, showing a de- ed economy over the use of belts. ubtless in the installation shown in the ture, it was far superior to the electric rive

## Automatic Unloading Device for Belt- or Motor-driven Air Compressor

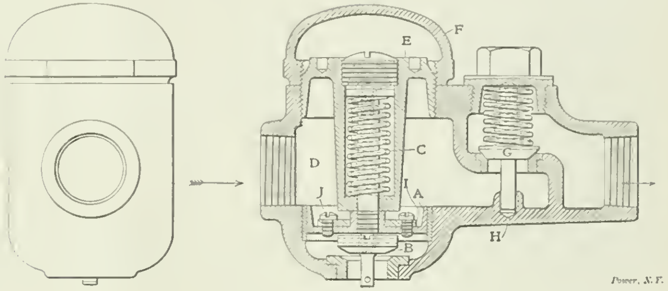
By S. Rice

In the accompanying sectional sketch s own an ingenious unloading device r motor-driven air compressors, which ice consists primarily of a piston hav- g a bypass, a valve which is closed the piston reaches its extreme mo- n against a spring, and a check valve. is placed in the discharge pipe between compressor and the reservoir and pro- s an opening from the discharge pipe he atmosphere until the motor reaches redetermined speed for which the de- is set.

When the driving power is first applied, pistons of the compressor will move wly and will gradually increase their ed as the motor revolutions increase, s raising the air output of the com- sor. The air first passes into the ber *D*, through the bypass in the pis- n *A* and to atmosphere through valve *B*, h is held open by a spring *C*. As the ne of air becomes greater, the bypass the piston can no longer take care of ncrease as the motor comes up to ewhere near full speed and the pres- rises in chamber *D*. When this pres- reaches a point sufficient to compress piston *A* and seat the valve, the check ve *G* immediately begins to work and leakage of air to the atmosphere is t off by the seating of valve *B*.

The device can be so adjusted that the ton will seat valve *B* when the motor s reached a limit of approximately three- rths full speed. When the motor is pped, the check valve *G* is seated and ssure in chamber *D* is gradually re- ced by the leakage of air to the atmosphere through the small opening *H*. When the pressure is slightly reduced in chamber *D*, the piston *A* and valve *B* are drawn in through the action of the spring *C*, thus unseating the valve *B*, and the motor is ready to start again.

The bypass consists of two good-sized holes drilled in the piston *A*, and two corresponding holes in the plate *I*, which may or may not match, according to the position of plate *I*, and which may be adjusted to give any size of opening desired by means of screws *J*. Further adjustment may also be made by removing the cap *F* and turning the nut *E* holding the spring and locating the inner position of the piston, thus increasing or diminishing the amount of travel that the piston has to make in order to seat the valve *B*.



UNLOADING DEVICE FOR AIR COMPRESSORS

## Air Receiver Practice

By Howard H. Bliss

While reading Frank Richards' article on "Air Receiver Practice," in a recent number, I became curious to know what proportion of the moisture contained in compressed air could be got rid of by the expedient of cooling the air thoroughly and allowing plenty of time for the mist to settle and be drained off. To investigate this I assumed the following problem:

Taking saturated air at 72 degrees Fahrenheit, compressing it to 150 pounds per square inch absolute, cooling it in an aftercooler to 72 degrees and allowing it to stand until no free moisture remains suspended, how much water is removed per pound of air? If the entire water content of the air were carried through the system and the air used in a drill taking 100 cubic feet of free air per minute, how much more water would be released to clog the exhaust than if the drill were run with air dried as in the first case?

According to Kent (page 484, edition of 1898), one pound of free saturated air contains 0.0168 pound of water at 72 degrees. When this pound of air is compressed to ten times the original pressure and the temperature is brought back to 72 degrees, the volume of the air, by Boyle's law, will be one-tenth of the original volume. The weight of water which can exist as vapor in one cubic foot of air is independent of the pressure of the air and depends only upon the temperature; therefore there can be now only one-tenth as much vapor in our pound of air as there was at first nine-tenths of the 0.0168 pound will have become mist. Hence, the answer to the first question is, nine-tenths of 0.0168 or 0.0151 pound. The water remaining as vapor is 0.0017 pound

To get an answer to the sécond question an assumption must be made as to the temperature of the exhaust. It may be taken at 0 degree Fahrenheit. Then, by Kent's table, the vapor in one pound of exhaust air amounts to 0.0009 pound. All the rest of the water present will be frozen as it passes out. So in the case where the compressed air is cooled and the water drained off the ice in the exhaust would weigh

$$0.0017 - 0.0009 = 0.0008$$

pound for each pound of air. When none of the moisture is removed from the compressed air the ice in the exhaust will weigh

$$0.0168 - 0.0009 = 0.0159$$

pound per pound of air.

Each cubic foot of free air at 72 degrees weighs 0.0747 pound, so that the drill using 100 cubic feet per minute takes

$$100 \times 0.0747 = 7.47$$

pounds per minute. The ice formed in the exhaust each minute would be

$$7.47 \times 0.0008 = 0.006$$

pound for the dried-out air, and

$$7.47 \times 0.0159 = 0.119$$

pound for the undried air. Hence, the process of aftercooling and allowing the water to settle out saves

$$0.119 - 0.006 = 0.113$$

pound of ice in the exhaust every minute. The proportion of ice in the two cases is 0.006 to 0.119 or 1 to 19.8.

# To Determine the Value of a Water Powe

## Simple Methods for Making an Estimate of the Available Power; the Two Essential Factors; Things Owner and User Should Know

### BY W. T. RYAN

Up to a few years ago water powers were usually bought for a "song," and water wheels were installed, as the business increased, without first ascertaining the actual horsepower of the stream. Now, however, the available power has increased in value to a point where both owners and users find it desirable to determine beforehand, as nearly as possible, how much power there is available.

It is the purpose of this article to point out the principal things the owner or purchaser should know, and to present simple methods for making an estimate of the available power.

The first thing to be done is to determine the specific conditions which nature has established, the principal items being average, maximum and minimum rainfall, drainage area, run-off, evaporation, absorption, available head, flood, and minimum discharge of the stream.

There are two factors which enter directly into the determination of a water power: the quantity of water flowing down a stream per unit of time, and the "fall" or "head" available. The fall or head should be determined by a competent surveyor. This head is usually limited by the cost of the overflowed lands. It is advisable to accompany the surveyor when he runs his levels, in order to see that no little drainage ditches or natural outlets are overlooked which might be draining many acres of valuable land and which would be rendered useless when the water is backed up by the dam. A county map is a great aid in getting the acreage of the submerged lands.

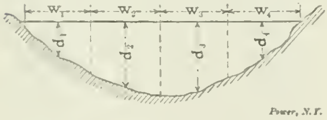


FIG. 1

The next quantity to be determined is the quantity of water flowing in the stream per unit of time. It is usual practice to get this in terms of pounds per minute. This determination is extremely important and to be accurate the measurements should extend over a period of several years. This usually being impossible, the best that can be done will be to take measurements at periods of low water. If the observer is a stranger in the community, good information as to these periods of low water may be obtained from some of the old fishermen or hunters. It is not advisable to depend on the merchants or bankers for this information. If the stream is large enough a Government report may be had by applying to the United States Geological Survey. These reports are very valuable in making an estimate of the annual power, but care should be taken in using the reports on maximum-flood flow, as in some instances they are unreliable.

The quantity of water flowing in a stream may be fairly well estimated as follows: The velocity of water is obtained by means of a float. In this method of measurement the velocity is obtained by observing the time it takes a light floating body, such as a ball or piece of wood, so colored and weighted as to be readily seen, to pass over a known distance. The surface velocity is then

$$v = l \div t,$$

where $l$ is the distance described between parallel transverse alinements whose distance apart is known, and $t$ = the time taken. The velocity is a maximum just below the surface and diminishes from that point, both toward the bottom and toward the surface. It is also a maximum near the middle of the stream, diminishing toward the banks. The mean velocity is about 83 per cent. of the maximum surface velocity when the air is still. Therefore:

$$Q = 0.83\ A\ v, \qquad (1)$$

where

$Q$ = Discharge in cubic feet per second,
$A$ = Area of a transverse section of the stream in square feet.
$v$ = Maximum surface velocity in feet per minute when the air is still.

Of eight experimenters cited by Professor Bowser, only one gives a value (= 0.62) differing more than 0.05 from 0.83, while others obtained the values 0.82, 0.78, 0.82, 0.86, 0.82 and 0.83.

The horsepower available is obtained from the formula

$$H.P. = \frac{(Q)\ (h)\ (62.5)}{33{,}000}, \qquad (2)$$

where $h$ = the fall or head, in feet.

An improvement over the foregoing is to divide the stream into a number of subdivisions (Fig. 1) of widths, $w_1$, $w_2$, $w_3$, etc., and mean depths of $d_1$, $d_2$, $d_3$, et and with respective maximum surf velocities of $v_1$, $v_2$, $v_3$, etc., which may determined either with a float or w current meters; whence we may write

$$Q = 0.83\ (w_1\ d_1\ v_1 + w_2\ d_2\ v_2 + w_3\ d_3\ v_3 +)$$

The use of double floats (Fig. 2) preferred by many engineers. Two b of the same bulk and condition of s face, one lighter, the other heavier t water, are united by a slender chain, t weights being so adjusted that the li ball without projecting above the s face buoys the other ball at some p determined depth. By placing sev double floats across a stream and not their velocity the average velocity be quite accurately determined.

If a very accurate determination of velocity is desired, a reliable current m should be employed. There are three g eral methods for getting the velocity a current meter: the single-point meth

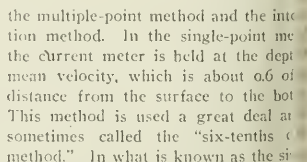


FIG. 2

the multiple-point method and the inte tion method. In the single-point me the current meter is held at the dept mean velocity, which is about 0.6 of distance from the surface to the bot This method is used a great deal a sometimes called the "six-tenths method." In what is known as the si point subsurface method the current r is held near the surface or just enough not to be affected by the This method is used when the meter not be submerged to 0.6 of the dept account of the swiftness of the stre

The multiple-point method may be b- divided into (1) the vertical-vel curve; (2) surface and bottom, and 3) surface, mid-depth and bottom. The r- tical-velocity curve method consists o ing velocities at several depths equ in- tervals apart and taking the mean ve ity of the stream as the average of values. The surface and bottom m

; sometimes used for shallow streams ·ith comparatively smooth beds. The rrent meter is held about six inches below the surface and about six inches above e bottom, and the mean of the two vecities is taken as the average velocity of e stream. In the top, mid-depth and tt m method the current meter is held x inches below the surface, at mid-pth and six inches above the bottom. he mean velocity is obtained by dividing ie sum of the top velocity, twice the d-depth velocity and the bottom venty by four. In the integration method e meter is lowered to the bottom at a w uniform speed, then back again to urface. The total number of revolus divided by the time gives the mean locity. It is well adapted for measures under ice and as a check on the t methods.

I small streams the quantity of water y be measured by means of a weir. m extensive experiments at Lowell, ss., with rectangular overfall weirs, B. Francis deduced the following for-

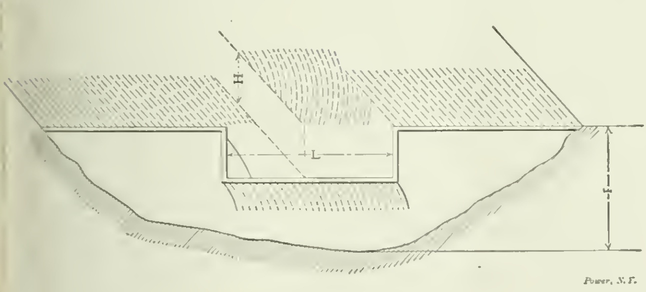


FIG. 3

$$Q = 3.33\,(L - 0.1\,n\,H)\,H$$

re

Discharge in cubic feet per second,
Length of weir in feet,
Distance in feet from sill of notch to level surface of water a few feet back,
= Number of contractions.

In neral:

= 2 when no edge is flush with the sides or bottom of a channel (Fig. 3),
= 1 when one end only is flush with the side of the channel
= 0 when both sides are flush with the sides of the channel.

he foregoing values of *n* apply only w the sectional area of stream is very la compared with the area (*L H*) of th weir. If *L* is greater than 10 *H* the eff of end contraction may be neglected wi t appreciably affecting the result; *L* ould be equal to or greater than three *H* nd *p* should be equal to or greater th two *H*

Ice formation has considerable effect on the flow of streams, hence due allowance must be made for it. It diminishes the cross-section of the stream and reduces the velocity of the water. Some of the rivers in the northern States have as low an efficiency as 50 per cent. in winter, due to ice formation. In very shallow, broad streams with rough bottoms the loss is very large. Due allowance must be made for both the decrease of the tranverse section of the stream and the reduction of the velocity of flow.

The question of a good reservoir is a very important one in determining the value of a water power. The use to which the power is to be or may be put should be known. The size of the reservoir depends very much on the value of the land and in cold climates due allowances must be made for ice. In climates where the ice freezes several feet thick, the depth of the reservoir would have to be increased considerably. The following example illustrates the importance of reservoirs:

A certain stream has an available head of 24 feet and a flow of 6000 cubic feet of water per minute, thus giving 272 available horsepower. A town on the river requires 500 horsepower for four hours a day for lighting purposes. The power is not sufficient. A reservoir might be put in to store water for the remaining twenty hours. The storage area would be

$$\frac{(6000)\ (20)\ (60)}{43,560} = 162$$

acres, if the reservoir is one foot deep. The total energy stored would be

$$\frac{(6000)\ (24)\ (20)\ (62.5)}{33,000} = 5500$$

horsepower-hours, giving

$$5500 \div 4 = 1375$$

horsepower for four hours, which is ample for the town. The energy required by the town at ten cents per kilowatt-hour is worth $54,000 a year. The total gross earnings is usually the principal factor which determines whether a reservoir may be used to advantage.

# What is $CO_2$?

By F. R. Low

Power has had a great deal to say lately about $CO_2$. What is $CO_2$ anyway, and how does it interest engineers?

$CO_2$ is the gas which is made when carbon is burned; and as wood and coal and oil and peat and all of our fuels are for the most part made up of carbon, the well informed engineer will naturally know considerable about this gas and its production.

Combustion is the falling together of atoms which have a natural attraction for each other, as have those of carbon and hydrogen for those of oxygen. Drawn together by this mutual attraction they acquire velocity and momentum as does a falling body being drawn in a similar way to the earth; and it is this momentum, this energy of motion which, when it is possessed by atoms, we recognize as heat.

An atom of oxygen comes within the influence of an atom of carbon and they rush together like two little planets. The probability that they will strike is very remote. They will rather form a couple and revolve about each other in elliptical or other orbits. Such a combination is a molecule and a gas composed of molecules made up of one atom each of carbon and oxygen is "carbonic oxide" or "carbon monoxide." "Mono" is a Greek prefix meaning one, as in monocle, monograph, monogram, monolith, monopoly, etc. The chemical symbol for this gas is CO, signifying that its molecule is made up of one atom of carbon (C) and one of oxygen (O). It is made in the gas producer by forcing air through a bed of incandescent carbon; not enough air completely to burn the carbon but enough to furnish one atom of oxygen for each atom of carbon given up by the coal.

But, one atom of oxygen does not satisfy the carbon, each atom of which is ready to combine with two atoms of oxygen, and if this affinity is satisfied a gas is produced each molecule of which is composed of one atom of carbon and two of oxygen, whose chemical symbol is thus $CO_2$, the little subscript 2 signifying that there are two atoms of oxygen, O, combined with a single atom of carbon, C, in the molecule. This gas is known as carbonic-acid gas, or carbon dioxide, "di" being a Greek prefix meaning two. When one man does all the talking it is a *monologue*, but if it is a talk between two persons it is a *dialogue*. It is the same gas that bubbles up in a glass of soda water or beer or champagne, clean and colorless, heavier than air, and of course incombustible, for it is the product of the union which is combustion.

When a weight has been raised above the earth, there exists in the earth and the weight, by reason of their mutual attraction by reason of their separation against that attraction and the possibility of their coming together under the influence of that attraction, the power of doing work. If the weight is allowed to fall freely the energy developed takes the form of kinetic energy, or energy of motion, in the mass and velocity of the body and the earth rushing toward each other.

After they have come together they have no more value for producing energy. A clock weight run down, water at the sea level, a rock lying upon the ground at the lowest available level, have no potency for the production of energy. It takes just as much energy to raise the weight, to separate the centers of attraction of the earth and the body which is to fall as it will generate in falling.

In this carbonic-acid gas, this $CO_2$, we have the run-down clock, the fallen weight. The great momentum (temperature) attained by the atoms in their rush together has been communicated to surrounding bodies by radiation and connection, perhaps communicated to the molecules of water whirling them apart into steam. Its own atoms are now whirling about each other at a diminished velocity, but so strongly within the sphere of each other's attraction that to pull that one pound of carbon atoms away from the oxygen atoms with which they are united would require as much energy as it would take to pull apart a rod of steel 20 inches in diameter.

How, then, is the clock wound up?

How are these atoms lifted apart that by falling together again they may develop more energy?

How are the tons and tons of carbon which are daily burned and sent out into the atmosphere not only from our house and factory chimneys, but in the breath of every living animal (for it is the product also of the combustion going on within us), how are these tons and tons of carbon to be separated from the oxygen with which it is combined?

Here comes in one of the most wonderful, beautiful, and mysterious of nature's processes. It is a peculiar property of vegetation that under the influence of sunlight it can overcome the attraction which exists between the atoms of carbon and oxygen, appropriating the carbon to its own use, building it into its structure, and letting the oxygen go free into the atmosphere. To separate these elements in our laboratories we are obliged to resort to the most powerful chemical agents and to conduct the process in vessels composed of the most refractory materials under all the violent manifestations of light and heat; and we then succeed in liberating the carbon only by shutting up the oxygen in a still stronger prison, but under the quiet influence of the sunbeam in that most delicate of all structures, a vegetable cell, the chains which unite together the two elements fall off, and while the solid carbon is retained to build up the organic structure, the oxygen is allowed to return to its home in the atmosphere. To separate a pound of carbon from the oxygen with which it unites in burning would require the expenditure of an amount of energy which would raise the weight of a ton to a hight of over a mile, and yet in the economy of nature this process is constantly going on, not with the noisy demonstration of prodigious effort, but quietly in the delicate structure of a green leaf waving in the sunshine.

When a pound of carbon is burned to carbon monoxide, CO, 4450 heat units are generated; when it is burned to carbonic-acid gas, carbon dioxide or $CO_2$, 14,500 heat units are generated—more than three times as many.

Is it not interesting to know how much CO and how much $CO_2$ there is in the gas which is going up the chimney?

When a pound of carbon is supplied with exactly enough oxygen chemically to combine with it, and that oxygen is furnished mixed with nitrogen in the form of air, the resulting gas will be a mixture of $CO_2$ and nitrogen and the $CO_2$ will be a definite proportion of the mixture.

In practice it is necessary to furnish more than the theoretical amount of air, because of the impossibility of bringing each atom of oxygen into contact with its respective atom of carbon in the brief time allowed in the furnace.

If not enough air is admitted or if it is not so handled as to come in contact with the carbon while at a temperature above that of ignition, there will be CO in the flue gas. If more than the theoretical quantity of air is admitted there will be free oxygen in the gas. There may be both free oxygen and CO if the oxygen were admitted and the conditions necessary for combustion not brought about. All the air admitted has to be heated to the uptake temperature and carries away heat. Therefore too much of it is bad. The more air admitted the less the percentage of $CO_2$, so that it is plain that the percentage of $CO_2$ in the flue gas is an important and interesting thing to know.

The articles in POWER have told how it could be found out, what the percentage ought to be for given conditions, what the significance of lower or higher percentages and of the presence of other gases is. It has been found that high percentages of $CO_2$ did not always mean the best efficiency, and there is a discussion on at present as to why this is so. No special training, nor high degree of education is necessary to understand the discussion, even if one does not go into analyzing gas on his own account. If after one gets interested in the subject he wants to make some gas analyses he will find that he can get up an apparatus himself, which will serve the purpose fairly well for a few dollars, and can learn to use it and interpret its indicatio with less effort and in less time than took him to learn to indicate his engi and read the diagram.

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## Solid versus Double Disk Wed

By C. R. Yerrick

The solid wedge is simplicity itself compared with the double disk, which made up of a multiplicity of parts wh are continually getting out of order. T information has been given me by en neers and inspectors who have had exp ence with both kinds. A chief inspec of one of our large cities is unaltera opposed to anything but the solid-we valve.

The split-wedge manufacturers cl that the solid wedge valve drags on seats. This is an impossibility, due to nicely fitted guides and tapered se Naturally, when opening, the gate ris in a vertical plane pulls away from seats. Of all the double-disk types valve made, I have yet to learn of in which the disk does not rub on seat. The method of constructing guides for the disks in these valves cludes the possibility of keeping the from the seat.

The wedge of a solid-wedge valv so constructed that it is perfectly r and solid and has not the tendency t ruptured that the double disk has. latter not only carries the pressure of steam or water, or whatever agen being carried, but is subjected to the ditional central (concentrated) load the wedging mechanism. I have disks of the double-gate type with center pushed out, due to this cause

It is impossible to replace a spi of a double-gate valve without shut off valves on either side, pumping water from the main and taking the from the valve body. With the wedge we have a condition in which wedge remains tight, the spindle ca removed and a new one inserted out the bother of closing the valve either side, probably half a mile a and pumping the main dry.

Cases are known in which bronze w ing pieces in double-gate valves crushed and fallen to the bottom o body, in which case, if the valve opened it was impossible to close gate because these pieces did not p the gate to reach a position low enough to shut off the full waterway.

These are some of the reasons wa design embracing such a multiplicit of parts is not desirable, and naturally s ws that one constructed as simply as possible is the one to be desired. Su is the solid-wedge type.

# Some Useful Lessons of Limewater

## A Simple Method of Analyzing Hard Boiler Scale and Proving That It Is Composed Mainly of Calcium and Sulphuric Sulphur

### BY CHARLES S. PALMER

You remember that it was said in the last lesson that an important part of analysis consists in knowing how to get things into solution, and not merely in precipitating them after somebody else has got them into solution for you. You will find that only experience will teach you how much this means; and often you will find that the tricks of insolubility, and the almost freakish obstinacy that many substances show when one tries to get them into solution, will prove just as valuable in identifying substances as the sharp and clean methods of precipitating them after they have been got in solution.

### A Good General Rule

This one general rule will solve almost all of your problems: acids, alkalies; water, fire, oxidation, reduction. That is, the methods and tricks suggested by these six words will guide you through almost all your difficulties. Of course, one most always naturally thinks first of using acids but one is liable to forget that if acids will not work on everything, alkalies may. Then again one is liable to start out with water and the reagents soluble in water but one is apt to forget that dry heat may effect marvelous changes. And then oxidation or reduction can change almost any obstinate insoluble substance so that the resulting compound will yield to some acid or alkali; that is where the oxidation tables come in handy to help you trace, as on a map, the chemical changes that your substances take, back and forth, with more or less of oxidation or reduction. There is one other word that should be added to the general rule as given above, and that is time. Very frequently ten or twenty minutes will do where ten or twenty seconds will not do; and an hour or two, and perhaps twenty-four hours standing, will show solutions and precipitations that one would never suppose could be got.

I know of a case recently where a chemist was called upon to find some cheap method to break up a rust joint which otherwise would have to be chiseled out at the expense of much time and effort. The chemist hastily saturated a piece of the rust-joint iron with crude muriatic (hydrochloric) acid, and, noting no result, laid it aside in a saucer to take the problem up again next day. That was Saturday. When he came back Monday morning, he was surprised to find that the tough rust-joint iron mass had itself fallen apart to a loose brown powder which could be brushed away. Just how this particular remedy will be used in any of your special cases remains for you to find out; but it is a good thing to remember that if you can afford to wait a day or two, it will save you lots of strength and annoyance.

But to come back to our hard scale or calcium sulphate. This preamble has been given to show how one would naturally turn to an attack by fire in analyzing the scale. Take a piece the size of a marble and pulverize it and mix it with some powdered charcoal. Put this mixture in a little cavity on a good clean block of charcoal and then throw the reducing flame—the very tip of it—directly into the mixture of powdered scale and charcoal. Now you want to give this ten or fifteen minutes of good heating. Then take out the black half-fused mass on the point of your knife, and lay it on a clean silver coin, either a silver quarter or a dime. Moisten this with a drop or two of water, enough so that a little flows down onto the coin, and let it stand for half an hour. When you take it off you will see on the coin more or less of a black stain of silver sulphide. This silver sulphide evidently has come, in part, so far as the sulphur is concerned, from the calcium sulphate which was heated on the charcoal.

Now the sulphides may be considered as salts of hydrogen sulphide; and the silver sulphide got its sulphur from some calcium or lime sulphide which was formed by the blowpipe on the charcoal from the calcium sulphate. Calcium sulphate is a salt of sulphuric acid; and calcium sulphide, being a salt of hydrogen sulphide, evidently so far as sulphur is concerned, it has been reduced from the sulphuric-acid end (which is at the oxidized extreme of the table of sulphur compounds) to hydrogen sulphide (which is at the reduced extreme). You will see this at a glance if you turn back to the oxidation table of the sulphur compounds.

All metal sulphates when heated, even on charcoal, are not reduced to their sulphides. Some of them are very sensitive when heated at all and lose sulphur trioxide, leaving behind the oxide of the metal in question: copper sulphate and iron sulphate act in this way. But the sulphates of the alkali metals (sodium and potassium), and the sulphates of the "alkaline-earth metals" (calcium, strontium and barium), and one or two others, are so strongly basic that when heated on charcoal they give up their oxygen to the hot and burning carbon monoxide (which really does the reduction) and cling to the sulphur, as your calcium sulphate has just been changed to calcium sulphide.

It may seem a foolish thing to do but it will be well for you to put a piece of the moistened calcium sulphate or hard boiler scale on a wet silver coin and let it stand for half an hour. In this case you will get no black stain of silver sulphide, because although a little silver sulphate might be formed, yet there is no reduced "sulphide sulphur" to stain the silver black. Also, if you want to be very exact, you should put a little of the powdered charcoal by itself on another silver coin, wet it, and let that stand for half an hour to show that there is no "sulphide sulphur" nor free sulphur in the charcoal. When you come to think over these last two tests, you will see that you have proved indirectly that while the calcium sulphate contains sulphur, yet it is certainly not in the reduced form; and hence, by inference, it must be in the oxidized form.

### Two Forms of Oxidized Sulphur

There are only two forms of oxidized sulphur: one of these in this case would be calcium sulphite (a salt of sulphurous acid) and the other would be calcium sulphate (a salt of sulphuric acid). Calcium sulphite is not very insoluble in water and is readily soluble in hydrochloric acid with effervescence of sulphur dioxide; and this does not meet the case in hand, for your calcium sulphate or hard scale is quite insoluble in small quantities of water and only slightly soluble in dilute hydrochloric acid. Hence in a negative way you have proved that so far as the sulphur in the hard scale is concerned, it must be in the form of "sulphate sulphur;" and here that means calcium sulphate.

But let us attack this same question a little further. Pulverize some more of the hard scale or calcium sulphate, mix it well with some powdered charcoal and, as before, give it a good heating for five or ten minutes, with the tip of the reducing flame about a quarter of an inch in front of the mixture on the charcoal so as to get the reducing effect of all the hot carbon monoxide possible. Of course you remember that when charcoal is heated, the carbon, of which it is mostly composed, can burn in two stages, carbon monoxide and carbon dioxide; and of course the limited supply of oxygen in and around the hot charcoal will prevent most of the carbon from burning, at first, to anything more than carbon monoxide. And you also remember that the burning of this carbon monoxide and carbon dioxide releases about 70 per cent. of the possible heat obtained from the burning of carbon. Hence it is well to use the hot charcoal to help in reducing your mixture. When you have given the mixture a good reducing heat for some minutes, remove the half-fused mass with the point of a knife to a clean test tube, and pour over it an inch or so of dilute hydrochloric acid. The acid will react on the calcium sulphide which has been reduced from the calcium sulphate according to the following reaction:

| $CaSO_4$ | + | $4CO$ | = | $4CO_2$ | + | $CaS$ |
|---|---|---|---|---|---|---|
| Calcium Sulphate Solid. | | Carbon Monoxide Gas. | | Carbon Dioxide Gas. | | Calcium Sulphide Solid. |

The principal point of this reaction you want to notice is that you get an effervescence of hydrogen sulphide in the test tube, the bad-smelling gas (of course the powdered charcoal muddies the liquid but you needn't mind that, for hydrochloric acid has little action on powdered carbon). This hydrogen sulphide you will easily detect by your nose, even if the smell is mixed with some of the pungent fumes of the hydrochloric or muriatic acid. But you want some other test beside that of the nose, good as it may be; so you will moisten a narrow strip of common white paper with any soluble lead salt, such as sugar of lead (lead acetate) or lead nitrate. This lead nitrate you can easily make for yourself by dissolving a bit of any old lead pipe in nitric acid, diluting and filtering, and then putting it in a clean bottle and labeling it: "Lead Nitrate." You will see the strip of paper moistened with the lead salt instantly turned to a stove-polish black, which is of course lead sulphide, and is formed according to the following equation:

| $Pb(NO_3)_2$ | + | $H_2S$ | = | $PbS$ | + | $2HNO_3$ |
|---|---|---|---|---|---|---|
| Lead Nitrate, White or in Colorless Solution. | | Hydrogen Sulphide Gas. | | Black Solid. | | Nitric Acid. |

Now to go back to the boiler scale again: Pulverize another bit of this hard scale or calcium sulphate and mix it with some dry powdered sodium carbonate. Put this in a little cavity on the charcoal and expose it for some time to the tip of the reducing flame of the blowpipe. After giving it a good heat, remove the fused mixture, putting some of it as before on the wet silver coin and some of it in a test tube, which you will treat with hydrochloric acid as before. In the one case you will get the same stain of black silver sulphide on the coin; and in the other case you will get the effervescence of hydrogen sulphide, which you will test both for the odor, and also by the black stain on a paper moistened with lead nitrate. In this case you will of course get a double effervescence when you treat the fused mass with hydrochloric acid in a test tube; for some of the bubbles of gas which come off are hydrogen sulphide, and some are carbon dioxide from the sodium carbonate mixed with the calcium sulphate and still undecomposed. There is a peculiar double reaction here between the calcium sulphate and the sodium carbonate which is as follows.

| $CaSO_4$ | + | $Na_2CO_3$ | = | $CaCO_3$ | + | $Na_2SO_4$ |
|---|---|---|---|---|---|---|
| Calcium Sulphate Solid. | | Sodium Carbonate Fusible Solid. | | Calcium Carbonate Solid. | | Sodium Sulphate Fusible Solid. |

(This sodium sulphate can also be reduced to sodium sulphide.)

The result of this reaction is that the strongly acid sulphion, $SO_4$, of the calcium sulphate leaves the metal calcium and goes to the metal sodium which is more strongly basic than calcium. This illustrates a general principle of the use of sodium carbonate in blowpipe analysis, which is that the sodium carbonate catches any strongly acid radical in any salt and lets go of the carbonic acid. Thus, if you fuse a sulphate with sodium carbonate you get some sodium sulphate; if you fuse a sulphide you get some sodium sulphide; if you fuse a phosphate you get some sodium phosphate, and if you fuse a chloride you get some sodium chloride, and so on. In this case, also, there is another reaction possible between the sodium carbonate, and some calcium sulphide which may be produced, as shown in the following:

| $CaS$ | + | $Na_2CO_3$ | = | $Na_2S$ | + | $CaCO_3$ |
|---|---|---|---|---|---|---|
| Calcium Sulphide Solid. | | Sodium Carbonate Fusible Solid. | | Sodium Sulphide Solid Brown. | | Calcium Carbonate. |

Also, in this case the calcium carbonate which would be formed at first according to a previous reaction loses its carbon dioxide on heating according to the following equation:

| $CaCO_3$ | = | $CaO$ | + | $CO_2$ |
|---|---|---|---|---|
| Calcium Carbonate. | | Lime. | | Carbon Dioxide Gas. |

This means that the resulting fusion before the blowpipe should contain some lime, but you cannot test for this directly and easily because, when you wet it, the sodium carbonate present would precipitate the soluble calcium hydroxide as calcium carbonate, although even this might be tested for by the skilful use of the indicators phenolphthalein and methyl orange which can be used instead of litmus to test different kinds of alkalinity. We will examine this more carefully in a later lesson.

Now let us turn back to the solutions of calcium chloride that you obtained by treating the reduced fusion of calcium sulphate and charcoal and of calcium sulphate and sodium carbonate with hydrochloric acid. In neither case will all of the lime compound be soluble in the hydrochloric acid, for some of it will remain as calcium sulphate, and some of it will be reprecipitated as calcium sulphate the sodium sulphate which is formed the reaction on the charcoal; but, if y filter these solutions you will get enou calcium in solution to test for it, bc by the ammonium carbonate test, and the solution of this in acetic acid wh you will follow with oxalic acid or a monium oxalate.

In looking back at the last lesson y will note that we succeeded in gett the calcium into solution by boiling calcium sulphate with sodium carbon which changed the insoluble calcium s phate into calcium carbonate, insoluble water but soluble in hydrochloric ac and so we succeeded in getting the c cium into solution. Also you tested the sulphion in the sodium carbonate so tion, after boiling the hard scale, barium nitrate. And in this lesson have followed the sulphur of the calc sulphate on the charcoal from "sulpl sulphur" to "sulphide sulphur;" and have also succeeded in getting the calc into solution; and so by acids and alka by water and by fire, by oxidation and duction, and by time, we have been to prove that the hard scale is ma composed of calcium and "sulphuric phur."

Also, you will note the necessity doing careful working and careful th ing as you go along; for there is no reagent nor any one rule of thumb w can do your thinking for you in anal however simple the problem may appe

# Bituminous Coals and Low-G Fuels

By J. V. Hunter

I have just read with some int the communication on page 401 o September 7 number, by C. M. Riple "Characteristics of Bituminous Coal Low-Grade Fuels." I think that h put the limits of the efficiency o bituminous fuel rather below what c obtained in practice. In fact, I have it possible to obtain such efficienci bituminous fuel as he gives for anth Of course this requires care and vision in firing and attention to such details as production of high $CO_2$ an of the boiler settings, etc.

What I wish to call attention his statement in regard to the nev which he is advocating for judgir efficiency of a power plant, namely many pounds of water are evaporat $1? This is merely another way o ing the proposition, which is a ve unit with which he should have familiar from his Kent's handbook. I refer to is to be found in the tal entitled, "Data and Results of Evap tive Tests for Boilers," arranged in ord ance with the short form advised the boiler-test committee of the Americ Soety of Mechanical Engineers, code of 99. Item No. 33 of this table is "Cost Coal Required for Evaporating 1000 unds of Water from and at 212 Degrees hrenheit." To anyone who is familiar h this subject, this would seem a much re logical way of stating this proposi- n than to state it as Mr. Ripley has ne

Such a way of testing coal is certainly value when many different varieties d prices of coal are under considera- . We have found that it is practical s to test coals from five different s: West Virginia, Ohio, Indiana, Ken- ky and Illinois, and as all these fuels y in price it always resolves itself into t uestion of which one will afford the heat under the boilers for the least y. This is the only way of looking e matter, unless the question of the ke-making qualities of the different ls must also be considered. Such a stion is very apt to bring to the fore t latile contents of the different coals, t with low-volatile matter naturally nting less smoke nuisance and, there- f , in some cases, due to city ordinances ke restrictions, the desire for a light ke-producing coal will outweigh the a ntages derived from low fuel cost vaporation.

boiler capacity and stack draft also c r this consideration, it being im- p le with some of the low-grade w fuels to obtain sufficient capacity fr the furnaces which may already be r the boilers, and in such cases it b es necessary to use a fuel of high value in order that the furnace ca- p y f such a boiler setting will not be cked with the enormous amount of coal w h would be necessary to derive er gh heat from some of the low-grade cc

may also call attention to the value of Ringlemann smoke charts and with th se to the value of the record which be kept of the smoke-producing qual- i the different coals tested. Only y ping some sort of record is it pos- t know what a coal has done in th vay of smoke when months may have between tests of different coals. In aking a record from these charts, r rd should be continued for a ugh time, say for half or three- qua rs of an hour, so that a good firing per l may have elapsed. It is also fair t k into consideration and keep on the rd that load which may have been n plant at the time of taking the test, a hvy load naturally occasioning more c nt firing and therefore the produc- ti f a much greater quantity of smoke.

I s certainly advisable for most power pla to call upon the service of reputable con lting engineers when they are con- sideng a change of fuel, as only a spec list in this line will have a correct w ng knowledge of the great variety of els from different localities which are now on the market I think it would be safe to say that in the average steam plant, outside of central stations, too much attention is given by the purchasing agent toward obtaining a cheap coal about which the engineer will not complain of too much ash, rather than to obtain, as he should, the most heat for the least money.

# Water Columns and Methods of Connection

By W. H. Wakeman

Fig. 1 illustrates a method of connecting water columns to steam boilers which the writer has favored for a long time, especially where the water used contains much sediment. Judicious use of the valves shown will keep this column clean, and a true water level will always be shown by the trycocks and gage. In a certain place these valves did not prove satisfactory, owing to the following conditions: When the plant is shut down at night the columns are shut off, as no night fireman is employed. As the valves are located where they become comparatively cool the disks in each one contracts and allows water to escape. This heats the disk again, but it soon cools, consequently the valve seat is cut, causing a leak which cannot be stopped until there is a chance to let all steam escape from the boiler, allow the water to run out, remove the bonnet from the valve, use a valve file on the seat, put in a new disk and replace the bonnet.

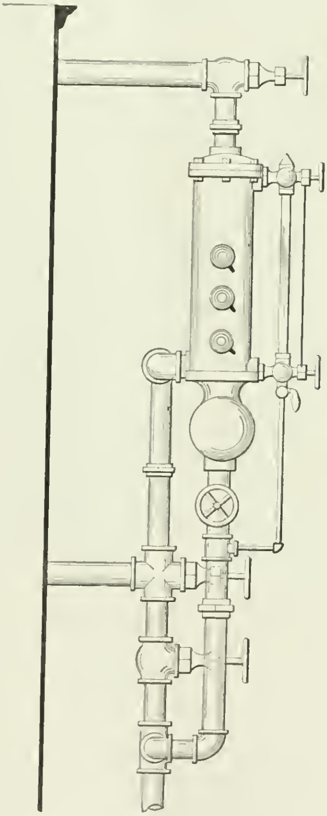
Power, N.Y.

FIG. 1. GOOD METHOD OF CONNECTING WATER COLUMN

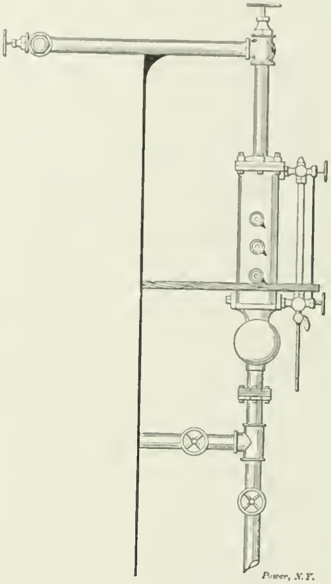
Power, N.Y.

FIG. 2. A MODIFICATION OF FIG. 1

To overcome this objection the method of connection shown in Fig. 2 was substituted. The angle valve in the top connection was changed, thus bringing the stem into a vertical position. The cross valve in the lower connection was taken out, a globe valve put next to the boiler, followed by a nipple and a tee as shown. This globe valve is connected so that pressure comes on top of the disk when closed, instead of under it, according to common and approved practice, except in special cases. Pressure acts in the same way on the angle valve. Under these conditions the valves are tight through all changes of temperature, as there is no chance for contraction.

A brass tee was used in the lower connection, as it is much safer than cast iron. The first one received for this purpose was rejected because it was too light for such service, although it was warranted to stand 125 pounds pressure. This tee weighed just one pound, but the accepted kind weighed 2¼ pounds. Both were rough, without finished surfaces of any kind. In Fig. 1 there is a union in both top and bottom connections in order to disconnect them easily when the high- and low-water alarms need repairs. In Fig. 2 there is no union in the top connection, because the top of the water column is bolted on, hence it can be used as a flange union. By substituting longer bolts than were used originally, and using a piece of pipe on each as a washer, the nut is raised until it can be turned conveniently with a wrench. In the bottom connection a flange union is substituted for the screwed union that was formerly used. The advantages of flange unions in this case are as follows: It is not necessary to get a big monkey wrench, or a solid wrench that will fit, and shake the whole system of piping in an effort to loosen a screwed union that has not been disturbed for some time, or to run the risk of starting some of the joints when the union must be tightened after repairs are completed.

Formerly it was necessary to reset the column whenever it had been disturbed, as it would turn on the unions, thus bringing the water gage out of its proper place, which is square to the front. After bringing it back to this place it was necessary for one man to hold it while another tightened the unions. It was always a disagreeable job, especially on the lower connection. With the flange unions shown in Fig. 2 it is necessary to loosen eight small nuts and remove the bolts, thus disconnecting the column without shaking the pipes or straining the joints. When returning the column to its place no time is lost in bringing the water gage to its place and holding the column from turning, as the bolts go into the holes easily, and there can be no doubt about the water gage and trycocks being in their proper places. The faces of these flanges are turned true but have circles formed on them in order to hold the packing securely.

One disadvantage of the method illustrated in Fig. 2 is that more joints are required in the main pipe which forms the lower connection, but this is offset by the absence of a large drip pipe containing a globe valve and several joints. Another point against the arrangement is that pressure is always on the stuffing boxes, making it impossible to repack them without removing pressure from the boiler. This objection applies to valves which were not designed for this service, but the manufacturer of these valves claims that when one of them is wide open the steam forms a tight joint with the bonnet which prevents steam or water from coming out of the stuffing box. If this theory works well in practice, the valve stems can be repacked at any time. Packing these stems once a year ought to be sufficient for good service and, by attending to it when the boilers are cooled off for cleaning, they will not make trouble until there is another good chance to renew the packing. A good packing for these stems is asbestos wicking coated with a mixture of cylinder oil and graphite. The top connection of Fig. 2 is fitted with an emergency valve near the boiler, which enables the engineer to shut pressure off from the angle valve if necessary. If one side of

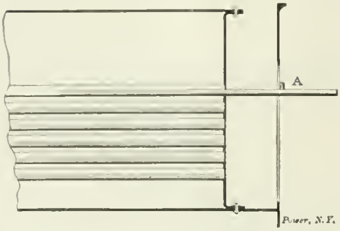

FIG. 3. INDICATING WATER LEVEL ABOVE TUBES AND BELOW GAGE

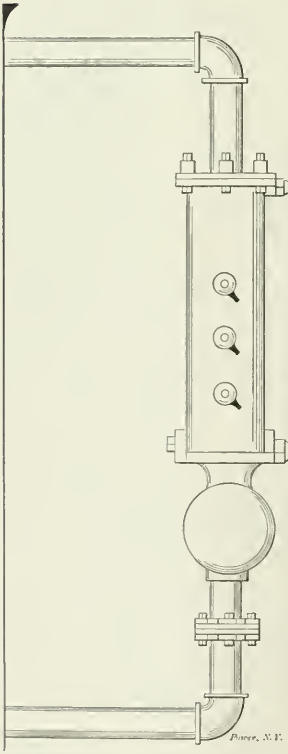

FIG. 4. NO VALVES FOR WATER-COLUMN CONNECTIONS

the gaskets used to pack these flang
unions is coated with the above men
tioned mixture, it will allow the joint
to be broken easily, and no time wi
be wasted in cutting out new gaskets.

In Fig. 2 there is a spirit level on th
lower nut which holds the gage glas
in place. This was used for the pu
pose of locating a line on one of th
boiler fronts that would be exactly lev
with the water when it first appears i
the gage glass. This line was drawn ju
underneath the level. A straight pie
of 1¼-inch pipe was inserted in one
the upper tubes, as shown in Fig. 3, a
allowed to project out of the doorw
in the front. The level was again a
plied and the end of it appears at *A*.
line was drawn on the boiler front on t
of the level, as that corresponded to t
highest part of the tubes. The first li
mentioned was 3¼ inches above t
latter, hence this represents the depth
water over the tubes when it is ba
ly visible in the gage glass. As t
low-water alarm whistle blows wh
the water shows one gage of solid wat
there is little danger of low water ca
ing trouble unless all warnings are u
heeded.

This is an important point which sho
receive due attention, especially when
water column is refitted, as otherwise
may be set too high or too low for go
results. Some time ago I saw a wa
column which was set so high that w
water showed in the glass there
danger of wrecking the engine by exc
sive priming. Consequently that boi
was run for a greater portion of the ti
with no water in sight, and nobody kn
exactly how far out of sight it w
There was no low-water alarm on
column.

Fig. 4 is presented for the benefit
those engineers who object to valves
water-column connections, and there
none here. It will be noted that they
absent from the water gage also, so
if the flange union needs repacking
gage cock is out of order, or a g
breaks, it becomes necessary to cool
the boiler, empty it of water and m
repairs, then fill it and get up steam ag
I suppose that readers will say that t
should be valves in the water gage, t
enabling the engineer to shut off st
and water in case a glass breaks, bu
it is dangerous to put them in the
nections because they may be closed
some malicious person or forgotten
the fireman, it is also dangerous to
them in the water gage for the same
son, hence a logical combination has
presented in this respect, as it is hi
inconsistent to put them in one place
omit them from the other. If valves
not to be used in both places, the w
would choose to have them omitted
the water gage, for here they are not
used, while valves in the connections
operated every day.

# Mechanical Refrigeration in Air Compression

## The Time Has Come for Utilization of the Ammonia Absorption System in Compressing Air for the Transmission and Storage of Energy

BY JOSEPH H. HART

Air compression as a mechanical process is today probably one of the most inefficient known, or at least in universal use. Developments of equal efficiency in other branches of engineering would not be tolerated at all, and this factor of low efficiency is the chief limitation in the wide application of compressed air for power purposes and for the storage and transmission of energy. Its convenience is unsurpassed, with the obtainment of the raw material from a practically universal reservoir and its transmission with a loss in efficiency comparable to that of electrical transmission. Its range of applicability in this form is fully as great, and the possibilities of development in this field are limited only by the process of production and the efficiency of the device.

Compression in an ordinary reciprocating air compressor, even if the latter is of standard type, is a remarkably inefficient process. The author has in mind one installation, a three-stage compressor, capable of compressing to 3000 pounds, with inter- and aftercoolers, which requires 10 horsepower to operate with [illegible] open and only 17 horsepower when loaded. This may undoubtedly be considered an abnormal condition, but unquestionably many plants in commercial developments occupy an analogous position in this regard, and the fact remains that [illegible] the reciprocating-air compressor is the only available type of universal application. The Taylor hydraulic air compression system, in which a stream of water falling entangles minute bubbles of air which are freed at the bottom and held under this pressure, possesses in a number of its installations an efficiency of [illegible] 70 per cent., but this type is limited by the great cost of installation and the necessity of a water supply or [illegible] available under special conditions. The latter limits its use as a universal type and renders it practically unavailable except in a comparatively few special installations. The development of the Rateau air compressor utilizing a steam turbine operated in reverse direction is progressing slowly today, but possesses an efficiency at the present time only comparable to the reciprocating type. Under the circumstances a consideration of the limitations upon efficiency in the production of compressed air are not only a matter of interest in their effect on the present existing types, but present possibilities of elimination not fully considered before, and their thorough consideration shows opportunities more or less present as a result of some modern developments in engineering in other fields.

### Intrinsic Energy of Compressed Air

Air compression in its process is practically a transformation of energy into its potential form and involves the transformation rather than the storage of energy. Air compressed in the cylinder of an air compressor has all the work done on it transformed into heat. Thus heat is almost immediately radiated out into the atmosphere, so that to all intents and purposes the energy is lost. The compressed air, however, is an energy transformer rather than an energy reservoir and occupies a position somewhat analogous to the average battery. The fact that compressed air does not possess intrinsic energy to any great extent can be readily shown by allowing it to expand under conditions such that heat cannot enter it from surrounding bodies. The expansion is then adiabatic and the gas cools off rapidly with a corresponding rapid decrease in pressure on this account. Hence, the energy available from compressed air due to the intrinsic energy in it is a comparatively small fraction of the whole supply obtainable. Compressed air in reality expands or cools off, is then heated up from the surrounding atmosphere and then expands again. Of course, the process is not intermittent but a large fraction of the work obtainable from compressed air comes from the energy stored in the outside atmosphere and in surrounding bodies and available through this means of transformation.

### Natural and Mechanical Limitations to Efficiency

In efficiency, the limitations are precisely analogous to the limitations in power production, only more pronounced on account of special conditions. Thus, in the modern gas engine, the fuel expands and exhausts at a low pressure, but this pressure is from 30 to 40 pounds and the work obtainable on account of the difference between this and the atmospheric pressure is unavailable. A gas or steam engine increases in efficiency in direct proportion to the initial high pressure and operates at the low pressure near the exhaust with minimum efficiency. Adiabatic expansion is most efficient in power production for high temperatures, but is most inefficient for compression purposes, since the mean effective pressure increases rapidly with rise in temperature, and an isothermal compression is the theoretical condition desired in the air-compression plant. The chief limitations on efficiency in air compression can be summed up briefly into two classes: natural ones and mechanical ones.

The natural limitations have to do primarily with the low-initial pressure obtainable from the ordinary atmosphere and the corresponding low efficiency of the first part of the stroke; secondly, the necessity of isothermal compression for best efficiency and the opposition of this factor to high speed and other mechanical developments. This feature can be summed up briefly in the statement that high temperatures are especially inimical to efficient air compression and are related almost inversely to this development, and in the further statement that by ordinary mechanical processes high temperatures are unavoidable and the mechanical efficiency factors are such that high temperatures necessarily result.

The mechanical features which limit efficiency are primarily packing and large friction factors. Air is a much more volatile substance than steam, and the packing must be tighter and more complete to prevent loss. This factor as a limitation on efficiency is of much greater significance in air compression than in steam utilization. Again, high speed is recognized as a prime condition of high efficiency in the mechanical field, since the capacity of a given size machine is in direct proportion to speed, and a given capacity machine can be of much smaller dimensions, if operated at high speed. A high-speed air compressor results in high temperatures in the cylinder, and the reheating effect on successive cylinder charges is cumulative and results in diminished capacity at lower density, with increase in mean effective pressure in the operation of the machine. Thus, the problem in air compression can be readily seen in its development in this type. The various factors for and against efficiency are in direct opposition and so connected and interrelated that they are absolutely inseparable.

### A Comparison of Compressional Types

A study of these special difficulties can be more fully shown by a consideration of compressional types for other purposes. Ammonia compression in refrigerating plants is in many respects equivalent to air compression, but is modified by the important condition that the critical temperature of the material is much higher than in the case of air. Under normal conditions ammonia gas behaves exactly as air and becomes superheated on compression. Cylinder reheating effects have been so pronounced, however, that the wet compression system is almost universal as the more efficient refrigerating type. In this the ammonia gas is compressed as a saturated vapor and is kept in this condition by contact with its own liquid, a small amount of which is injected at each stroke. This condition with its resulting increase in efficiency is absolutely impossible in air compression, and even if possible would be a further limitation on the efficiency of utilization. Water jackets are used in ammonia compressors as well as in air compressors and serve the same purpose. However, in the wet-compression type the compression is often completed with the cylinder covered with frost, and in this condition the jacket can be considered as using mechanical refrigeration with a fair degree of efficiency. The condition of high temperatures resulting from rapid compression has been eliminated slightly in air-compression design by what are known as the two- and three-stage air compressors, with forecoolers, intercoolers and aftercoolers sometimes installed. These coolers are in reality extensions of the cylinder jacket and serve the same purpose with increased efficiency. The three-stage air compressor possesses an increased efficiency due to the fact that the compression curve is a saw-tooth diagram, made up of a series of adiabatic transformations with relapses between compressions to the initial temperature. Thus the work area in the diagram is diminished over that required by simple adiabatic compression.

### Mechanical Refrigeration vs. Cold Water

The utilization of mechanical refrigeration in place of cold water in the forecoolers, intercoolers and aftercoolers as a direct means of increasing efficiency has never been attempted directly for air-compression purposes, but has proved very satisfactory in indirect applications, and there is no special reason why this development should not occur in the immediate future, especially when various conditions incident to mechanical refrigeration are considered in their relation to this development. Ordinary pressure blowers are in reality rotary air compressors of an extremely inefficient type, and the utilization of mechanical refrigeration for other purposes with their indirect effect on the efficiency of ordinary pressure blowers is a recent development in mechanical refrigeration presenting enormous possibilities for progress in the field of ordinary air compression.

Reference is made especially to the utilization of mechanical refrigeration for the removal of moisture from the blast in iron furnace operation. One of the first plants to be installed for this purpose was at the Isabella furnace at Aetna, Penn. Two 225-ton refrigerating machines were installed to freeze the moisture out of the air before entrance to the blast furnace, with the hope of making the product uniform, since all the other constituents in the operation of the blast furnace were of this character, and the air with variable moisture content was the sole disturbing factor. The refrigerating plant was of two units of a nominal capacity of 225 tons of ice-melting effect each. Only one was operated under normal conditions, the other being held as a reserve unit and for assistance in case of abnormal moisture content in the air. The moisture which passed through the furnace under normal conditions was approximately 40 gallons of water per hour per grain of moisture per cubic foot of air, and at times the content was considerably over 300 gallons of water per hour. The temperature was lowered from 80 to 28 degrees Fahrenheit, and the moisture content lowered from an average of 5 grains to considerably less than 2 grains per cubic foot. The air handled after the blowing engines were slowed down, on account of increased density and removal of the moisture, was 34,000 cubic feet per minute. About 10 tons of water were collected per day and the output was increased from 350 tons of iron, with 2147 pounds of coke consumption per ton of output, to 450 tons of iron per day, with a coke consumption of 1729 pounds per ton of output. The blowers were slowed down from 114 to 96 revolutions per minute, and the air consumption was diminished greatly, since it was approximately 40,000 cubic feet per minute before the installation of the refrigerating plant. The horsepower of the blowers was reduced from 2700 to approximately 2000, whereas the refrigerating plant, operating at maximum, took only slightly more than 500 horsepower. This development represents one of the initial installations of mechanical refrigeration in this field and the results shown are remarkable. Since that time many other iron works have installed refrigerating plants with even greater increases in efficiency resulting, and the largest single order, in tons refrigerating capacity, ever given in the United States was recently made in this development.

A study of the results of this development with a view to investigating the causes of increased efficiency are not only interesting, but present a number of remarkable features. The iron production in the case under consideration was increased from 350 to 450 tons of iron per day. The air consumption was lowered
from 40,000 to 34,000 cubic feet per mi
ute. A much larger total amount of co
was consumed per day. In fact the i
crease was approximately 33 per cen
and the decrease in air consumption a
cording to volume was approximately
per cent. In reality the air-consumpti
rate was reduced slightly owing to t
fact that moisture was not present w
the consequent production of exhau
gases; but a much larger quantity of
by weight entered the furnace than und
former conditions. The air by prelimina
cooling underwent transformation due
the elimination of water vapor and
consequent occupation of this space by a
ditional air before there was a further
crease in density of the air due to
initial cooling at constant pressure. T
fact that increase in efficiency of t
most inefficient type of air compress
the rotary-pressure blower, is possi
under these conditions, results in a grea
consideration of its possibilities in dir
air compression for other purposes.

If this increase in efficiency is p
sible at the low pressures and low
ciency of this type, undoubtedly m
superior results can be attained un
conditions where these limitations on
ciency are not existent to this ext
Thus, a three-stage compressor for
compression utilizing mechanical re
eration for the operation of the f
coolers and intercoolers, and possibly
aftercoolers, presents possibilities for
creased efficiency that are most rema
able. The further fact that the factor
the installation here mentioned are t
certain extent in opposition only
creases the possibility in its further
plication. Thus, the cooling of the
blast for the removal of moisture is
direct opposition to the heating effect
essary for chemical action in the pro
tion of iron. Further cooling would
move more moisture and increase
density of the air supplied to the blow
but this cold air would have a chil
effect in its utilization in the blast
nace. Undoubtedly there exists a limi
temperature below which the air ca
be cooled without loss in efficiency du
this condition, but it was probably
reached in the installation herein
scribed.

### ABSORPTION PLANT SUPERIOR TO CO PRESSION SYSTEM

Again, the utilization of mechanical
frigeration in its various types and
velopments presents possibilities fo
correlation with air compression. Re
erating machines consist of two
tically standard types, the ammonia-
pression system and the absorption
The compression type utilizes a
chanical compressor for the produ
of the liquid ammonia or refriger
fluid. The ammonia-absorption sy
utilizes the absorptive power of water
the loss of this power with rise in

erature to produce the same result. The nechanical compressor requires steam or some prime mover for its operation, vhereas the latter utilizes the heat in team and later types have been constructed to utilize the exhaust steam from almost any source for this purpose. Thus, he installation in iron-blast operation resents further possibilities in the utiliza- ion of absorption machines for increased ficiency, these latter being operated by xhaust steam from their auxiliary units or m the blast-furnace gases directly. The pe, of course, can be operated in turn internal-combustion motors operated the same source, but in practically he plants installed to date direct steam ts have been used with the compres- n system. The ammonia-absorption tem, on the other hand, possesses pos- lities in the line of mechanical re- rigeration itself not possible with the ression type. Thus, the efficiency of compression refrigerating plant is de- dent upon temperature required, and wer and lower temperatures are ob- d only at the expense of lower op- ting efficiency. The absorption system produce low temperatures even more iently than higher ones, and this can readily seen from the fact that ice-mak- g installations of the two types have r brine tanks at 16 degrees Fahren- approximately for the compression e, and 0 to 10 degrees Fahrenheit r the absorption system.

Thus in the utilization of mechanical igeration for increased efficiency in compression the absorption type is ubtedly superior. Much lower tem- ratures can be obtained and the ex- st steam from the air compressors can rate the refrigerating plant with ease. lower temperature obtainable by the rption system results in a much lower perature obtainable for the initial sup- f air and a corresponding increase initial density. The volume of a per- nent gas is directly proportional to the lte temperature if the pressure is mained constant, hence an air com- sor with preliminary cooling of the to one-half of its absolute tempera- results in an increased initial ca- ity of fully 100 per cent. When the er fact is considered that the mois- is removed as well and the pres- dependent upon this eliminated and lace taken by an additional charge of the advantages of low temperatures preparation are at once apparent. fact, if air could be cooled to abso- le zero or its vicinity and maintained re during compression, practically no rk would be required for almost limit- ls compression, and work would be ainable at once by reheating or by ural radiation from surrounding bodies this case.

Reheating effects, in turn, would be re pronounced and the increase in ssure due to the injection of water vapor with diminution in density as used would be very great, almost in direct proportion to the temperature range possible in the two cases. The question of relative increase in efficiency of mechanical refrigeration in the forecooler, intercooler and the aftercooler is very interesting. Undoubtedly refrigeration in the intercooler would be more efficient than in the forecooler. The fall in temperature could be made even greater, and the increase in density resulting on this account would be more pronounced, with a tremendous increase in ultimate quantity of air compressed per stroke and available for expansion purposes under normal conditions. The effect in the aftercooler would be a function largely of the duration of storage of the compressed air and the size of the reservoir. If utilized directly with a small reservoir or available supply requiring refrigeration and with reheating and the ingress of water or steam before utilization, the density variation between supply and utilization could be made enormous, with a resulting increase in efficiency at this end. However, mechanical refrigeration at this point would not prove nearly as efficient for storage purposes as for direct mechanical refrigeration. The utilization of the exhaust or waste from the refrigerating coils could be used with high efficiency for jacketing purposes, and when the fact is further considered that all this increase in efficiency could be accomplished by what is now considered a waste product, namely, exhaust steam in this process, its applicability becomes at once apparent.

The utilization of liquid air for refrigerating material for this purpose would be an extremely inefficient process, since practically the sole source of liquid air is from compressed air primarily with a very small efficiency factor in its production. Ammonia is undoubtedly best and its efficiency is great in this regard, since it utilizes the latent heat of change of state for the production of refrigeration and reduces the efficiency of cooling to a figure comparable to that of steam production and its utilization for heating purposes. Undoubtedly the same conditions or similar ones hold here as in the iron-blast development. Extreme cooling would prove inefficient due to the fact that the cost of producing the refrigeration would more than balance the increased efficiency resulting from its use. This is readily shown by the two cases mentioned. Liquid air is unavailable. The temperatures while not necessarily too low are too difficult and expensive to obtain.

Ordinary normal temperatures can be readily maintained by means of cold water in jackets and condensers, and this is considered an efficient process in comparison to heating the system up to the point where the radiation loss to surrounding bodies equals the heat gained. The fact that water cooling is the most efficient process and that mechanical refrigeration is unavailable is a conclusion unwarranted by the facts at hand. Cold water for its availability often requires power as well and has a certain efficiency of production. Mechanical refrigeration would give a more efficient temperature for compression and has a certain efficiency of production as well. Undoubtedly a mean temperature for compression below normal atmospheric temperatures and approximately the same relative position on the temperature scale below normal conditions that steam and other prime movers possess above the normal conditions, would prove theoretically the most efficient, especially when the further fact is considered that what is today practically a waste product in air compression becomes immediately available for increase in efficiency and is limited today only by the design and cost of ammonia-absorption plants, exactly as the cold-water development was formerly limited by the design and cost of pumping installations.

Undoubtedly the time has come in the ammonia-absorption development for its utilization in this field. With mechanical refrigeration for the preparation of air for compression and with its further utilization for increased efficiency during compression itself, with its utilization to the last dreg, and its production by an otherwise wasted product, and with the further possibilities of reheating as at present practiced in its effect on air under these conditions, there is no doubt that the process of compressing air for the transmission and storage of energy should become an efficient process, if not on a par at least closely approximate to that of electrical transformation.

---

The loftiest chimney in the world was recently put into service at the large smelting works at Great Falls, Mont., where it will serve to carry off the gases from the greater part of the large plant. The chimney, which is built of brick, is 506 feet in hight above the ground. It is 50 feet in diameter at the top, and increases gradually in diameter to the base. The flue includes a dust chamber in which vertically hung wires serve to take out the dust from the smoke. The dust is removed from the wires by shaking mechanism and falls in hoppers in the floor, from which it is loaded into cars in a pit below.—*Scientific American.*

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At Pearsons' furnace, Netherton, England, a recent crank-shaft breakage involved a badly bent piston rod, seven inches in diameter. The rod was cut through close to the cylinder gland by means of an oxyhydrogen blow pipe. The hight from the ground, showers of burning metal, etc., made the work unusually difficult, but it occupied only 35 minutes.

# Repairing a Vertical Steam Engine

By William Kavanagh

The crank pin of a vertical engine was so badly worn that it was decided to put in a new one at the first opportunity. Fig. 1 shows the crank pin attached to a disk crank, and it may be noted how the pin was worn on a taper. The engine had been running for years and no difficulty was ever experienced in keeping it in daily operation except that of occasionally fitting the brasses to the tapered pin. Lately, however, it became difficult to keep the brasses in line, so it was decided to have the pin taken out and a new one inserted in its place. There being no way of doing such a job in the engine room, the crank shaft and disk were taken out of the engine bearings and sent to the makers of the engine, it being thought that the builders of the engine were best equipped to do the job, and besides it happened that the shop of the builders was in the vicinity.

While the crank shaft was away in the shop two of the assistant engineers were detailed to overhaul the engine, take out the piston and valve and inspect them, and also note conditions inside of the cylinder. The cylinder head was removed and a chain tackle was attached to an eyebolt screwed into the piston. In this way the piston and rod were removed from the cylinder and placed on some heavy boards so as to prevent any grit from finding its way into or around the steam packing rings. Fig. 2 illustrates an elevation of the piston and piston rod, and Fig. 3 is a plan view of the piston viewed from the follower end. Upon inspecting the piston it was seen that the follower was cracked, as indicated by the irregular lines, and a large piece was knocked or broken out of the follower at *B*. The three holes *C*, *D* and *E* are core holes (the piston being hollow), and one of the core-hole plugs was unscrewed about half way out.

As it was necessary to wait for the crank pin, there was a fine opportunity offered to have a new piston inserted in the cylinder, so the makers were given the engine number and a piston very promptly arrived. It was decided to run a line through the engine the moment the crank shaft was back in position, and try and locate the cause of the crank pin wearing tapered.

When the crank shaft arrived it was hoisted into position and a line was dropped through the centers of the cylinder stuffing box and crank shaft, as shown in Fig. 4. A heavy piece of wire, bent as shown at the top of Fig. 4, was placed on a cylinder stud and held in position by means of a washer and nut This piece of wire acted as a radial arn and was of assistance in finding the center of the cylinder in one direction. In the other direction the line could be movec along the arm to find the center. The line was dropped through the cylinder and stuffing box and the lower end was attached to another radial arm, as shown in Fig. 5. The arm is also shown in Fig. 4 lying inside of the engine base The lower arm is attached to a piece o board by means of a bolt and washer The device was inserted in the engine bas and held in position by means of tw weights. The line was now made tai and by swinging the arms and movin the line along the arm, the exact cen of the cylinder, stuffing box and cr shaft were quickly located.

In order to learn if the disk was par with the line, the disk was rotated four positions as shown at *1*, *2*, *3* an in Fig. 4. The disk was lightly cen punched so that the same point on disk would be used at each new posit The four small circles indicate the cr pin at the four positions. Referenc Fig. 6 will show how the caliper used to determine the parallelism of disk and line. In order to pass the c pin beyond the line, it was necessar pull the line to one side. Accu measurements were taken, and it is

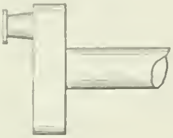


FIG. 1

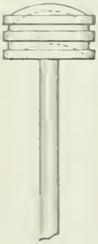


FIG. 2

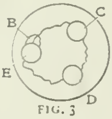


FIG. 3

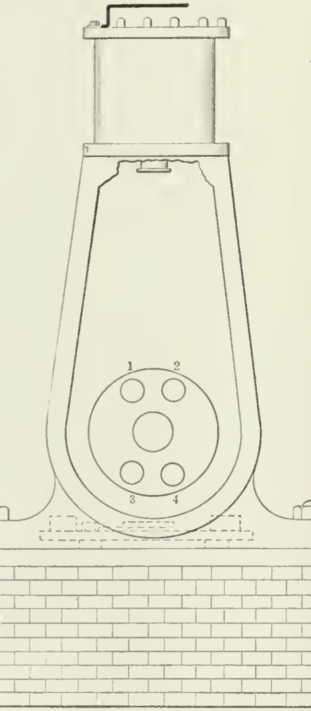


FIG. 4

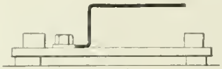


FIG. 5

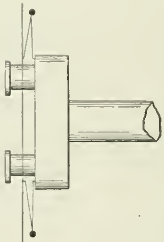


FIG. 6

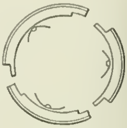


FIG. 7

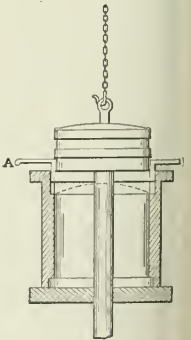


FIG. 8

Power, N

ound that the shaft and crank pin were erpendicular to the line and the disk as perfectly parallel. It was thus clear hat the shaft and pin were in line and he wear did not occur from any fault n the engine alinement. Further investiation developed the fact that the crank in was soft along the tapered part.

The piston packing rings are made in ree parts, as shown in Fig. 7, and a escription of how the piston rings were eturned to the cylinder may be of in-est. Eight pieces of heavy copper wire re each bent at right angles and placed thin the cylinder, as shown at *A* and *B*, . 8. The pieces of wire within the cyl-der were hammered out to suit the th of the counterbore and were spaced al intervals around the inside of cylinder. The piston was now raised the chain tackle and lowered into sition. As the piston entered the terbore the bent wires acted to com s the packing rings into the slots, d after the follower passed the wires were taken out.

After the engine was put together it run under a friction load during the stment of the crank pin and crosshead es and main bearings, and when the tment was as close as it is practical have it, the engine was started on its r duties, proving that the job was ctly satisfactory in all respects.

# Electric Motors for Industrial Plants

By W. E. Crane

Called upon to put in a small power t for electric drive, I found this con: The motors were already in , some of them being too large for work, and the power factor low in quence. The current was supplied e local electric company at 196 volts r a 220-volt system. By supplying their current and keeping it up to 225 s, it meant a still lower power factor. record of the meters on the motors, the record and the diagrams from gine that had been in use, footed total of 170 horsepower.

When they had run by steam they had l the exhaust for heating the factory winter, and during the summer they used about 25 per cent. of the ex t for heating dry rooms and for a ater for furnishing hot water. The k pressure carried had been 2 pounds.

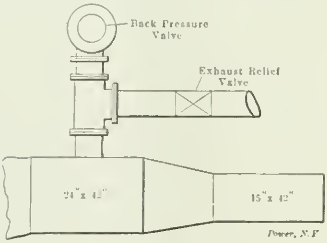
To put in a single-cylinder engine under se conditions meant a consumption of ter of not less than 28 pounds. I prosed to put in an engine to require but ½ pounds in winter and about 17 in mmer. They had an available steam essure from tubular boilers of 100 unds.

A tandem engine was selected, with cylinders 15 and 24 by 42 and running at 90 revolutions per minute. This is a fair proportioned, noncondensing tandem engine and when so run should deliver a horsepower from 22½ pounds of water. The exhaust piping from the low-pressure cylinder is shown in plan in the accompanying sketch. The condenser used is the siphon injector and not shown.

In the exhaust leading to the condenser are placed a tee and an exhaust relief valve and this pipe leads to the exhaust heating system. Attached to the ell, looking up to the condenser, is a back-pressure valve, and then the regular vertical pipe to the condenser.

From the receiver is a 2½-inch opening with a pipe in which is a pressure-reducing valve to reduce from the receiver pressure of, probably, 30 pounds to 2 pounds and this opens into a 4-inch pipe that goes to the dry rooms. In this pipe is a stop valve and connected to the same pipe is a 4-inch pipe from the main exhaust heating pipe, with a stop valve.

The operation is as follows: When using the exhaust for heating the condenser is idle. All the steam goes through the low-pressure cylinder and the exhaust from it goes to heat the shop and dry rooms, the back-pressure valve in the exhaust pipe maintaining the requisite 2 pounds pressure, should there be sufficient exhaust. If not, it must be supplemented by steam from the boiler.



PLAN OF EXHAUST PIPING

Should the shop be sufficiently warm without necessity for heat, the engineer shifts over the stop valves from the exhaust to the receiver for the dry rooms, starts the condenser, lifts the weight from the back-pressure valve and the engine becomes a condensing engine, using steam from the receiver for heating the dry rooms. The exhaust relief valve is entirely automatic, opening when there is no vacuum and closing when the condenser starts.

The engine becomes fairly well balanced, as when the condenser is in operation about 25 per cent. of the steam is going in another direction and the receiver pressure will be less. When the condenser is not in use the low-pressure cylinder gets about 25 per cent. more steam and a higher receiver pressure. Just what receiver pressures in each case will give the highest economy cannot be told until it has been worked out in practice.

To get the economy promised, it was necessary that the electric equipment be highly efficient, as where there are electric measuring instruments it readily becomes the practice to look at them instead of taking diagrams from the engine. But a number of the motors are inefficient and the easiest way to cover that is to put in a big generator, one sufficiently large to be perfectly safe to load with wattless current, the excuse being that wattless current is not energy and does not take energy from the engine and no harm is done.

While it is true that wattless current does not represent power, it is also true that it causes just as much heating as the energy current. Consequently, if, say, 20 per cent. of the current is wattless, the useful current can be only 80 per cent. of the maximum capacity of the generator, and the latter can carry only 80 per cent. of the load which it could carry if the current did not lag—that is, if the power factor were 100 per cent. The larger the motors are for their work, the greater will be this lagging current, the lower will be the power factor and the less load can the generator carry in actual energy or power.

If we put in a synchronous motor and over-excite its field magnet, it will cause a leading current to flow in the line and this can be adjusted to neutralize the lagging current caused by the induction motors and put the power factor up to 100 per cent., thereby enabling the generator to carry its full load without overheating. Without such compensation, however, and with extra-big motors and an extra-big generator, the plant must operate inefficiently.

With direct-current drive there is the commutator problem, and to avoid commutator troubles with full and over loaded machines it has been not uncommon to put in motors "amply large." While this gave less efficiency, there was no trouble with lagging current and the generator had only to turn out the energy current required.

Induction motors have no commutators and therefore give no commutator trouble and can be overloaded without giving trouble up to a point where they slacken speed, when they get out of step and stop.

The question is often raised whether the motor shall be chosen for the maximum load or the average load. Suppose we have a drive that requires a maximum power of 100 horsepower and an average of 70 horsepower. It would help us to know how often and for how long the maximum load would last and for a direct-current motor it might not be unwise to install a motor of 100-horsepower capacity, but it would be unwise to install an induction motor of that size because of the effect of the lagging current; such a motor should not be of more than 75 horsepower, which would give a fair power factor at the low loads and carry the overload all right.

With conditions as mentioned in the beginning of this article the only course to pursue is to regroup the drives as far as possible and cut out some of the motors, and possibly change others for smaller.

If then the whole capacity of the generator is wanted for energy current, put in a synchronous motor in place of one of the others, or run one empty with an over-excited field.

In another case a factory owner proposed to change from shafting to induction-motor drive. His machines were all alike. I suggested that he get his generator for his full engine capacity, as he was to add another small shop, set his generator so as to belt from the jack shaft, group such machines as could be done readily and get a motor for the group and take readings, and thus learn the size of motor required; then put in motors no larger than actually needed. When all was ready, the generator was to be moved over so as to drive direct from the engine and the shaftin taken out at leisure.

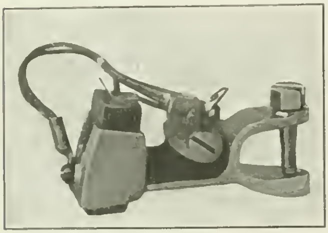


FIG. 314. BRUSH HOLDER USED ON THE GENERAL ELECTRIC MOTOR SHOWN IN FIG. 312

He turned it over to an electric company which sold him his generator and concluded they could estimate closely enough for the size of the motors and get them "big enough," with the result that for turning out some 55 horsepower they have 160 horsepower of motors, and their 75-kilowatt generator has its surplus ampere capacity taken up with wattless current, leaving no margin to turn out more energy current for the addition to his factory.

Is it wiser for him to change his drives so as to get decent-sized motors for the drives and throw out the others, or get a generator large enough to take care of all the wattless current and use up a large part of his engine power to take care of the larger friction, wind resistance and heat losses, with a possibility of having to get a larger engine?

## Catechism of Electricity

1085 *What form of brush holder is used on the motor just described?*

One of the brush holders is shown separately in Fig. 314. The carbon brush *v* is held against the commutator by a lever arm *a*, actuated by a spiral spring wound around the stud *u* upon which the lever arm is pivoted. This spring provides a practically uniform pressure throughout the whole life of the brush. An auxiliary spring *l*, formed from flat spring steel, is attached to the under side of the lever arm and has the proper degree of flexibility to allow the brushes to follow any irregularities of the commutator due to wear. A flexible copper pig-tail *c* prevents the passage of any appreciable current through the springs.

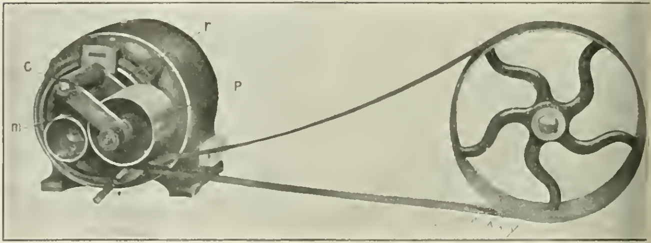


FIG. 315. GENERAL ELECTRIC MOTOR SHOWN IN FIG. 312, EQUIPPED WITH A BELT TIGHTENER

1086 *What is the use of the arrangement shown in Fig. 315?*

It is a belt-tightening attachment such as is frequently used on motors of this kind to permit setting the motor at a short distance from the driven shaft and to allow the use of a small driving pulley. The belt tightener gives a greater arc of belt contact on the driving pulley, thereby decreasing the amount of belt slip without excessive belt tension, and it also does away with the need of a sliding base. I also takes up any jarring that woul otherwise be transmitted from the drive machine to the motor armature.

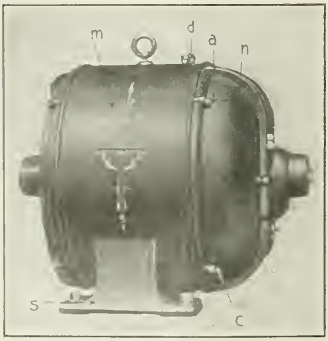


FIG. 316. INCLOSED DIRECT-CURRENT MOTOR MADE BY TRIUMPH ELECTRIC COMPANY

1087 *Explain the construction of tl belt tightener.*

The belt tightener consists, primaril of a cast-iron ring *r* with an adjustab arm *c* carrying an idle binder pulley The arm *c* with its pulley may be set any position necessary to produce the r quired binding effect. The picture shov a driving pulley *m* of smaller diamet than the standard driving pulley furnish with motors not equipped with the idl attachment.

1088 *Illustrate and describe an inclo. type of direct-current motor.*

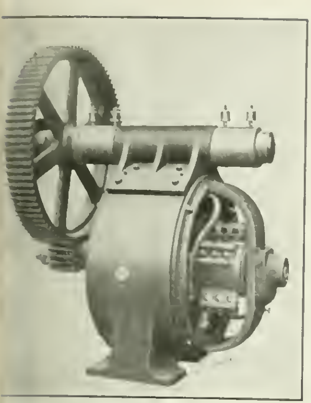
Fig. 316 shows an inclosed direct-c rent motor built by the Triumph Elect Company. The cover *n* completely closes the commutator end and is held place by the bolts *a*, *c*, etc., which sc into the frame *m*. A similar cover li wise incloses the pulley end of the chine. The main leads are brought up run through insulating bushings to terminals at *d*. One of the characteri features of this particular make of closed motor is its close-grained s frame, which makes the machine sma for the same output than would be sible with cast iron. The magnet p are also of steel cast into the frame, are equipped with removable lamin pole shoes which hold the field-ma coils in place.

1089 *What kind of motor is that sh in Fig. 317?*

A back-geared direct-current Triu motor designed for driving machine t or other slow-speed apparatus. The ject in using the gears and counters is to get a considerable reduction in s with rigid drive or with minimum space. Aside from the absence of end covers, the general design and struction of the motor is practically same as that of the motor in Fig. 3

1090 *Describe the machine show in Fig. 318.*

This is a vertical direct-current Cro



317. BACK-GEARED DIRECT-CURRENT MO-
R OF TRIUMPH ELECTRIC COMPANY

Wheeler motor for special application under conditions which make the ordinary horizontal-shaft motor impracticable. The frame *m* is of cast iron, with field-magnet poles of steel, cast-welded into the frame. The armature core is of the usual slotted and laminated construction, wound with formed coils. The field-magnet coils are wound on bobbins which fit on the circular magnet poles and are held in place by pole shoes fastened to the ends of the poles.

1091 *Does not the motor shown in Fig. 319 possess some radial departures from ordinary direct-current practice?*

Yes; the construction of the field-magnet frame is peculiar to this particular type of motor, which is built by the Northern Electric Company.

1092 *Illustrate and describe the construction of the magnet frame of this motor.*

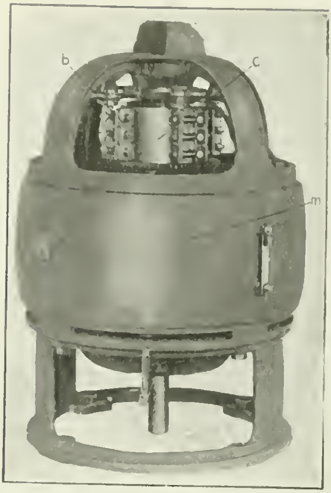


FIG. 318. CROCKER-WHEELER DIRECT-CURRENT MOTOR OF THE VERTICAL TYPE

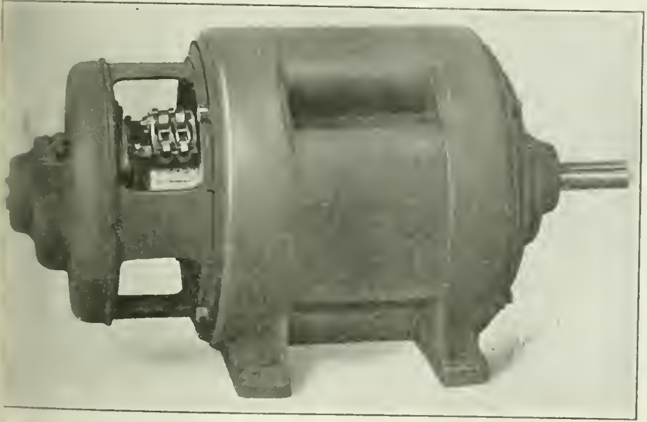


FIG. 319. DIRECT-CURRENT MOTOR BUILT BY NORTHERN ELECTRICAL COMPANY

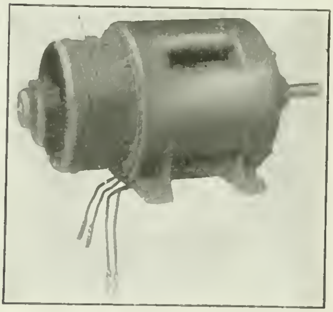
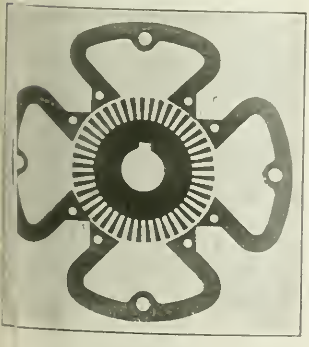


FIG. 321. NORTHERN DIRECT-CURRENT MOTOR SHOWN IN FIG. 320, FITTED WITH COMMUTATOR-END COVER



FI 320. OUTLINE OF THE IRON MAGNETIC CIRCUIT IN THE NORTHERN MOTOR IN FIG. 319

Referring to Fig. 320, which shows the outline of the complete magnetic circuit of the machine, it is claimed that the internal pole tips *t* maintain a stable neutral position for the brushes under overloads. The recesses *r* formed in the poles increase the heat-radiating capacity of the motor, thus permitting of comparatively high ratings.

1093 *For what kind of service is this type of motor adapted?*

It was originally designed for direct driving of machine tools, but it can also be used for belt drive. When fitted with a sheet-steel cover at the commutator end, as shown in Fig. 321, it is especially well adapted for driving grinding machines or other service where the air is dust-laden. It will be noted the bearings are supported in bonnets or end shields *c*,

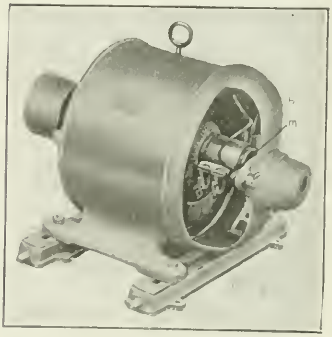


FIG. 322. DIRECT-CURRENT MOTOR BUILT BY THE WESTERN ELECTRIC COMPANY

etc., Fig. 320, which are held in position by through bolts.

1004 *Does the motor shown in Fig. 322 possess any unusual features?*

Yes, the field-magnet poles have a different shape from those in other motors, as indicated in the sectional view, Fig. 323. That portion embraced by the field-magnet coil *c c* is approximately circular in section, resulting in a small average length per turn of field coil which makes for an increase in efficiency. The axis of the pole is curved and intersects the armature periphery at an acute angle. The pole piece is elongated in such a way that a rectangular pole face of large area is obtained, yet one over which the field-magnet coil can be readily slipped. The field magnet is bipolar and the frame is of cast steel in a single piece. This type of machine is built by the Western Electric Company.

1005 *Describe the construction of the other parts of this motor.*

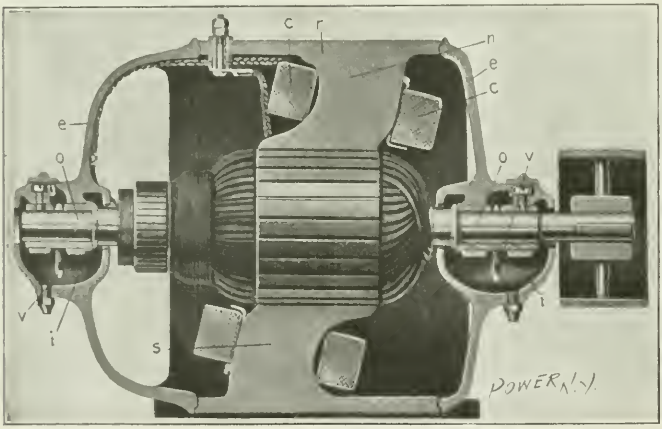


FIG. 323. SECTIONAL VIEW OF THE WESTERN ELECTRIC MOTOR SHOWN IN FIG. 322

The bearing brackets *c*, etc., are of cast iron, and are fastened to the ends of the frame by means of bolts. The bearings are cast integral with the brackets and are provided with oil wells *i*, and oil rings, *v*. They are lined with sleeves *o* of special bearing metal, which it is claimed has a low coefficient of friction.

The brush holders *m*, Fig. 322, which are of the box type, are mounted in a fixed position on the arm of the bearing bracket *b*. The brushes are of carbon. The field-magnet coils are form wound, and after being insulated and wrapped with tape for mechanical protection they are treated with a moisture-proof insulating varnish. They are securely held in place on the poles in an inclined position, as shown in Fig. 323, so that the surfaces of the coils form oblique angles with the direction of the air currents generated by the rotation of the armature, resulting in a rapid dissipation of the heat generated in the armature and field coils.

# Electric Ignition on Large Gas Engines

By F. F. Junge

Instead of magnetos or induction coils which are largely used for small and medium-sized work modern large gas engines employ frequently what is termed in Europe "arc-light ignition," a system which precludes breakdowns and failures almost entirely and should therefore be employed where greatest reliability of operation is desired. Arc-light ignition is equipped either with single-pole or with double-pole interruption of the current. The first method possesses the disadvantage that in case of a ground joint short-circuit or an overbridging of the isolating section of the commutator, the igniter box is apt to receive current, which gives cause to premature ignition. The second system offers a guarantee against one of the troubles mentioned, namely, ground circuiting, but not against overbridging of the commutator, since the igniting apparatus receives current for all that.

An arc-light ignition device built by the Felten Guilleaume Lahmeyer Works, at Frankfort-on-Main, Germany, possesses the advantage of not being susceptible to any of the disturbances outlined. This is obtained through a special arrangement of connections (wiring diagram), which is diagrammatically presented in the accompanying sketch. The scheme shown serves for a double-acting tandem engine. The essential feature of this connection is that the hammer part of it and the igniter box are short-circuited within themselves during the time while ignition is not desired to take place. With this connection a ground circuit or an overbridging of the isolating section of the commutator will produce a complete short-circuit, which causes burning out of the fuse, so that the current is interrupted and cannot p
on to the igniter box.

For reasons of reliability it is alw
wise to provide for each combustion cha
ber two hammer devices and igniter box
Therefore, in the drawing eight of th
are shown, although there are only f
combustion chambers. The complete ig
tion outfit consists of a contact appara
which is common for all igniter bo
being usually mounted on the cam
secondary shaft, and the hammer p
which is fastened to the cylinder, act
on the ignition boxes, mounted intern
The contact breaker has a set of brus
for each ignition chamber, which cl
the current at the moment of firing.
current flows then over the hammer
the ignition box. The hammer part
turn attracts an anchor, or armature,
lever of which strikes against the turn
lever of the igniter box, whereby
circuit is interrupted and a light
produced between the contact points
poles of the igniter box, which prov
ignition.

The hammer part is essential for
sure and safe action of the arrangen
since it is the only guarantee offered
the light arc is formed independen
the friction in the igniter box at a
tain moment, and with greatest exact
The forces operating during each blo
the hammer are large enough to
come all internal friction that may o

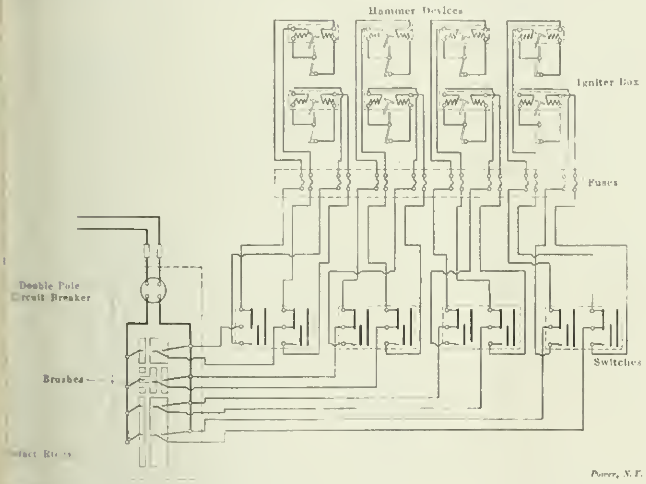
The contact device consists of a st
cast-iron casing mounted on the bo
the gas engine. Fastened to its
side is the brush holder, which is ca
of being turned by about 50 degree
as to allow of adjustment of the
of ignition (early and late ignition).
it is desirable, in double-acting en
that the point of firing in the front
bustion chamber is diverse by a c
amount from that of the back comb
chamber, the brushes are capable
ing shifted by about 10 degrees, rela
to each other. This is done by loos
the brush bolt and adjusting the
in the desired direction.

Switches are provided in the cas
casing, allowing one to switch the
ent hammer devices in or out a
case may require. For instance, i
hammers are provided for each co
tion chamber either both may be sw
in together or only one, or the tw
be switched out. Moreover, the
contains a double-pole fuse for each
mer device, which is easily accessi
removing the upper cover. At the
end of the contact apparatus is m
a double-pole main switch, by me
which all actions can be interrupted on
time. The conductors are intr uce
through a gas pipe located at the o osit
end; they are therefore protected ain t
mechanical injuries. The doul -pole
switch and the handwheel serving shift
the brushes can either be arranged t the
right-hand or at the left-hand side f the

pparatus. The device contains four sets f brushes for double-acting two-cylinder ngines, and two sets for single-acting ngines.

The hammer part proper also consists f a strong cast-iron casing from which lever of hammer shape projects. This ver is firmly connected with the anchor, hich is vigorously turned by a certain ngular amount when the current flows rough the magnet coils. The lever there- re performs the same motion and on its nd blows hard against the lever of the iter box. This motion may be either -handed or right-handed, as the con- ruction of the engine may require. The iter boxes are preferably manufactured the engine builders themselves, since ir construction depends largely on the pe of the cylinder.

Ignition apparatus of this description e usually built for a tension of 65 volts,



WIRING DIAGRAM FOR ARC-LIGHT IGNITION ON DOUBLE-ACTING TANDEM GAS ENGINE

that they can be connected to the light- s net by means of a resistance. In phase-current plants where the re- ed current is generated by the ex- r a battery is required, which delivers rrent while the engine is stopping, and can be loaded during operation from exciter. At 65 volts the igniter re- s about 6 amperes, but this only dur the short moment while the contact aker closes the current. The battery ds therefore to possess only a small pacity and may deliver current to all niters, since these are not all active at same time. Arc-light igniters of this scription are being used by a number of most prominent German gas-engine ms.

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A movement is under foot in Germany t utilize the flow due to the tides in a nch of the Elbe river to generate elec- t power.

# Gas Engine Cooling Water Temperature and Valve Stem Pitting

By Rossiter Holbrook

In a 150-horsepower gas-engine and producer plant situated near New York City, the engineer has had trouble with acids forming from the combinations of water and the producer gas. The engine in question is of three-cylinder vertical type and approximately three years old, and the valve stems enter extensions at the side of the cylinder. After running a year, ten hours a day, it was found that these valve stems were very badly grooved and pitted and the engineer concluded that it was due to acid formation. He discovered that the cause of this acid formation was that the water circulated through the valve stems was too cool and made them sweat. This moisture coming in contact with the gas formed a reaction that created the result mentioned.

To obviate this difficulty, the engineer, instead of telling the manufacturers that their engines were no good and to come and fix it up, took the matter in his own hands. He bought enough chrome-nickel steel to make the stems, bored them out for the circulation as the others had been made and turned them down to fit the guides. He then took the water from the cylinder jacket, which was at a higher temperature than that formerly used, and circulated that through the valve stems. The combination of the finer-grade steel and the higher temperature of the water, which prevented the sweating, attained the desired object of preventing the pitting of the stems. The writer saw these new stems, which were installed nearly two years ago, and there is not a mark on them.

An engineer in another plant has been having trouble of a similar character. The exhaust pipe from his two-cylinder single-acting horizontal engine runs into a tank of water to muffle it. This exhaust pipe was literally eaten up. He is now replacing the pipe with cast iron; this will probably last somewhat longer. It would seem as if the producer manufacturers could find some way to eliminate these acids.

# Boiler Explosions in England

A parliamentary paper recently issued comprised a report to the secretary of the Board of Trade on the working of the boiler-explosion acts, 1882 and 1890, during the year ended June 30, 1908. It shows that 62 preliminary inquiries and 11 formal investigations have been held respecting boiler explosions which occurred during the year. Of these 73 explosions, 36 resulted in loss of life or personal injury, 23 persons being killed and 50 injured. While the number of explosions is slightly above the average for the previous twenty-five years, the number of persons killed or injured is below the average.

The 11 formal investigations showed that in no case was the explosion really unavoidable, although one case was due to water hammer, and in another case a fine was laid against a superintendent for oversight in supervising the cleaning of a boiler. The fines ranged from $25 to $300 and were borne by the individuals held to be responsible. In 6 of the 11 formal cases this meant the owners. Of the total of 73 cases, 30 were laid against owners, and among the others were four engineers, one foreman of works, one boiler foreman and one mechanic. In 34 cases previous inspection had not shown defects, and in 18 cases there had been no inspection. The types of boiler and other apparatus involved were: Horizontal multitubular, 16; vertical, 8; cylindrical, 7; locomotive, 2; water-tube, 2; tubes in steam ovens, 2; heating apparatus, 4; steam pipes, stop valves, chests, etc., 23; miscellaneous, 9.

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An exchange gives the following method for drilling slate and marble: Use ordinary twist drills for holes 1½ inches or less in diameter, giving the lip plenty of clearance; above this size, wing cutters will give better results. Keep the tool thoroughly wet with water while cutting, and keep clean to avoid jamming. A speed of 400 revolutions per minute for ¾-inch or less and 200 revolutions per minute above ¾-inch will be found satisfactory. Feed by hand and be careful when nearly through, as the material is apt to break off in large pieces.

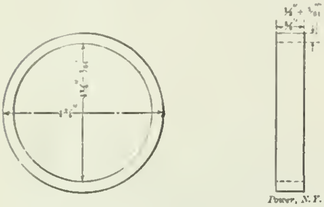
# Practical Letters from Practical Me

Don't Bother About the Style, but Write Just What You Think,
Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

## Flywheel Repair

A repair to the 18-inch cast-iron flywheel of a high-speed paraffin engine was made as follows: The flywheel shown in the sketch was cracked as in the elevation and as blacked in the sectional side view. The dimensions were as given and the speed at which the engine was run was 850 revolutions per minute. The engine had been supplied direct by a Continental firm to the owners in this city and was eighteen months old.

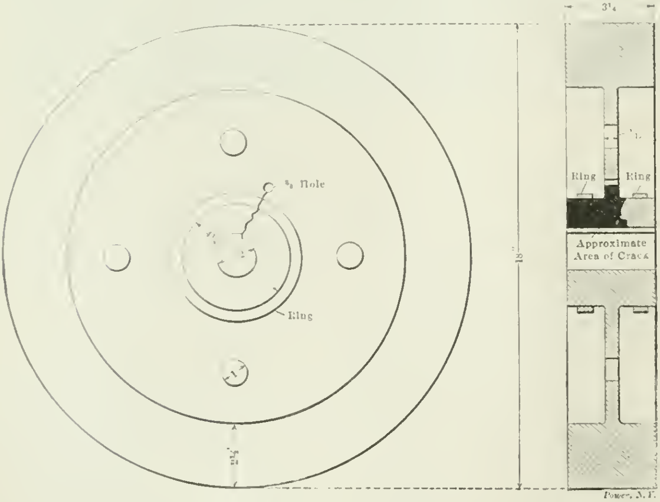


ONE OF THE RINGS

When the crack was discovered it was evidently an old one, as the metal was dull and slightly rusted, as seen through a powerful magnifying glass. As the owners did not wish to go to the expense of getting another wheel from the builders or of having a new one cast and machined, they made the repair here described.

At one place the point of a feeler gage of 10/1000 would enter the crack. The paint was scraped off and the crack followed up with the glass. The wheel having been removed from the shaft, a 3/8-inch hole was drilled through the web at the end of the crack, to prevent it from spreading. It is important that the hole should be drilled *right at the end of the crack*, or it will inevitably cause the crack to spread instead of arresting it.

The wheel was then placed in a lathe and the boss, which was rough and about 4 5/16 inches in diameter, was turned down to exactly 4 1/4 inches on both sides of the wheel. Two steel rings were then turned up 4 3/4 inches outside and 4 15/64 inches inside, the latter measurement being made very carefully. The rings were then heated till they could be forced over the boss; one was put on at each side and they were then allowed to cool.



SHOWING CRACK IN FLYWHEEL

The wheel was replaced on the engine shaft, and the repaired engine has now been running for two and a half years and the flywheel is as sound as ever.

Of course commonsense must be u to determine the limit to the length o crack which could be repaired in this m ner. I should not myself use this meth for a wheel of like size and revoluti if it were cracked radially more t one-third of the radius of the wheel.

From the sketch it will be seen that is another case of a crack starting fr the sharp corner of a keyway.

JOHN S. LEES

Manchester, England.

## Feed Pipe Trouble

I visited a small plant consisting of horizontal-tubular boilers, an engine a generator, and as I was sizing up plant the engineer, whom I knew, c m. Just at the time he was having tro with his boiler-feed pump, which w small triplex pump belted to a cou shaft. He said the belt would run o he attempted to start it. There w house pump of the same type which cross-connected to the boiler-feed p He tried the house pump on the b but it acted the same. Thinking I n help locate the trouble, I closed the valve between the boiler and the c valve; then, thinking the check might be sticking, we unscrewed the but found it working freely, and a had the cap off I started the pump t if the line was clear up to the check. it was. I then knew that the trouble lie beyond the check valve.

By this time the water ran rather in the boiler, so we deadened the fir let the steam pressure down so tha could work. As soon as the pressur off we removed the bonnet of the valve and there we found the tr The collar on the end of the valve to which the disk holder is fastene broken off, disengaging the disk from the valve stem. The directi the water flow through this valve opposite to that in the check valv tendency was to seat the disk h ler. which had become disengaged fro the valve stem, thereby shutting off de ery from the pump to the boiler. We s ted up after replacing with a duplicate em which the engineer happened to ha

ARTHUR P. SCHM

Chicago, Ill.

## Follower Bolts

Aside from water, broken follower bolts doubtedly cause the engineer his great- annoyance in engine cylinders. The l:aking of a follower bolt or the working f a nut, and their subsequent dropping the small clearance space when the pon is at the head end of its stroke, ls undoubtedly caused more engine vecks than any one cause due to modern pn construction.

e form of bolt illustrated in Fig. 1 rcomes this difficulty to a great extent is being adopted by many of our fore- engine builders and engineers. Re- ing to Fig. 1 the bolt or stud is de- ned so as to have its weakest point jt back of the shoulder in the section is tapped into the piston body.

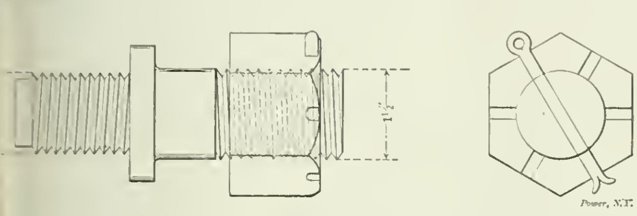


FIG. 1

n a bolt breaks it invariably does ween the follower and the piston b due to the wearing between these parts. Referring to Fig. 2, *A* is the p of usual breakage. As this type of

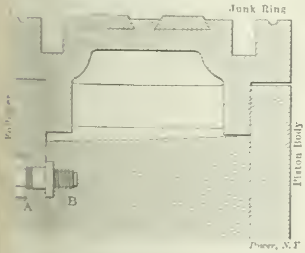


FIG. 2

follower bolt is strongest at this point, the breakage will occur at the nearest w t, or at *B*. The bolt being pro- with the shoulder, the broken prevented from dropping into the and thus breaking a head or e wrecking the engine. When the examination of the piston occurs, broken bolts may be removed, no having been done by them.

bolt as shown in Fig. 1 has another feature. The nut is fastened to the or stud by a dowel pin, but instead riling through the nut, as usual, slo are planed across the nut from face ice, of sufficient size to admit the dowl pin. This allows a slight tightening or osening of the nut without drilling extra dowel-pin holes. Fig. 2 shows a section of a box piston with the follower bolt in position.

N. L. Daney.

Elyria, O.

## Centrifugal Pump Thrust Bearing Gave Trouble

One of our two-stage centrifugal pumps was brand new, had two cast-iron impellers and a thrust bearing of the usual marine type, only the lubrication for this bearing was arranged in a different, and I may say not very effective way, as it had a tendency to run rather hot all the time. After a few months' service this thrust bearing began to give all kinds of trouble from heating and finally started to cut quite badly, when we discovered that the thrust on the collars had been reversed in direction from what it was when the pump was first started up. This indicated, of course, that the latest trouble must be laid to the action of the pump instead of poor lubrication, as the pump had evidently become out of balance, and it was taken apart to examine the impellers.

The first impeller taken out, on the pressure side, was found just as good as new, did not show any sign of wear whatever. When we reached the other one, however, the one on the suction side, there was a surprise in store for us. Hitting the hub a few smart blows with a light sledgehammer to start it sidewise on the shaft the hub and the rest of the impeller parted company, and on removing we found it corroded and honeycombed not only around the hub, but most of the vanes inside the impeller were eaten away. Examination showed an unusually soft casting, no doubt explaining the trouble, as the high velocity has a tendency to start corrosion in this type of pumping machinery. This can be guarded against easily enough in most cases by having the impellers made of bronze.

The writer is now operating four single-stage centrifugal pumps, 14 inch suction and 12-inch discharge, with a capacity of eight million gallons each at a speed of 750 revolutions per minute, with nine feet of suction and working against a head of 140 feet, which can be increased to 200 feet. In this case we have a straight run from the pumps to suction supply without any air chambers or foot valve, priming the pump with a vacuum pump connected with the highest point of the pump casing, and so far we have had no trouble of any kind.

Where there is a steady pull and water is bad, I do not think any engineer would regret the change from piston to centrifugal pumps. A steady load will give a comparatively high efficiency for this new type, an efficiency not cut down after a few months' run, as is generally the rule with piston or plunger pumps.

R. Cederblom.

Gary, Ind.

## Slack Coal and Evaporation

A young engineer told me of evaporating 10 pounds of water with a pound of washed slack, and as it had only been a short time since I helped on a washed-slack test, I was skeptical. There are only about 11,000 B.t.u. in his coal. Later he said his water float in the heater did not shut off until the overflow pipe was half under water.

A year ago, an engineer of a 1000-horsepower compound-condensing engine, who was proud of a stoker he had, gave me the startling news that it evaporated 15 pounds of water per pound of slack coal. Said he: "The engine is 1000 horsepower, and you know that a boiler horsepower is 30 pounds of water evaporated, or just about that." I admitted it. "Then,

$$30 \times 1000 = 30,000$$

and as I only use a ton of coal an hour,

$$30,000 \div 2000 = 15$$

pounds of water per pound of coal. Can you beat it?" I said I could not.

E. H. Lane.

Kansas City, Mo.

## Repairs on Engine

Some time ago, at the plant of which I am employed as engineer, a crack developed in one-half of the boss where the piston rod screws into the crosshead of a 350 horsepower engine.

The following device was used in making repairs: A piece of angle iron 11x3x½ inch, with an angle brace in the center to strengthen it. We had two holes drilled in one side of the angle iron for the crosshead drawbolts, also two holes for ⅞-inch bolts, with thread enough for locknuts on one end and square hooks turned on the other to go over the crank end of the crosshead. We pulled the nuts up good and tight and ran the engine ten days until a new crosshead arrived from the factory.

J. E. Dawson.

Cumberland, Md.

## A Plea for Even Inches

Several times of late I have received blueprints from some of our leading pump manufacturers and want to call your attention to the manner of locating foundation bolt holes with dimensions ending in 1/16 inch. This could be entirely overcome by a little care on the part of the draftsman in designing the supporting feet, by using even inches for dimensions instead of the ever-bothersome sixteenths. Giving dimensions in even inches would greatly help the draftsman in checking up the drawings and, most of all, in simplifying the work of locating the foundation bolts in the field.

The writer recently had to redesign some foundations to carry certain overhead bridges. Originally the steps in the foundations were 8 inches wide and 12 inches deep and the lower course was dimensioned in half inches. In redesigning, all steps were changed to six inches in width and the twelve inches in depth retained, and all the other dimensions were changed to feet and half feet, thus simplifying the work in the field and making it easy to calculate the cubical contents of each type of foundation at a glance, without having to stop to obtain the different decimals of the foot.

F. Harvey Searight.

San Francisco, Cal.

## Small and Large Dynamos in Parallel

In our plant there are two generators, a 60-kilowatt and a 45-kilowatt, both Western Electric 125-volt direct-current compound-wound, belted to simple non condensing Corliss engines. We have a little difficulty in changing over from the small unit to the larger by the larger taking all the load. For instance, if the small unit is running and we cut in the large machine, the amperes will drop to zero on the small one. On the other hand, when the large machine is running and we cut in the small one they will run together. I have looked for loose connections on field rheostats and generators, but could not find anything unusual.

Before cutting in either generator we made a thorough investigation as to the voltage being the same on both machines, therefore I think the trouble could not possibly arise from this. Another thing is that after the large unit is cut out and the small one cut in, the voltmeter band will swing slowly back and forth for a few minutes, showing a variation of 4 or 5 volts, before settling down to its normal condition. Our load at present is not sufficient to warrant running both machines, but I am curious to know where the trouble may be.

Arthur P. Schmitt.

Chicago, Ill.

## Gas Engine Troubles

In the plant of which I have charge is a 50-horsepower gas engine, with crank brasses of the marine type. One morning a pound developed after the engine had been in operation about an hour. Knowing that something must have worked loose, I staid right by the engine until the noon hour, by which time the pound had become so violent that I was glad of the opportunity to shut down.

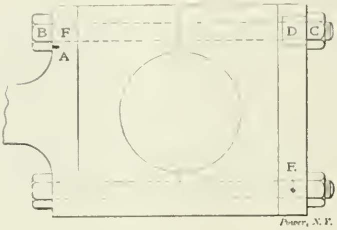


FIG. 1

I found that the small pin *A* (see Fig. 1) had sheared off, allowing the bolt *B* to back out of the nut *C*. This nut carried an extension *D* upon which bound the set screw *E*. First I thought of a jam nut on top of *C*, but there was not enough of *B* protruding.

The thing must be fixed and running inside the hour, and the only drills on the premises were driven by the disabled gas engine. To get the sheared-off pin out and a new one in without a drill was impossible, and I began to think I was in for trouble from my superintendent, who would have to send half his employees home.

In desperation I pulled out the bolt *B*, laid the part *F* on the anvil and flattened it out with a hammer until it made a tight driving fit in the hole. I had the engine running at one o'clock. That was five months ago and the bolt has not stirred yet.

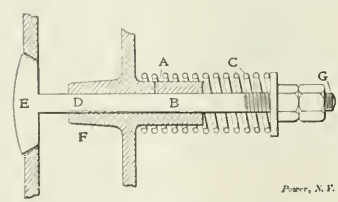


FIG. 2

I do not call it "good mechanics" and am not really proud of it, but sometimes a fellow has to keep his end up by the use of kinks and tricks. I would not risk such a fix if there were a pull on the bolts.

On this same engine I had some trouble with the exhaust valve, which can be easily understood by referring to Fig. The oil hole at *A* is the only means which oil can be got to the valve stem and this oil hole is almost covered by t coils of the spring *C*. A little carelessne allowed me to oil up for weeks, n noticing that the hole *A* was plugged dirt. Soon compression began to go ba and on taking out the valve I found t stem dry and worn, as shown by t thin line at *D*. This was allowing t valve *E* to drop to such an extent t it struck on the lower side of its seat a failed to fit into its place as quickly it should. I was lucky in finding guide *F* very little worn, and by turni the valve half around I was able to the good side of the stem down and cure a very good fit. After regrind the valve into its seat, with emery turned the worn side of the stem up made a mark on it at *G*, so that I am a to keep it so all the time. Compress is now good.

It all goes to show what a little ca lessness may amount to, for it was my fault that a new valve did not have be purchased.

R. Manly Or

Brantford, Ont.

## Lead in Vertical Engines

Almost invariably directions for the ting of the valves of vertical eng specify that more lead should be give the bottom than at the top end of cylinder. Usually no reason is given there should be lead at either end of stroke, and none can be found for its at the lower end of a vertical cyli When steam is admitted to the cyli in front of the moving piston its pres is exerted in a tendency to retard or the movement of the piston, and vertical engine this effect is shown by lifting of the crank shaft in the main ing, causing, if lead be sufficient, an ar ing pound in the journal, to accoun which the bottom-lead advocate is at

Steam is or should be used in the inder of engines only for the purpo turning the crank shaft and not to from its bearing, only to let it drop, the proverbial thud, as soon as the pin has passed far enough beyon center line to allow the pressure the piston to have a turning effect o crank instead of the direct lift whic tains while the engine is on the cen

There are many engineers who are to secure the noiseless passage o centers by a valve adjustment whic introduces a resistance on the front c advancing side of the piston, which tak up all of the clearance in the moving rt and holds them in contact when ste is let into the cylinder, producing pr ure in a direction opposite to the mov ent of the piston.

The direct effect of this course is to decrease the speed of rotation and the power of the engine, which can only be restored by a lengthening of the cut-off of the next stroke. In the vertical engine, when the shaft lifts in the bearing because of lead on the lower center the cap is adjusted until the shaft cannot lift, increasing the friction, adding to the power needed to do the work, and multiplying the chances for heating.

Caps on the main bearings of vertical engines are useful to keep the bearing covered, protecting it from dirt and leakage, but should never serve for holding the shaft down in place. Its own weight should do this, and the total lifting effect of the steam on the under side of the piston should not exceed this weight. Steam should not be admitted under the piston of a vertical engine until the piston has started on the up-stroke, and then so slowly that the total upward pressure will not be sufficient to lift the shaft from its bearing.

H. E. Mansur.

Newark, O.

## Boiler Inspection Laws

Today 21 States have laws requiring those who want to sell spectacles to go before an examining board. The reason is that unscrupulous men calling themselves optometrists have sold glasses with cheap frames and lenses for solid gold frames and pebble lenses.

If the optometrists have been able to secure this law in 21 States, how is it that we humble engineers, with the aid of the boiler inspectors, are not able to get more States to pass laws requiring boilers to be inspected, and requiring men in charge of boilers to go before examining boards?

If a man buys a pair of glasses that do not fit him and finds that the frames are not gold but brass, he has injured no one but himself. But if an employer buys an old, condemned boiler and installs it in a factory basement under several hundred employees, then all concerned—the employer, his help and the public not only run the risk of spoiling their eyesight, but their lives are in danger. What we need is a national law, requiring all boilers to be inspected, and the time is ripe for its enactment. Maine and Vermont are among the 21 States mentioned, as to the eye-measuring law, yet each State furnishes a good market for rejected boilers from Massachusetts.

Let us hope that the eyesight of all the politicians who have voted for better spectacles will have their eyesight so improved that they will see the need of a boiler-inspection law and vote for it next year.

C. E. Bascom.

adsboro, Vt.

## Kerosene and Boiler Compounds

I have had charge of the plant at a flouring mill for the past six years, and have been familiar with its character for at least ten or twelve years. The plant consists of an 18 foot by 72-inch high-pressure return-tubular boiler, a 14x36 Corliss engine, a Smith Vaile heater and filter, and other apparatus. Until about two months ago we were using water from a well at the plant, with most unsatisfactory and damaging effects, on account of the impurities, which consisted of some of the worst incrustating solids known to chemistry. The result was a bagged boiler about eight years ago, followed by internal corrosion until the boiler is no more safe for high pressure, but has been reduced to 120 pounds, with prospects of further reduction or being condemned after a service of only nine years.

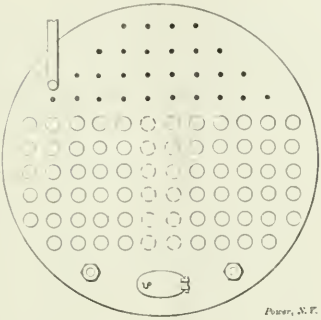


FIG. 1

There have been several kinds of compound used, and kerosene was also used several different ways, with no results whatever. We were able to keep the bottom of the shell fairly clean by constant scaling, and also between the tubes vertically, but were unable to reach the scale between the tubes crosswise. All kinds of kinks were suggested to knock out the scale, but they were of no avail as the scale was so hard, and packed so solidly between the tubes that radical means had to be resorted to if the boiler was to be cleaned.

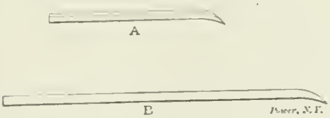


FIG. 2

I suggested to the manager to let me remove the two center rows of tubes vertically and replace them. The tubes were ordered and in June (which is the overhauling season for most mills) I removed the 12 tubes in the center, as shown in Fig. 1, giving a space of 11 inches to work in. Then I had tools made of $\frac{5}{8}$ inch tool steel, as in Fig. 2. The tool *A* was 12 inches long and was used until the second row on both sides was cleaned, using it as chisel and hammer; then enough was welded on to reach the next row, etc., until the chisel was 24 inches long, as at *B*, Fig. 2, so as to go clear through the tube. The point was drawn out all one way as with a wood chisel and slightly curved better to hug the tube; and was made $\frac{3}{4}$ inch wide and well tempered and sharp. The writer, with the help of another man, put in three days of hard work and removed 1400 pounds of scale from among the tubes alone.

The expense for the tubes and putting them in (which I did myself) was about $75 and since this we are saving at least 1 ton of coal on a 24-hour run. Two months ago we began using city water (the waterworks being just completed) and find it so far superior to the water from our own well that instead of cleaning the boiler every two weeks, as formerly, we clean every four weeks, have fewer impurities to contend with and no injurious effects. The use of kerosene or compounds may be O. K. for some waters, but I must say they have been a total failure with this place.

Edward C. Billau.

Moundridge, Kan.

## Electrical "Don'ts"

Don't use too much oil on commutators.

Don't use waste around commutators or windings.

Don't use emery on commutators.

Don't let commutators get rough and black.

Don't wear out commutators needlessly by turning, "sanding," etc.

Don't let dust collect on any electrical apparatus.

Don't let carbon brushes become too short or stick in the holder.

Don't let copper brushes go too long without a thorough cleaning.

Don't close or open a switch until you know it is safe to do so.

Don't open the field circuit when the machine is running.

Don't close slowly a switch that carries a heavy current. Close it quickly and let the breaker do its work.

Don't break heavy currents with hand-operated knife switches. Open the breaker first.

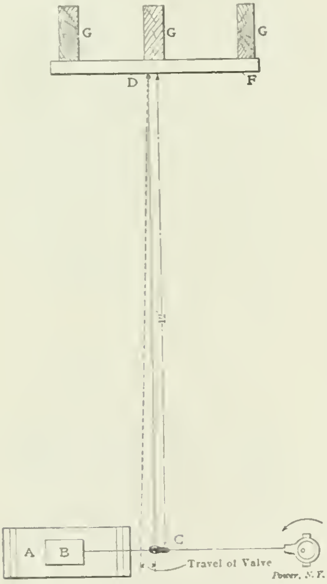
Don't touch any electrical apparatus or wires unless you know the voltage and are sure it is safe to do so.

Harry J. Burton.

Schenectady, N. Y.

## A Quick Repair

About twelve years ago I was working for a firm in Philadelphia. One day when we had a rush of work on the engine, a small high speed one, a cast-iron bracket which acted as a guide for the valve stem was broken. The repairman who did all of our repairs sent an ex marine engineer, and the way he did the job is worth telling. He told the boss that it would take at least four days to fix the broken bracket for a pattern, get a casting and machine the casting to fit. This nearly gave the boss a fit. He wanted the job done and the engine running at once. The man said: "If you are very anxious to get started I can get you going inside of an hour."



HOW A QUICK REPAIR WAS MADE

The sketch shows how he did the job. At *A* is the cylinder; the crank ran under as shown by the arrow; at *B* is the valve chest and *C* the knuckle joint. The travel of the valve was not more than 2 inches at most. The joists *G* were at least 12 feet above the engine. The man fastened a piece of wood *F* to the joists and screwed a lagscrew into it perpendicularly above the knuckle joint *C*, to which he fastened a piece of stout wire. The other end of the wire he fastened to the lagscrew *D*. As the engine ran under, the weight and friction of the eccentric strap on the eccentric tended to draw the wire tight. It looked like a flimsy job, and the boss was afraid of it, but the man stood on the knuckle joint to show that it was all right. The whole job took about an hour. The new bracket was ready to put in about four days later, but the boss was so pleased with the repair, and we were so busy running night and day, that the new bracket was not put in for a long while.

S. Wolfson.

New York City.

## Bearing Troubles

Following is an account of trouble I experienced with the bearings of a three-phase alternator: The generator is rope-driven, 160 kilowatt amperes, 3000 volts. There is a bearing on each side of the inductor and an outer bearing outside the pulley. The exciter armature is overhung, and on the opposite side of the generator to the driving pulley.

All three bearings were lined with white metal. The bearings wore rapidly, the wearing surfaces appearing to have been eaten away, as if by chemical action. The shaft was badly cut up, the cutting taking the form of very fine lines in the plane of revolution. The oil was charged with fine steel particles which formed a brush-like growth in the oil-ways and the space between the bearing and shaft. The shaft was strongly magnetized and the brush formation was due to the particles of steel spreading out, as steel filings do when sprinkled over paper in a magnetic field.

We tried various oils, with no relief. We tried several classes of white metal, all well known brands, and still the cutting action went on. There was no heating of the bearings.

After many trials I concluded that, owing to the stray magnetization of the shaft, any small particles of steel, removed say by a little grit getting into the bearing, stuck to the shaft, and as the inductor was more or less floating, they were carried around. When the load varied so as to allow the shaft to rest somewhat heavily on the bearing, these small particles were driven into the soft white metal, acting like so many small steel tools, thereby continuing the cutting action until the shaft was all cut up.

I may of course be wrong in my deduction, but I am inclined to think that I was not very wide of the mark, because by changing the bearings to a hard silicate bronze, which would not form a bed for the steel particles, the cutting entirely ceased and the bearings gave no further trouble. The same oil which we used when the bearings gave trouble is used with the new bearings and it remains clean, whereas before it always ran black from the white-metal bearings.

We changed our bearing metal seven times.

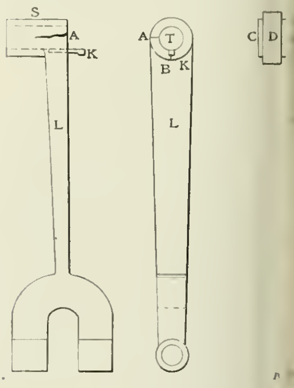
M. C. Gillean.

Barcelona, Spain.

## A Pump Lever Repair

The long lever *L* (see sketch), o 10 and 6 by 10-inch duplex feed pump veloped two cracks, *A* and *B*, where keyed to the rockshaft, and as the tinuous winking of these cracks ca the key *K* to become loose, I though repairing it, as my employer will not anything more at present because we soon occupy another building.

I rummaged the scrap heap unt found a wrought-iron ring *D*, which, properly bored to size, would still ⅛-inch thickness left. The hub *S* smoothed on the outside by a file, a lathe would not swing it. The ring *D* bored large enough to make a shri fit over *S*; a piece of wet waste was in the eye *T* of lever *L*, the wrought ring was heated to a bright red, on the end of *S* deep enough to there, and then the whole was set i vise. The ring was driven by the flush with the face *C* of the eye.



A PUMP-LEVER REPAIR

The ring was not wide enough to the bottom of the hub, where it most use, and for this I had in re one-half of a 2-inch flange union had on the inside face a recess that allow the hub to enter, but not th By setting this flange between t *C* and the jaw of the vise and tig it, the ring was forced as far tov as possible.

The whole operation of course w in a twinkling. A tiny stream o was run on the soaked waste in few seconds, then the whole was qu put up and the key driven home. this time it seems to be working any trouble.

Alexander Dol

Jamaica, N. Y.

A good stoker or furnace po y set is of less value than a poor st er r furnace well set. Good install on of furnace equipment is necessary.

# Subjects Under Discussion

Comment, Criticism and Debate upon Various Articles, Letters and Editorials Which Have Appeared in Previous Issues

BRING OUT YOUR IDEAS

## Reducing Rig for Vertical Engines

In the September 14 number, Mr. Smallwood answers my criticism of his reducing rig shown in the issue of July 6. He states that he is not at all convinced that his device will not work.

Allow me to state that with a 2 to 1 reduction it unquestionably will work, and might be made to work fairly satisfactorily with a 3 to 1 reduction under circumstances giving a moderate speed and short cord. It must be remembered, however, that vertical engines of small size usually run at a piston speed of from 600 to 800 feet per minute, which will naturally determine the rotative speed of the engine if the stroke be given.

With a 4 to 1 reduction or a 16-inch stroke, the speed will be approximately 5 revolutions per minute; and at this speed it will be necessary to use a comparatively long cord. As there are four parts to the cord, the spring of the drum or auxiliary spring will have to be pretty strong in order to take up the slack of the four cords and follow up the speed of the engine. This being the case, it will require a pretty strong pull on the cord to pull back the drum or spring, which will naturally result in more or less stretching of the cord; and besides this there are the friction of the pulleys and the inertia, as Mr. Smallwood says, of the pulley device. As the engines become slower and slower in speed, the natural consequence is an increase in the length of the stroke, as the piston speed remains practically constant, and an increase in the length of the stroke will mean an increase in the number of pulleys required in order to make the reducing motion correct. The probabilities of stretching the cord and inertia of the pulleys due to their increased weight will be increased.

Unquestionably the same holds true in any form of reducing motion, such as a reducing wheel; but does not hold with a well devised parallel motion. It is not difficult as a rule to adapt some sort of a parallel motion to almost any type of vertical engine; but in doing so, it is essential that the joints be so made that all slack can be readily taken up so as to reduce lost motion. Otherwise, the cords will be more or less distorted.

As a valve-setting device, Mr. Smallwood's suggestion seems to be a very good one; but for the purpose of indicating an engine for power purposes where accuracy is desired, I should doubt its efficiency in any case where greater than 2 to 1 reduction is required. The engine on which the device was tried with a 3 to 1 reduction ran at 220 revolutions per minute; its normal speed was 225.

Henry D. Jackson.

Boston, Mass.

## Sluggish Governors for Parallel Operation

I note in the September 14 number an article by F. J. Foote on sluggish governors for parallel operation, and wish to express myself as being thoroughly in accord with his position.

For successful parallel operation, generators should not be of too close regulation in themselves, that is, they should have a considerable armature reaction. The prime mover should be steady-running, having a uniform turning moment which may be obtained through the use of a properly designed flywheel; or it may be necessary, for successful operation, to have the units so synchronized that the cranks of the engine operate in synchronism. The governors should be sufficiently damped to prevent overrunning. Otherwise, hunting will be set up, and parallel operation become almost impossible.

Similar results can sometimes be secured through the use of damping devices on the poles of the generators, or the use of solid poles or amortis winding.

It may be the generators with which Mr. Foote had to deal were designed for very close regulation and not expected to be used in parallel. It is advisable when purchasing generators for a power plant to look far enough ahead to see whether or not they are likely to be used in parallel; and to purchase machines which have sufficient reactance in their armature to insure good parallel operation if the engines are adapted to the purpose. To adapt the engines to the purpose, it is necessary as a rule to damp the governors to a considerable extent, unless the engines have an exceedingly uniform rotating effort and the governors are inherently slow in action.

Henry D. Jackson.

Boston, Mass.

## Setting Gas Engine Valves

Why does not Louis J. Buschman in his letter in the August 24 issue, go on and tell us whether the engines he and Mr. Abegg had in mind were single- or multicylinder, if he has found that multicylinder gas engines require different valve setting than is the case with a single-cylinder? Tell about it.

All the so-called textbooks that I have consulted agree with Mr. Buschman as to opening the exhaust valve ahead of the center, but agree with me that the exhaust should close at the inboard center.

Albert H. Ziegler, in a recent issue of *The Rudder*, dealing with "Marine Engine Cams," had this to say in part: "Care should be taken to prevent the closing of the exhaust valve and the opening of the inlet valve from coming so close together as to allow slight wear of the seats to cause them both to open at once, otherwise backfiring through the inlet pipe will result." And yet one of your correspondents advocates holding both of these valves open during 60 degrees of the crank travel.

Mr. Buschman's quotation from the *Century* is correct in every detail, but to those who have access to the back numbers of the *American Machinist*, let me commend a series of articles entitled "Force in the Steam Engine and its Relation to Smooth Running," by Prof. Joseph Torrey. These articles go into the question of inertia somewhat more fully and are much more illuminating than the brief definition in the *Century*. (See the Volumes for 1888 and 1889). The diagram shown with Mr. Buschman's letter is not true to life, insofar that when the exhaust valve opens as designated by him, the pressure is shown as dropping through a curve that never had a counterpart drawn by a real indicator on a gas engine or any other reciprocating engine, driven by an expansive fluid, while releasing the gas at the end of the stroke seems to have so changed its nature that it positively refuses to leave the cylinder until pushed out by the returning piston.

If Mr. Buschman will "investigate a little" he will find that the behavior of gases under pressure depends on certain natural laws, and when drawing curves to show how gases perform under certain conditions, it is just as well to bear these aforesaid natural laws in mind.

If a 65-foot exhaust pipe will create a

partial vacuum at the cylinder, how long would a pipe have to be to put a steam condenser out of business?

In questioning my comparison of the mode of operation of a gas engine with an air compressor, I think Mr. Buschman makes a distinction without a difference. He goes on to say that "during both the inlet and exhaust strokes of a gas engine the gas is flowing from a higher to a lower pressure." I have never been able to make either gas or air flow anywhere under any other conditions, and if Mr. Buschman can do this he has made a wonderful discovery.

Does not Mr. Buschman make the very common error of taking "all of the textbooks" at their face value?

*Century* defines a textbook as one that is accepted as standard in any branch of study. Such a book, dealing with the gas engine, may be published at some future time, but is hardly in point now, simply because gas-engine practice at present is a mighty hazy proposition, and standard practice will come before the book telling about it does.

The point that I have been trying to make from the start is that any rearrangement of the valve gear from that intended by the designer is, in gas-engine practice, very liable to lead to disaster as far as economy is concerned. This question of "designing a new cam" is the point that should be combated. There are isolated cases, no doubt, where peculiar local conditions might suggest the advisability of alterations, but even then, all of the facts in the case should be put into the hands of the builder of the apparatus, thus giving him an opportunity to point out that stumbling block that lies in the path of the novice, not only in gas-engine design but in every line of endeavor.

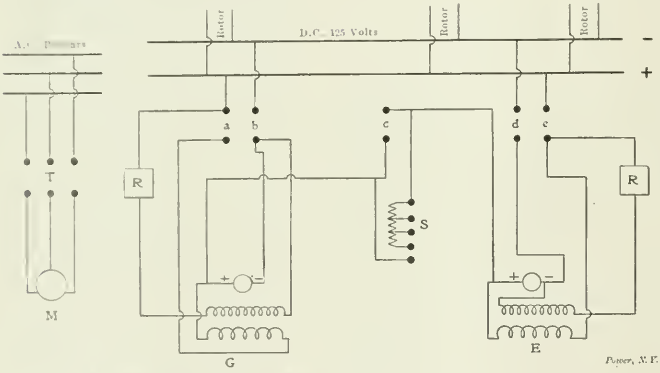
Before spending any money on offhand designing, the reader's attention is invited to an editorial on page 249 of the August 10 number of POWER, entitled "Think It Over First." If the readers of this journal would act on the advice given therein, that one editorial would be worth about a million dollars to the makers and users of power-plant apparatus.

F. G. TILDEN.

Downers Grove, Ill.

## Exciter Phenomena

In answer to L. Earle Brown on exciter phenomena, in the September 14 issue, I should like to ask what is to prevent current running from the positive side of *G*, through the equalizer switch *c*, through the series fields of *E*, through switch *c*, to the positive bus and switch terminal of *a*, through rheostat *R* of machine *G*, through the shunt field to a switch terminal *b* to the negative side of machine *G*. This will give a field on *G* and naturally allow it to be built up to a voltage depending on the speed of rotation.



HOW THE EXCITER CONNECTIONS WERE MADE (REPRODUCED)

HENRY D. JACKSON.

Boston, Mass.

## Saving by Throttling Steam

In the August 24 issue, H. H. Bliss explains that at 100 pounds pressure, if steam is throttled to 80 pounds pressure it will be superheated 10 degrees. There has been one point left out and it was my fault.

Saturated steam, when it reaches the engine, has from 2 to 5 per cent. moisture. Suppose it has 2 per cent.; then 1 pound will have 0.32 ounce moisture to be evaporated. It has 327 degrees and requires 966 for evaporation, less the 327, or 639 degrees. One ounce will require 39 degrees and 0.32 will require 12.48 degrees. To do this we have 10 degrees and none left for superheating.

W. E. CRANE.

Broadalbin, N. Y.

## Boiler Room Economy

In the August 3 number R. Cederblon proposed a regenerator arrangement fo recovering heat from the waste chimney flue gases of boiler furnaces, the heat s recovered to be applied to warming th air supplied under the grates. This ide is perfectly feasible and was, in fact, car ried out some years ago in some tests b the United States navy department, b the air heater proposed by Mr. Cederblo would not be the most suitable type, f a number of reasons. For one thing, u less the plates in the smoke flue we very close together there would not sufficient heating surface. Second, would be quite impracticable to keep t heating surface free of soot and du Third, with large passages, there wou be a tendency to stratification, and sin both air and gas are very poor conduct of heat, the transfer of heat would be as large as might be expected.

However, a waste-heat air heater been placed on the market in this coun in which these objections have been ov come. The apparatus is similar in g eral construction and operation to Green fuel economizer, except that air stead of water is circulated through pipes. The pipes are placed vertica as in the fuel economizer, and are ab the same size, and the accumulation soot thereon is prevented by autom scrapers.

In experiments with this apparatu has been found that the transmission heat is approximately proportional to average difference between the temp ture of the waste gases and the temp ture of the air, being also directly pendent upon the velocities of the air gases in a manner which agrees with results lately obtained by the U States Geological Survey, viz., that tr mission increases almost directly wit velocity of the gases. It has also found that the transmission can be further increased by the use of sui spirals and wings to break up the cur of air through the tubes and brin particles of air in contact with the of the pipes.

Of course the best manner of util any waste heat in a steam plant i preheating the boiler feed water, because of its low temperature and capacity for heat will absorb the much more readily and with less h surface than will air. This points t use of an economizer rather than hot-air heater or regenerator, but ere the boiler feed water is already ted to a high temperature, or where ted air is needed for some other pu se, the hot-air heater will prove a go investment.

FRANK J. MCMAI

New York City.

## Sewer Gas in Boilers

I read with interest the articles on the ove subject in the July 20 and August numbers. When I was second engi- er of an Atlantic liner sailing from e river Clyde, I had an experience hich was interesting.

Before the installation of the sewage- eatment plant at Dalmins the Clyde ed to become very "strong" in the sum- r months. We were lying at the y during one of these periods, and sent the third engineer to open up a ve through which we had been pump- Clyde water. He had an open lamp h him, and when he lifted the cover explosion took place and he was r severely burned.

On making inquiries I found that this s not an isolated case, as I was told an explosion which had occurred when k g off a condenser door. Probably ixture of air and marsh gas made xplosive mixture.

M. C. Gillean.

Barcelona, Spain.

## haracteristics of Bituminous Coals and Low-Grade Fuels

the September 7 number C. M. Ripley n article on coal which explains it- t but I should like to call attention e paragraph, headed "New Unit Sug- d," where he copies: "How many s of water are evaporated for $1?" speaks of it as an "original method." tests, of which I gave the results ree, were a part of this method used y years ago. So many pounds of er evaporated per pound of coal, and costs so much per ton. One dollar's f coal evaporates so many pounds ater. This method has been in prac- r years; there is nothing original t it.

f late there is talk of the B.t.u. in but it is no improvement over the l of learning how much water one r's worth of coal will evaporate under boilers, under certain conditions.

mentions "fixed carbon." There s t in this vicinity that made lots of , and there came along a man who sed to stop all smoke and save 25 cent., but said it would have to be with a coal composed of "fixed car- He put new grates under two rs, a steam blower and a few pipes rear of the bridgewall, used No. 2 kwheat, and showed by figures that saving was 26 per cent.; and he rged them $850. They claim to be aporating 10 pounds of water under ual conditions with one pound of No. 2 uckwheat coal. How is that for good ults with a fixed-carbon coal?

Mr Ripley says, "per pound of coal ans very little." We purchased our coal by the ton. We wanted to know how much water each ton of coal would evaporate, and the temperature of the water was reduced to the one standard; that is, we were getting at the amount we could afford to pay for coal from any of the different mines. All data were taken and tabulated, but the interesting point was: How much does it cost to evaporate 1000 pounds of water?

We had one boiler fitted up to make tests, and we could switch a test in any time. The test was begun at noon and continued two days, so as to include the amount used for banking the fires. The amount of coal burned per square foot of grate was about 12 pounds; the per cent. of ash: Egg, 10; Clearfield, 5.7; George's Creek, about 5.7. The moisture in the steam ran about 2 per cent. We used an egg-coal fire, about five inches thick under the Harrison boiler.

W. E. Crane.

Broadalbin, N. Y.

## Cooling the Exhaust of a Gas Engine

If I am not mistaken, some of the statements of H. B. Stilz, on page 454 of the September 14 issue, are more apt to prove misleading than those of the editors. In his seventh paragraph he says that the amount of work obtainable from an engine depends on how far the working fluid expands in the cylinder before release, regardless of the pressure against which the piston must force out the exhaust; but this is not strictly true.

It is true that the amount of energy obtainable from the working fluid depends on the temperature range, but part of this energy may be expended within the cylinder, to drive the piston as a compressor piston, to force out the exhaust gases against the back pressure, just as part of it is expended within the engine to overcome friction.

If a condenser is connected to the exhaust of a steam engine, running with a fixed cutoff and initial pressure the pressure at release and the temperature range will not change, although the back pressure is reduced and the engine generates much more power on the same steam consumption, which is shown by the increased area of the indicator diagram. The amount of energy obtained from the steam will be just the same as before, but this is a different quantity from the amount obtainable from the engine. This holds equally true with the gas engine and if the back pressure on the exhaust pipe could be reduced, the engine would have more power with the same temperature range and fuel consumption.

It is also true that a condenser may be used to advantage with a gas engine, for such a device is being used on one make of marine gasolene engine. This condenser has no vacuum pump but depends on the sudden shrinkage of the exhaust gases, when they come into contact with the cooling medium, to reduce the pressure. Of course the reduction is not as great as it is in a steam condenser, but the pressure is reduced to a sufficient extent to make it worth while.

S. M. Dunn.

Groutdale, Ore.

## Preventing Scale

The water purifier described by Charles Haeusser in the August 31 number is interesting as a sample of the homemade contrivances which engineers sometimes get up to do work which can be done better by commercial apparatus specially designed for the purpose. It is true that it is not always easy for an engineer to persuade his employers that improved apparatus is necessary, and if he is to have anything at all he may be forced to rig up some device of his own. But quite as often the installation of these crude contrivances is due to lack of familiarity with the latest improved appliances on the market, a lack which could be remedied if engineers would systematically read the technical papers (including the advertisements), and preserve classified files of clippings and catalogs on subjects relating to their work, as other business and professional men are compelled to do in this age of rapid advancement.

Returning to the water-softening apparatus, I would point out that the combination of ejector-heater, storage tank and chemical-solution pump devised by Mr. Haeusser performs only indifferently the work that would be better done by a regular hot-process system of water purification. In the first place, Mr. Haeusser obtains with his siphon condenser a temperature of only 160 degrees Fahrenheit, whereas 210 degrees can easily be secured in an open heater. This is quite an important matter, as the extra temperature is necessary to insure complete release of air and carbonic-acid gas, and precipitation of carbonates. It is also important from the standpoint of fuel saving, as the fifty degrees means about 5 per cent. in fuel. Further, the higher the temperature, the better is the reaction of the chemical introduced to transform the sulphates, chlorides, nitrates and other impurities which cause "permanent" hardness in the water.

After heating and treating the water, Mr. Haeusser puts it through a closed heater, but a closed heater is a very undesirable part of a purifying system, since it will soon become filled with impurities thrown out of solution by the chemical treatment, especially in the present case, as under the influence of heat in the closed heater the chemical reactions will be completed there. Then again, Mr. Haeusser has provided no water storage r sec [illegible] capacity for the water after heating, which, if provided, would relieve his filter of a good deal of its work, so that it would not require cleaning so often. The sand and gravel type of filter which, from the drawing, Mr Haeusser appears to have adopted, is peculiarly subject to clogging, and Mr. Haeusser has provided no automatic bypass around the heater, which is really an essential part of a hot-process apparatus.

From the reference to phosphate of lime, I judge that Mr. Haeusser is using tri-sodium phosphate for treating the water, and would point out that this costs about 2½ times as much as would soda ash, and gives no better results, although the phosphate of lime produced with the tri-sodium phosphate is, I understand, valuable as a fertilizer if it can be recovered.

Still another point: In Mr. Haeusser's apparatus the returns are pumped into the tank together with the raw water and chemical, which is permissible if the returns do not form a very large percentage of the boiler feed, and are reasonably constant in amount; otherwise, they should be heated separately, so that they will not dilute nor interfere with the water undergoing treatment.

Mr. Haeusser's arrangement is undoubtedly better than none at all, but in this day no man makes his own shoes, and there is even less reason why he should build his own hot-process softening system.

George H. Gibson.

New York City.

## Why Initial Pressure is Higher on Crank End

A. C. Browne presents some indicator diagrams in the September 14 number and asks why the initial pressure is higher on the crank end. Probably most of us, at some time, have asked that question and yet the answer is very simple. In fact the difference should be expected. As is well known, on the head end stroke the piston reaches half-stroke before the crank does, that is, the piston travels faster (relatively to the stroke) than the crank. Similarly, on the return stroke the piston travels slower than the crank. Since the crank revolves at fairly uniform speed it follows that the piston on the first half of the head-end stroke travels faster than on the return stroke. Steam is able to follow the slow crank-end stroke more closely than the swift head-end stroke and this gives higher steam lines on the crank-end diagrams. It is for this reason that many engines have valves set with less lead on the crank end.

The release is late in Mr. Browne's diagrams, especially on the crank end, and I should think it would be well to remedy that fault. Not knowing the make of engine I cannot give directions.

William E. Dixon.

Hudson, Mass.

I should say that the crank-end diagram usually shows a higher initial pressure than the head-end, due principally to the angularity of the driving rod, which causes the piston to move more solwly from the crank end than it does from the head end, thereby permitting more time and, consequently, a higher initial pressure on the crank end.

In this case, however, the trouble is somewhat aggravated by the fact that the crank end has a greater lead than the head end; if Mr. Browne decreases the lead on the crank end, or increases it on the head end, he will get diagrams that will more nearly coincide.

Charles J. Halloran.

Avoca, Penn.

In the September 14 number, A. C. Browne asks the cause of difference in hights of indicator diagrams. He states that the valve is not at fault. This difference in hight may be due to some constriction in the pipe connection corresponding to the lower card or to pipe connections of unequal length. It may also be caused by lack of symmetry in the connections. It would be better to use two indicators, one for each end of the cylinder, and make the connections as short as possible. By calibrating the springs and taking cards simultaneously, the indicated admission pressures should prove to be equal. If there is any difference, the pressure will be less in the head end of the cylinder, since for the first part of the stroke the velocity of the piston is greater for the *out* than for the *in* stroke. This, however, should hardly be noticeable.

John S. A. Johnson.

Blacksburg, Va.

## A Practical Study of the Chain Grate

The writer of an article with the above title, which appeared in the August 24 issue, hardly went into the particulars in sufficient detail. I should like to see explanation made of the saving through the use of mechanical stokers. A stoker when built for a finer fuel will cause better combustion than a stationary grate with natural draft, because the stationary grate holds the clinkers, whereas the stoker, moving all the time, keeps its surface clear, thus allowing the air to penetrate more freely; but the waste in the ashpit will be a great deal more with the movable than with the stationary grate. Seemingly, a test could be made of these stokers, giving the equivalent evaporation with a B.t.u. value of fuel. Then we would be able to judge the advantages the stokers.

The writer of that article also stat that the extension of the arches is i creased or diminished according to t wishes of the installing engineer, dis garding entirely the wear of the arch and stokers, on account of the excess heat caused by the extension of t arching.

V. Mackay.

Boston, Mass.

## Cylinder Lubrication

I believe the amount of cylinder we use shows fair economy. We use hydrostatic lubricator of good ma which we find to be reliable. One jection to this form of lubricator is t variations in the temperature of the gine room cause considerable change the rate of feeding. A cool wind bl ing in at the door or window will ret it considerably. The force-feed lubrica is much less affected or perhaps not all.

Manufacturers and agents of force-f lubricators tell us that as the drops smaller a more continuous flow can secured with the same quantity of and consequently a more effective lubri tion, thus permitting a reduction in consumption of oil. So we fill our sig feed glass with strong salt water glycerin, which makes the drops m smaller, probably not much larger t with the force feed, although the cy drical glass full of water makes th look larger than they really are.

Our engine is a Corliss, 16x36, runn at 95 revolutions per minute, rated at horsepower. It runs twenty-four hou day. We also have a boiler-feed pu a deep-well pump, and a general-ser pump, but the last is not used much.

On April 10, 1908, we emptied a ba of cylinder oil containing 60 gallons it lasted until May 29, 1909. Of thi gallons was sold to a neighboring pl leaving 55 gallons to be used in abo year. Some of this was used mixed graphite, for gaskets of various kind little for hot bearings about the mill, we also use cylinder oil on the valve g We do not give the pumps much oi they run slowly. Many people was great deal of oil on their pumps, as be seen by the quantity that oozes thr the gaskets and runs over the pump. cannot tell just how much oil the en takes, but from the foregoing it ca seen that it does not take more than gallons a month, and probably less. how long a quart will last we cannot exactly, as we aim to refill the lubric before the oil disappears from the glass, but it frequently lasts from th six to forty-eight hours. We feed 2 to 3 drops a minute. We use a grade of heavy oil, worth about 50 cents a gallon, and find it very satisfactory.

The factor we have found to be of greatest importance is the condition of the piston rings. If they are worn to a sharp edge they scrape the oil from the walls of the cylinder, largely increasing the quantity needed. Once the rings in our piston became worn in this way, and it took several times the usual quantity to keep it quiet. Rounding off the edges of the rings cured the trouble.

In one plant here they have a slide-alve engine of about 150 horsepower, ıning at about 100 revolutions per min te, and the superintendent told me that t took a gallon or more of oil per day of ig t or ten hours to keep it quiet. I n't know what was the condition of the ston rings, but I imagine they had someng to do with the excessive quantity f oil used, as I doubt if the piston had een examined for some time.

C. E. Howland.

Washington Court House, O.

Herewith are some data about our en nes and the amount of cylinder oil we d each month during the first five nths of 1909. For our 24x48 Allis-almers Reynolds-Corliss, running conısing, 12 hours a day, at 83 revolutions r minute, with an average vacuum of 3 inches, we used in January 13 gal : February, 12½ gallons; March, allons; April, 11¾ gallons; May, 12 llons.

For our 14x36 Bates engine, running ndensing at 81 revolutions per min , 12 hours a day, we used in January, 8 ns: February, 7¼ gallons; March, gallons; April, 7¼ gallons; May, 6½ ns.

r our 16x36 Vilter, running 15 hours day at 80 revolutions per minute, we d in January, 11¾ gallons; February, gallons; March, 11 gallons; April, 12 ns; May, 10¾ gallons.

T. C. Hill.

Beaumont, Tex.

Our 14x36 Corliss, at 100 revolutions minute, will not run satisfactorily on than one drop of "600 W" cylinder oil 25 revolutions.

r 10x10 automatic, at 300 revolutions nute, will "speed up" (due to the ss of the valve affecting the gov r arms) on less than one drop of W" oil per 100 revolutions.

d that if either of these engines is iled for a month, the oil will stand ing for a longer period than if they recently been allowed to run a little d

R. Manly Orr.

Brantford, Ont.

Ve use about 1½ pints of cylinder oil p day of 10 hours on our 16x38-inch p-cutoff engine, running at 92 revolutis per minute. It is a compounded oil containing about 5 per cent. acidless animal fat (tallow). It costs about 43 cents per gallon. The lubrication is perfect and though we use returns from heating system which come into the hotwell with an overflow, we have never been troubled with oil in our boilers. Of the lubrication of other engines and pumps in the plant we have no exact record.

D. M. Overman

Dracut, Mass.

I find that in the plant under my charge the amount of oil used by each engine bears a close proportion relative to their horsepower. I will therefore confine the data to one engine, a 20 and 36 by 48-inch cross compound condensing unit. After considerable experimenting in an effort to determine the least amount practicable to use, I have settled on the following for a nine-hour run: For the high-pressure cylinder, 3 quarts; for the low-pressure cylinder, 2 quarts. This is with about 100 degrees, Fahrenheit, superheat, but a low receiver pressure and a reasonably good vacuum.

O. J. Anderson.

New Brunswick, N. J

We have a 12x30-inch Fitchburg engine running at 100 revolutions per minute with 90 pounds steam pressure. We use a three-pint Rochester force pump and one filling lasts for a week of 54 hours. The oil costs 45 cents a gallon.

B. W. Thwaite.

Framingham, Mass.

Our engine is a 16x30-inch slide-valve type, with throttling governor, and runs at 126 revolutions per minute on 95-pound steam (gage) pressure. We use one pint of Capitol cylinder oil every ten hours.

B. Jarvis.

Toronto, Ont.

## Water Wrecked Compound Engine

Referring to the letter in the August 24 number headed "Water Wrecked Compound Engine," I thing it strange they had to put a ∩-formed section of the exhaust pipe on their engine to keep the water out, even if the water was near the condenser. We have no trouble where I work with the condensers at least 9 feet below the water level, and less than 3 feet from the cylinder. With a gate in the 6-inch line from the pond to the condenser we regulate the water supply as it is needed, but should we open the gate full and let the condenser have all the water it will take, of course we would have trouble at once.

As the engine mentioned in the article made about 20 revolutions, I think their suction gate must have been opened too much. The vacuum had risen to 21 inches, which would draw the water with a rush until the condenser and cylinder were full, which would lower the vacuum to zero. This would not have happened it the water had been throttled sufficiently. When the engineer stopped the engine, if he had broken the vacuum at about the same time he closed the throttle, it might have prevented the first wreck.

J. E. Estes.

Ponemah, Ill.

## What Caused the Air Pressure?

Replying to Louis B. Carl's problem on page 500 of the September 21 number: He doesn't explain the details of the centrifugal-pump connections, nor does he give the reason for the priming pipe being tapped into both the suction and discharge pipes, for it would seem that one connection should be sufficient.

But it is assumed there is a vent cock at the top of the pump casing to give relief for the air while the pump is filling, and through which the water will spurt when the level reaches the top of the pump. The pump is then apparently full of water and ready to start; but it is a fault of design of a good many pumps that there is opportunity for air to be entrapped in the suction passages of the pump when priming. This air, if in any quantity, remains in the eye of the impeller, while the much denser water is thrown to the outside, preventing the pump from picking up its water.

The following is probably the simple explanation of the air pressure found in the suction pipe: When water appears at the vent cock it is usual to close the cock as quickly as possible, which can be done by instantly turning the thumb key or lever. The globe valve in the priming pipe is then closed; but this takes an instant longer, which is sufficient time for some pressure to build up in the pump before starting.

The air pocket prevented the pump from picking up the water and the pressure found in the suction pipe after the pump was stopped was the same pressure which was there before the pump was started.

R. R. Pratt.

Lynn, Mass.

The air was compressed in the suction pipe during the operation of priming the pump, and as no vacuum was registered after the pump was started, and as I presume that the discharge pipe was filled with water, there was no chance of the pressure being dissipated. The impeller of a centrifugal pump is not air-tight unless sealed with water. If the vacuum gage had been removed during the operation of priming, air would have issued from the connection while the pump and suction pipe were being filled.

John Hurst.

Louisville, Ky.

POWER
AND THE ENGINEER

DEVOTED TO THE GENERATION AND
TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.
355 Dearborn Street, Chicago.
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of POWER solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "Powpub," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During 1908 we printed and circulated 1,836,000 copies of* POWER.

*Our circulation for September, 1909, was (weekly and monthly)* 141,000.

*October 5* ............ 42,000
*October 12*............ 33,000

*This paper reaches 42,000 separate readers each month and 33,000 each week.*

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*

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# Boiler Explosions in Great Britain and America

During the year ending June 30, 1908, there were in the United Kingdom of England, Ireland, Scotland and Wales seventy-three failures of steaming apparatus on land and water. This list includes all accidents to boilers, pipes, steam chests, steaming tanks and coffee urns. In all, twenty-three persons were killed and fifty injured.

Deducting from the seventy-three failures the thirty-eight which occurred in pipes, valves, cylinders and other supplementary apparatus, thirty-five boiler explosions proper occurred, out of a total of more than 150,000 boilers in operation, causing an aggregate of fourteen deaths and twenty-three injuries.

While it is not possible even approximately to estimate the number of stationary and portable boilers in use in the United States, it is known that during the same period there were some 470 explosions, with a death roll of 281, or about fourteen times as many explosions and twelve times as many deaths on land alone as on land and water in Great Britain.

In the United States there is no Federal law governing the operation and inspection of land boilers, either stationary or portable, and only five States have such laws and not all of these furnish adequate protection to steam users; and in the majority of large cities there are not proper regulations pertaining to the installation, inspection and operation of steam boilers.

While, in Great Britain, the laws are few and simple they are enforced. When an accident to a boiler or its attachments occurs, the owner or user is required to notify the Board of Trade, by which an official investigation is made. The usual course of procedure is an inquiry into the cause of the failure, the management, upkeep and inspection, by two commissioners selected by the board, one of whom is an engineer and the other a barrister. These commissioners have the power to order the payment of costs, which are much in the nature of fines.

British methods may not be applicable to American conditions, but a comparison of the results brought about by the operation of a short, simple general law in one country with heterogeneous State laws, municipal ordinances and utter lack of law over the greater part of our own country, should, as Hamlet said, "give us pause."

Allowing that the population of the United States is approximately double that of Great Britain, we have seven times as many explosions and six times as many deaths per capita, and eliminating the minor failures of steaming tanks, rendering kettles and supplementary apparatus, the ratio is more than doubled.

# Misleading Answers to Engineering Questions

In our issue of August 7 a correspondent, under the inquiry, "Do You Believe It?" cites some questions and the answers which were evolved by their discussion by an association of engineers. Another correspondent now claims that the answers as given appear in a much-advertised handbook and wants to know in what respect they are wrong.

*How many pounds of water are required to yield one horsepower with our best engines?*

The society's answer to this question as furnished by our correspondent is "25 to 30." The handbook answer is "15 to 30." It is understood of course that in both cases "per hour" is meant. Had the answer of the society been that of the handbook, it is not likely that it woul have been questioned, although "our bes engines" do considerably better than 1 pounds. Of forty-eight two-stage compound engines tested by George H. Barrus, and listed in his "Engine Tests, published nine years ago, one-half did horsepower-hour on less than fiftee pounds and seven on less than thirteen In only three of these seven cases wa the steam superheated. Two triple-expansion engines which he cites give consumptions between 12 and 13 pounds, th lower 12.55 without superheat, the highe consumption, in the other case in whic there was some superheating, being du to leakage. There are numerous reliabl tests on record between 11 and 12 pound and with high degrees of superheat b tween 8 and 9. Guarantees of 15 poun per kilowatt-hour are not infrequent t day, so that the answer even of the han book is hardly correct for our best e gines, although it is a fair general est mate of the performance of compour engines of the better type.

*What is the consumption of coal p hour on a square foot of grate surface?*

The question as asked is too general its scope. There are places where t amount of coal fired per day divided the grate surface will not amount to mo than 5 or 6. In locomotive practice it 50 or more. In electric-station wo the tendency is to get more out of t boilers by high rates of combustion, a it is found that a boiler can be made do twice its rated capacity with so sm a falling off in its efficiency as to ma it better practice to force it than to put more boilers. But the question de with general rather than special practi Boilers are usually rated at 10 square f of heating surface per horsepower water-tubes and 12 for horizontal tubula If a boiler has 40 square feet of heat surface to one of grate, is rated on 10-foot basis, and requires 3 pounds coal per horsepower, it will have to have 12 pounds of coal per hour per square foot of grate, 10 pounds if it takes 4 pounds per horsepower. Lower ratios of grate to heating surface will increase this onsumption, more heating surface to the horsepower will reduce it. The answer s open to the criticism that it applies only average factory and office-building practice and is perhaps low for that.

*What is the water consumption in pounds per hour per indicated horsepower?*

This question would seem to mean the same as the first one and yet both the handbook and the society answer it differently from what they do the first. The handbook says 15 to 45, the society 25 to The lower consumptions are discussed above. The society is wrong in raising the lower limit, but we opine that water consumptions of 60 and above are not difficult to find.

## Waterhammer

The annual memorandum by the chief engineer of the Manchester Steam Users' Association, always looked for with interest, is this year especially valuable, containing as it does a review and study of the Board of Trade reports dealing with waterhammer in steam pipes. C. E. romeyer, the chief engineer of the association, has made a specialty of this subject and we have before had occasion to mention his work in this line.

Out of a total of 121 Board of Trade reports on waterhammer, nine cases were rejected as not having been due to this cause. The remaining 102 cases are classified and analyzed in the report under consideration. One of the greatest difficulties with regard to explosions in general and of steam-pipe explosions in particular must always be that the sudden loud report either obliterates the recollection of what was being done at the time, or a feeling that the handling of a cock or valve had in some mysterious way been the cause of these explosions, combined with the fear of being blamed, makes people minimize or wilfully forget what they were doing at the time. These tendencies and the deaths of those who were handling the exploded valves are the difficulties which engineers who inquire into pipe explosions have to contend with. Another difficulty, the result in part of that already mentioned, is the meagerness of the data. In not one of the 121 reports is there any scale marked on the drawings. In few instances is the thickness of the pipe mentioned, and in fewer still is the length of the pipe given. In no cases have any details been given of the uninjured valves, pipes, bolts, etc., and yet it is exactly these details which are best suited for giving valuable information as to the conditions which led to the waterhammer. These pipes which have stood severe shocks without actually breaking ought to be examined quite as carefully as others, even if for no other reason than to guard against a new accident after the inquiry has ended. In one or two cases the breaks were actually discovered after repairs had been made.

As a reason why the pipe is frequently broken circumferentially when a pressure one-half as strong would split it longitudinally, it is suggested that the fracture may be due to strains introduced from the distortion of the flanges near which such circumferential fractures usually occur. For instance, imagine a blank flange or cover packed with a thin, hard packing, extending beyond the bolts and clear to the outside edge of the flange. When the flange is bulged by the impact of a plug of water the flange of the pipe is turned downward, introducing a compression strain at the fillet which may be neutralized by the pull of the bolts so that no explosion occurs, while if the packing is a narrow one, entirely inside the bolts, the effect of the pull of the cover under impact and of the bolt hold tends to rend the pipe. Forty-eight cases are analyzed and illustrated, a study of which would lead to an avoidance of the conditions of design and operation which have brought them about.

## Make the Engineer an Expert

During the past few years improvement in the steam engine has chiefly consisted in putting into practice what was already known to be desirable. In this, as in most other cases, it was found to be one thing to know what was desirable, and another to accomplish it. Better plans of construction have rendered the use of high steam pressure and high piston speed more common, and these with better workmanship and attention to details have brought about better economy.

Improvements in tools and machinery for doing good work cheaply have had much to do with improving the construction of the steam engine, not only by affording the means for doing so, but frequently pointing out the direction for improvement. Aside from this the introduction of better instruments for, and better methods of, measuring effect has been important.

Steam engineering embraces not only the designing and construction of engines and boilers, but their management as well, and here there is room for general progress in the direction of better economy. If not a new field, it is one that has not been as extensively cultivated as it ought to be. Owing to long and persistent effort, users of steam engines have been fairly well educated in the economy of paying for good design and construction, but they do not, to the same extent, appreciate the value of good management, and are often of the opinion that there is not much in the way of economy in the everyday management of a steam plant, except what is comprised in stopping and starting, and in keeping up the motion for the required number of hours. Their interest ceases after hiring an engineer just competent for this duty, or employing a competent engineer who finds no cooperation from any quarter in his efforts to reduce expenses in his department.

In many instances money expended in necessary engine room appliances is looked upon as being thrown away, rather than invested where it will yield good returns. It is all right so far as paying for a good engine is concerned, but here interest dwindles, for the engine ought to take care of itself. How many owners of steam engines believe that a steam-engine indicator is one of the necessary appliances of the engine room, or that an engineer should be provided with convenient appliances for weighing coal and water supplied to the boilers? A good engineer is not particularly different from any other good workman. If he finds that no one is taking an interest in his efforts to reduce running expenses; that such appliances as he needs for economical operation and for determining results are refused or furnished grudgingly, with no interest manifested in their use, he will be reasonably certain to form easy-going, careless and costly habits. A contrary course from that indicated will as surely yield good results, for it may be set down as a fact that a thoroughly competent engineer is never satisfied when power is costing more than it ought to cost. Keeping expenses down is a part of his "stock-in-trade."

If owners of steam engines would look with some degree of interest to authentic records of fairly conducted tests and then compare these with their own expenses for power, it is probable in many instances they would see something startling in the difference.

When the operation of a steam plant gets outrageously bad, an expert is called in to straighten matters out. But this is not usually done until after a good deal of waste has occurred, and the cost of discovering the trouble, to say nothing of the cost of the remedy, is likely to be more than that of previously supplying the engineer with such instruments as he required, and by reasonable encouragement making him an expert ready to suggest preventives rather than costly remedies. Economy in developing power is made up of small things, and observations must be specific as well as general. To a greater extent than most other workmen, engineers must educate themselves, and for this reason they should be afforded every reasonable opportunity.

# Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

## Richardson Improved Automatic Coal and Liquid Scale

The Richardson coal scale, Fig. 1, is primarily used for weighing coal as it falls by gravity from bins or bunkers in the boiler room, and discharging the coal to the stokers of boilers. The main frame of the scale, which is of cast iron, supports on suitable steel bearings a middle knife edge or fulcrum of an equal-armed beam *D*, Fig. 2. This beam supports, at an equal distance from the fulcrum on knife edges, a weight box *C* at one end, and a weigh hopper *E* to carry the coal at the other end. In the weight box are standard United States test weights for the required quantity of coal to be weighed, and the coal is fed into the weigh hopper. When both are empty the weight box and weigh hopper are equal in weight and balance each other on the equal-armed beam.

The coal is fed into the scale proper from the overhead bunker, chute, elevator or other feeding device through the sloping side feed chute *A*, Fig. 2, the size of this chute being arranged according to the size of the material to be handled. Generally whatever size of material will pass from the bunker will pass through this chute without blocking. In this chute a feeder is arranged which consists of a reciprocating plate *B*, made on the same angle as the chute. This is operated by eccentrics, and the bottom end is carried by two sliding blocks, which work in slots in the casting of the chute. By reason of the weight of coal pressing on the feeder through its peculiar action, no arching can take place, and as the angle of the feeder is quite steep, this continual shifting of the base of the coal insures a positive feed.

This chute delivers the coal into the side of a drum gate *F* so that there is no vertical feed to or head of coal above the gate, and the outlet from the drum gate being greater in area than the inlet from the steel chute, it follows that any piece of coal that enters the gate can pass out into the scale hopper.

With this drum type of gate receiving its supply from the side, only a small quantity of coal is carried at any time on the floor of the drum, so that when the gate is closed there is not a heavy head of coal upon it, and there is but little friction due to a head of coal upon the gate, so that the gate readily opens and allows the coal to pass into the weighing bucket. The action of the drum gate is a revolving one. At the beginning of the weighing it is wide open and a full feed of material enters the weighing bucket. When the weighing nears completion, the gate revolves, cutting off the feed to a small flow, and when the hopper has received its required amount the gate completes the segment of the circle under the influence of its own weight and finally cuts off the supply.

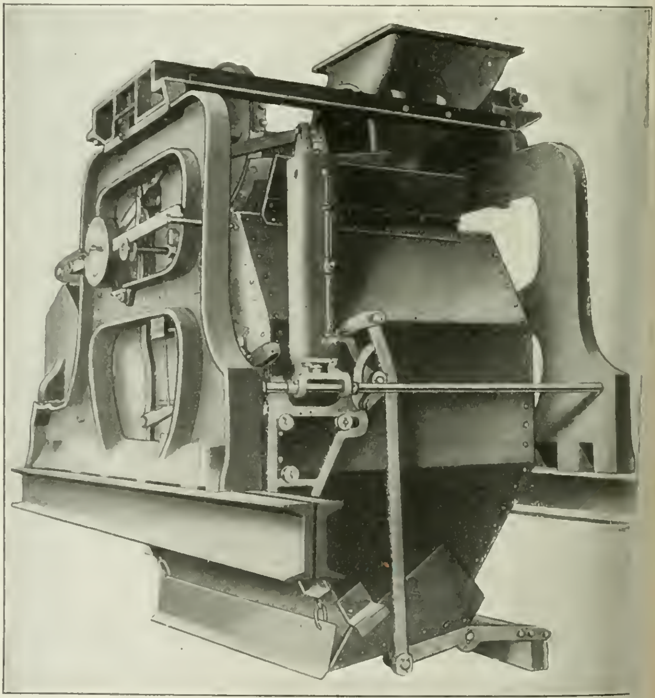


FIG. 1. RICHARDSON IMPROVED AUTOMATIC COAL SCALE

Should a large piece of coal be in the act of falling from the chute to the hopper as the gate cuts off, it cannot prevent the gate from closing and is thrown to the back of the drum gate. The gate is controlled by means of a dead-center lock formed by the levers *H* and *I*. The discharge from the weigh hopper is also controlled by means of a toggle *P* on the same principle.

In the past the supply gate has been operated by means of a spring and the power exerted by the dead weights on the weight box at one end of the equal-armed beam has been cushioned in its descent by a spiral spring, and the release of the gate-controlling levers has allowed thi spring to expand and open the gate Owing to the limited service which al spiral springs give this has not been foun reliable and a weight is introduced in Richardson scale in place of this sp in large scales, as shown in Fig. 1, w are used for heavy work.

Suppose that such a scale is used receiving coal and weighs, say, one at a discharge; one ton of weights placed in the weight box. It would be good practice to allow the full of this ton of weights to exert its sure on the working parts of the le. Thus, it is necessary to subtract from

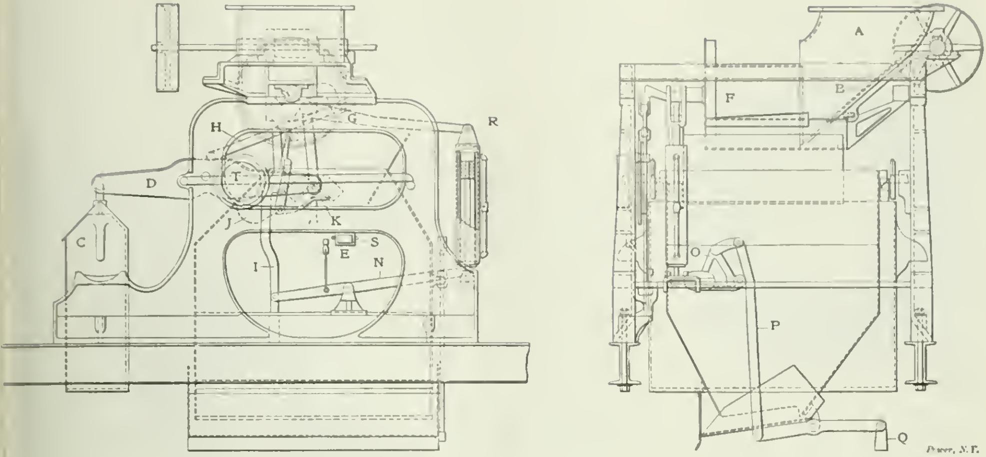


FIG. 2. SHOWING DETAILS OF RICHARDSON SCALE

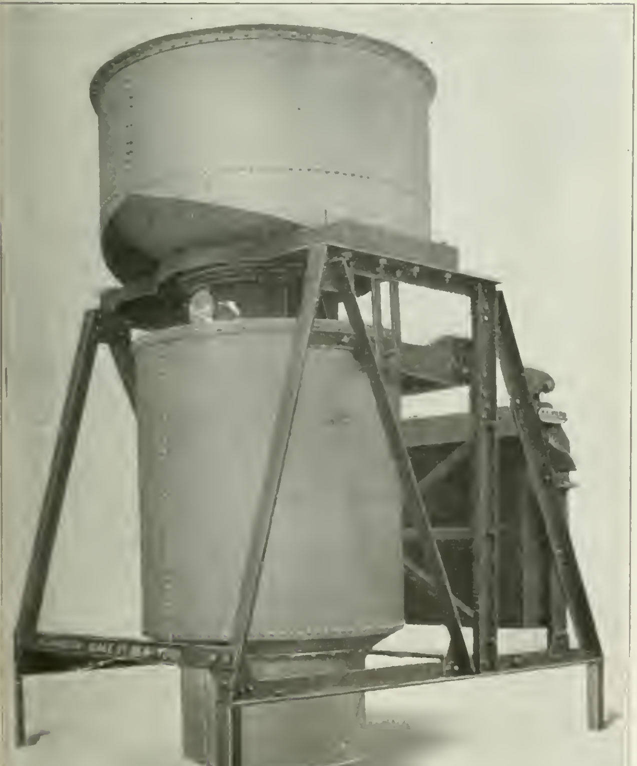


FIG. 4. RICHARDSON AUTOMATIC LIQUID SCALE

given power furnished by the weights in the weight box sufficient weight to minimize the shock and the amount of this power is regulated by the weight of an operating weight. By making the operating lever *G*, Fig. 2, of a large multiplication, it is possible to use quite a small weight, which may be called the power weight, *R*, on the extremity of this operating lever *G*. Supposing the leverage to be 6 to 1 and the weight at the end of this lever is 150 pounds, there would be a pressure on the gate of 900 pounds, leaving 1100 pounds free weight to descend out of the 2000 pounds in the weight box. Even the weight of 1100 pounds is sufficient to drop with a heavy jar if no air cushion were introduced, but by using a piston the blow is eliminated. The piston itself only exerts power according to its weight and is simply a cushion.

When the scale hopper has discharged its load, the weights in the box at the other end of the beam are free to return to their stops on the side frames, but for the fact that the pressure is taken up by a pendant from *K* to *G* connected to the gate, and the gate locking levers *H* and *I* being at a dead center the gate cannot open. The operating lever *G* is raised, thus raising the operating weight *R*. The air in the lower part of the piston passes through a small bypass pipe on the side to the upper end of the cylinder and thus the cushioning takes place. This piston now is at the top and remains so, because the gate-controlling levers *H* and *I* are in their locked position. Directly the locks are broken by the action of the trip mechanism *O* on the lever *N*, with which they come in contact as the hopper door is closed, the weight is free to fall, working on the fulcrum formed by the pin of the pendant at the end of *A*. The fall of the weight is also cushioned in the same manner as its uprising, namely, the drawing of the air in passing from the top to the bottom. The bypass pipe is fitted with a regulating cock by which the retard can be regulated. The cylinder is made of high-grade solid-drawn brass tube, is fitted with oil cups and drain pipe, and the piston rod is so fitted that no dirt can affect its work. The cylinder is incased in a casting which prevents damage by denting.

The drum gate is mounted on roller bearings and fitted with oil cups. All the levers of the scale are of cast steel. The drum gate is formed by two steel disks, to which is bolted the sheet iron gate plate which is lined with brass. This gate runs on roller bearings. The weigh hopper is lined with brass in order to prevent wet coal from sticking to the sides; also all the pins are of brass, as is the hopper door on which the coal rests in the hopper. The hopper door also operates on roller bearings. The reciprocating plate feeder *B* is so arranged as to be in action only at the time the gate is open and when the feed is taking place. Immediately the gate closes the feed stops. This is due to a connection between the gate spindle and a bell crank which engages and disengages the clutch.

The weigh hopper is cut away, as shown in Fig. 3, in the base to allow of a full closing in case a piece of coal should be between the body of the hopper and the door at the moment of the closing of the latter. By this arrangement the door cannot be held open through a piece of coal wedging between the body of the hopper and the door. A flapper seals or closes the joint but at the same time hangs loosely.

It is claimed for the machine that it will weigh both small and large coal, wet or dry, with equal facility by an automatic system. It also provides a continuous registration of all the coal passing over it by means of the automatic counter *S*. The column of coal in the act of falling at the time of the final closing of the gate is provided for by the sliding adjustable weight *T* acting on the beam.

A type of automatic liquid scale is shown in Figs. 4 and 5, the former being an exterior view and the latter a sectional view of one side. This machine consists of a strong, iron frame which supports the equal-arm beam *A*, Fig. 5. On one end of this beam is hung the weighing tank or hopper *B*, in which the liquid is carried. To the other end is suspended the counterbalance or weight box *C*. United States standard weights are placed in the weight box, which furnish the power to actuate the scale.

The liquid enters the scale from the hopper tank *D*, which is fed by the feed pipe shown and is controlled by the circular bell-shaped valve *E*. This valve is raised through the plunger *G* by the power of the weight in the box *C* and is controlled by means of the levers *K* and *L*, which form a dead center.

A full stream of liquid enters the weighing tank until its weight in the hopper begins to offset the counterpoise, and in so doing releases the plunger *G*. As the valve is then partially closed, only a reduced flow of liquid enters the hopper until the

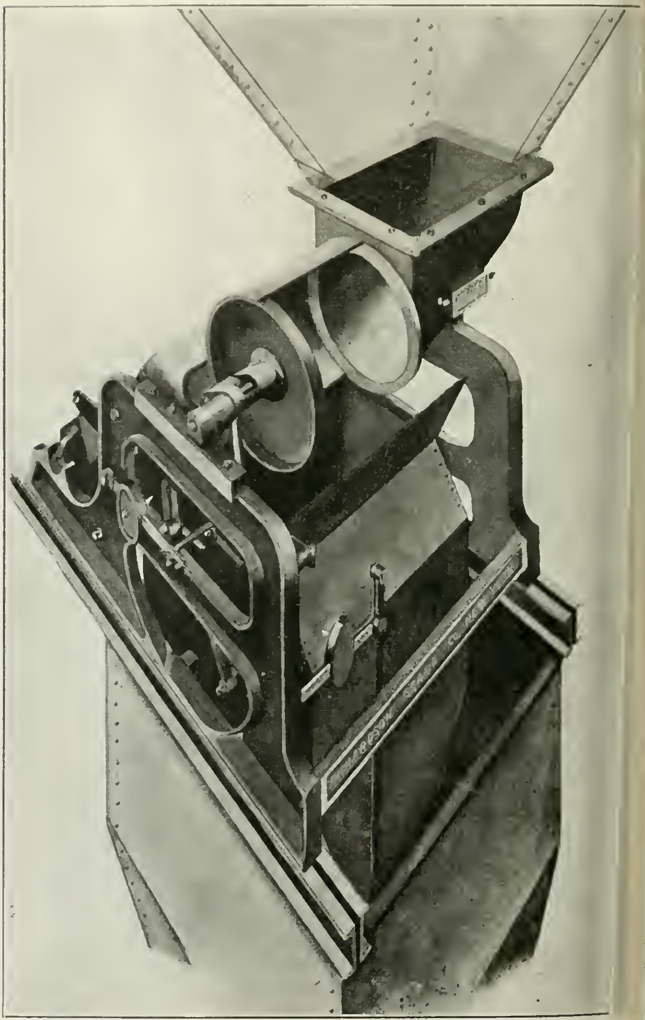


FIG. 3. SHOWING WEIGHING HOPPER

balance is reached, this final flow being enlarged or reduced by means of the screw *J*. When balanced, the beam trips the arm *W* and the valve completely closes. The lever *L* then engages with the lever *N*, breaking the lock formed by the dead center of the lever *N* and *M*, and the weight of the liquid opens the outlet valve and the contents of the tank discharges, the discharge being controlled by th conical valve *H*. This valve has a rubb seat and thus forms a joint against tl wall of the tank at *S*. The liquid is d livered into the funnel *Q* connected wi the outlet valve *H*, the weight of the liqu on this funnel having the effect of hol ing the valve open until all the liquid drained from the weighing tank. Th valve returns to position by means the weighted lever *M* when relieved the weight of the liquid on *Q*.

The final dripping of the liquid in een between the inlet valve and weighin ank at the time of cutoff is compensat for by the weight *T* acting on the bea sup- porting it. This scale is equipped th a n-hanical counter, shown at *R*, which r isters every weighing so that the total wght of liquid that has passed through tl scale can be read at a glance.

'he machine is self-testing in accuracy, itbeing wholly unnecessary to draw off tl liquid into an ordinary tank and weigh itn the usual way to check its weight. It can be built in sizes to suit any req'ement. Both types of scale are manuf. ured by the Richardson Scale Compy, 50 Park row, New York City.

## Cse-Hardened Corrugated-Copper Gasket

case-hardened corrugated-copper gaskt manufactured by the Chapman Engi ering Company, 917 and 919 Land T building, Philadelphia, Penn., is illu ated in Fig. 1.

hen in use the corrugations are not supposed to mesh down in the flange and stay set, but simply flatten and retain their spring, which enables the gasket to contract and expand to meet the variations of temperature and pressure, which feature would fit it for use with superheated steam and on high-pressure work.

It is claimed for this gasket that this corrugation will spring or expand and contract in a flange 1/16 of an inch, and that it cannot blow out; also, that it closes the pores of the metal, and for that reason the gasket will neither set nor crack under pressure, nor corrode from electrolysis nor the presence of sulphuric acid, and it can be used over and over again. It is suitable for use with steam, water, air, oil, gas, tar, naphtha and gylcerin, and under ordinary circumstances, it is claimed, will last as long as the pipe.

It is made the exact size and shape that is wanted, and is applied as shown in Figs. 2 and 3; Fig. 2 showing the gasket in position on the lower flange, while Fig. 3 shows the position of the gasket inside the flange. This also indicates that the gasket can be applied by removing only half of the bolts, which would be a feature in case one were in a hurry to replace a gasket.

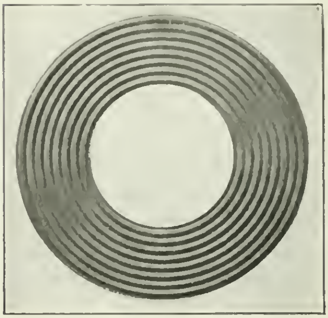


FIG. 1. CASE-HARDENED CORRUGATED-COPPER GASKET

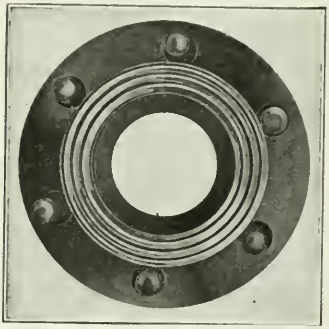


FIG. 2. GASKET IN POSITION

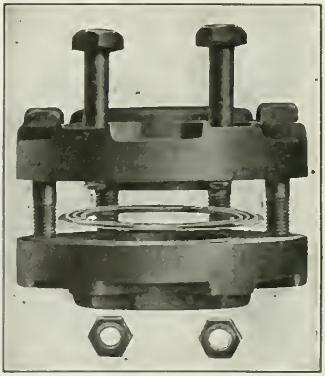
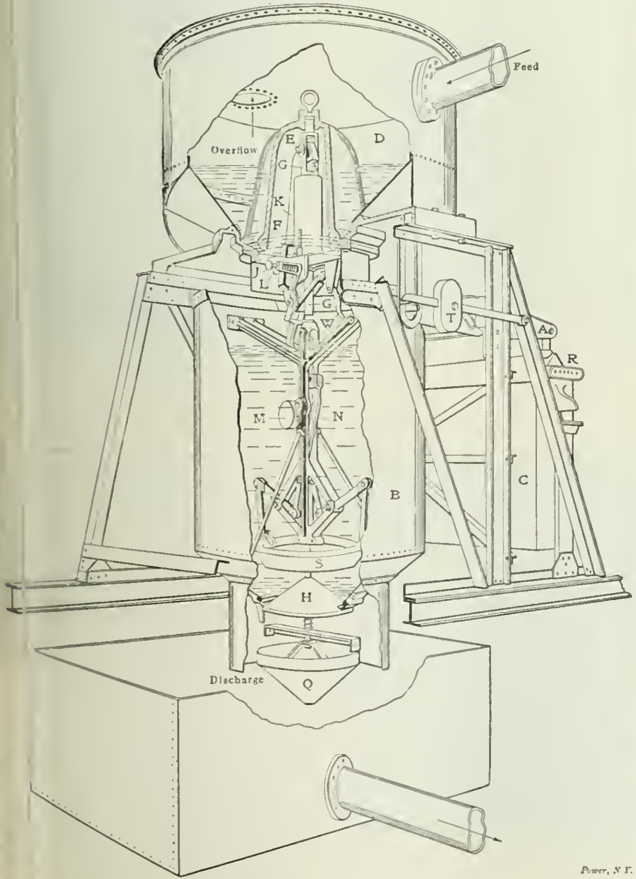


FIG. 3. GASKET BETWEEN FLANGES



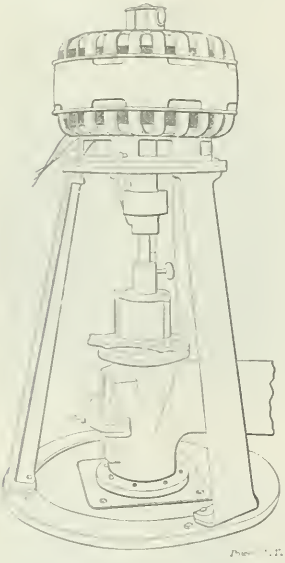
Power, N.Y.

FIG. 5. SHOWING DETAILS OF LIQUID SCALE

## Columbus Impeller Pump

A field which impeller pumps have invaded to some extent recently is that of pumping the water used in condensers. As they are built vertically and are motor-driven, they occupy small floor space and can be placed in the most convenient location.

The design consists of a properly shaped impeller, surrounded by a suitable shield and retarders and all bearings in the well are eliminated. The pump consists of a shaft extended down in the well, provided with impellers. Each impeller has an annulus cast integral with it, and surrounding this impeller and carried by three stationary bars is a steel protecting shield. Below each impeller three retarder blades are provided, which are secured to the stationary bars. Each 10-foot section has three impellers, three sets of retarders and three stationary bars, which form what is termed a "cage section." Any number up to twenty sections, or 200 feet in length, can be coupled together, thus enabling the pump to operate to a depth of 200 feet. The pumps are designed to be driven either by belt or motor.



COLUMBUS IMPELLER PUMP

This type of pump requires no pit, and has no wearing parts located below the surface. It is especially adapted for slow-producing wells, which by its use may have their capacities greatly increased by extending the pump deep enough to lift the column of water of the vein, thereby permitting a greater and more rapid inflow. This pump is manufactured by the Roth Manufacturing Company, Indianapolis, Ind.

## Improvement in the Lagonda Automatic Cutoff Valve

The Lagonda Manufacturing Company, Springfield, O., recently made improvements in its automatic cutoff valve, as shown in Figs. 1 and 2.

In Fig. 1 it will be seen that instead of a friction joint between the valve ster and lever connecting with the weight arn an arrangement of links has been incor porated, thus reducing the liability sticking. The design of the double-dis valve has also been changed, the onl guide used being that of the stem be tween the upper and lower disks.

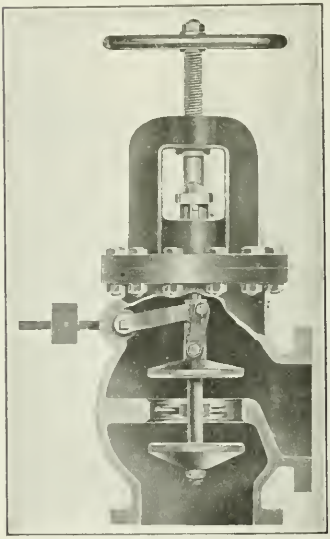


FIG. 1. SHOWING INTERIOR IMPROVEMENTS IN LAGONDA AUTOMATIC CUTOFF VALVE

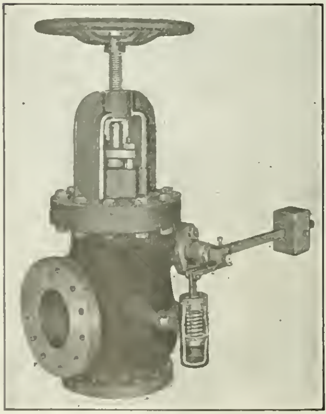
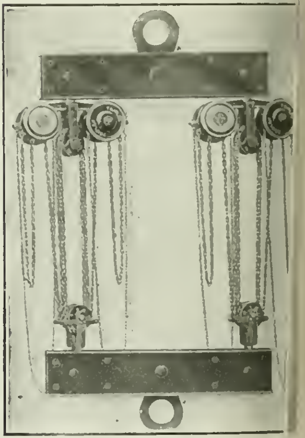


FIG. 2. DASHPOT ARRANGEMENT

In Fig. 2 is shown the arrangement the dashpot on the outside of the val body, to prevent chattering by the closi of the valve too quickly, or when a su den overload occurs.

## A 40-Ton Triplex Chain Bloc

The 40-ton Triplex chain block ill trated herewith has been developed meet the demands of engineers for a ha hoist to handle heavy loads where the stallation of an electric crane or pow steam hoist is not used.



FORTY-TON TRIPLEX CHAIN BLOCK

It is composed of two 20-ton units, equalizing bars at the top and bo This provides for single-point suspo and a single point for attachment of The equalizing bars are made of channels placed back to back with arators. Provision is made for the s ing of each unit at the top and b The points of attachment enable th easily to put the hoist in place wh used, and also afford a convenient for the attachment of the load.

The hand chains are arranged to per- mit from two to eight men to wo e- fectively. Where the load is large han 40 tons it is generally of sufficier size to permit two of these hoists to be w ked together, giving a capacity of 80 ton This hoist is manufactured by the Y & Towne Manufacturing Company, Mur- ray street, New York City.

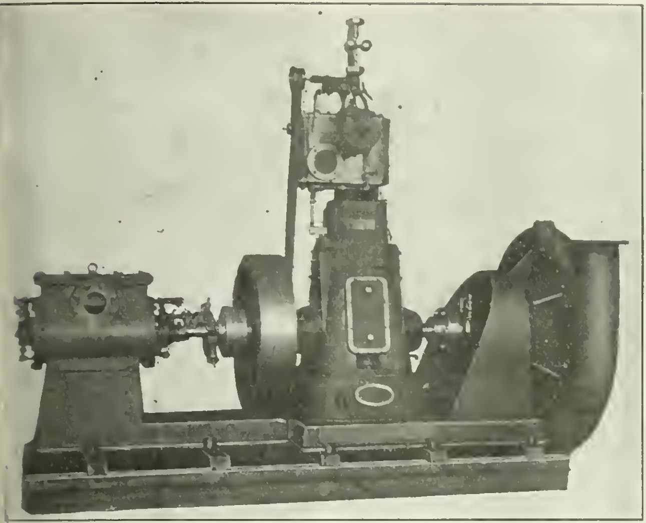


FIG. 1. ROTREX AIR PUMP AND CENTRIFUGAL PUMP DIRECT-CONNECTED TO A VERTICAL STEAM ENGINE

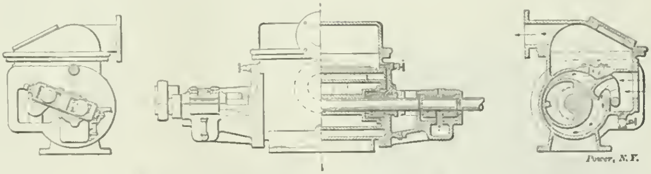
## Rotrex High Vacuum Air Pump

e steadily increasing demand for h r economy of steam prime movers w h has been accompanying the develop- n and application of steam turbines g the past few years made a simul- t s advance in the design of con- d g apparatus necessary. Guided by s nsiderations, the C. H. Wheeler M acturing Company, Lehigh avenue a ghteenth street, Philadelphia, has de- v d a new type of rotary-air pump em- b g the essential features of a high- v m air pump occupying a compara- t small space, with the advantage of b adapted for direct-connection to an- o auxiliary.

1 illustrates one of the standard ar ments, consisting of a vertical st ngine direct-connected to a Rotrex ai mp on one side and a centrifugal ci ting pump on the other. By this ar ment, one engine drives both p , the speed of the combined outfit b from 180 to 250 revolutions per min- ut rding to the size of the unit. This el tes the additional steam cylinders cr rily used to drive the air pump. Fi 2 shows the application of the Rotrex pu to a condenser.

e construction of the Rotrex pump is wn in Fig. 3. It consists of a light- we t cylindrical casing, one rotor eccentrically mounted on a heavy steel sh carried in outboard ring-oiled bear- ing independent of the stuffing boxes. Di sion between the suction and dis- ch ge in the pump cylinder is made by me s of a radius cam, which is carried in dependent bearings and operated by means of a lever and crank from the rotor shaft on the outside of the pump. By this arrangement internal contact is eliminated; the rotor operating with a close clearance from the bore of the pump cylinder and the cam maintaining a close clearance from the rotor. The clearances, by an ingenious arrangement of parts, are thoroughly water-sealed at all times, i.e., the pump relies on water sealed clearances to produce the high vacuum obtained, and not surface contact nor sliding fits. The other notable feature of this pump is a special arrangement of metallic discharge valves, no suction valves being used, thus practically eliminating expensive upkeep.

The pump is being made in capacities from 50 to 5000 horsepower in one unit; beyond that size multiple units are used, an independent air-pump engine having one Rotrex pump direct-connected to each end of its crank shaft.



F 3. SH NG CONSTRUCTION OF THE ROTREX PUMP

## Automatic Tank Switch

This device is designed automatically to maintain the water level between desired limits in open-tank or sump systems. The construction permits the switch to be placed on top of the tank or sump cover, and allows any desired variation in water levels to be carried without relocating the electrical apparatus. When the switch is placed on top of the tank, there is no necessity for boring a hole in the side of the tank, and there is no danger of the switch flooding and becoming short-circuited.

The operation of the switch in starting

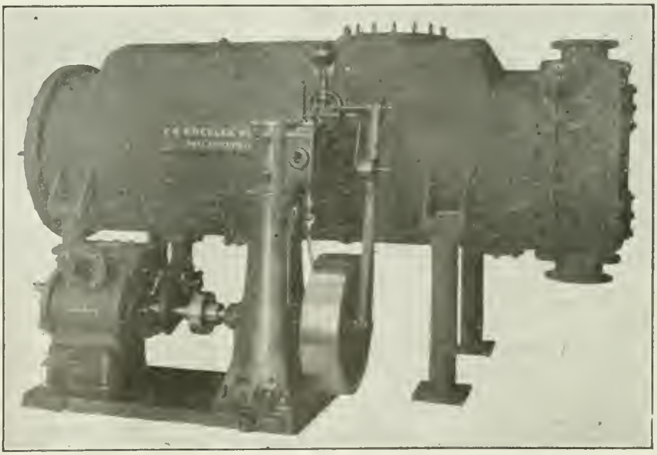


FIG. 2. APPLICATION OF ROTREX PUMP TO A CONDENSER

and stopping the motor is dependent upon the movement of a falling hammer, the movement of which in turn is governed by a suspended copper float, nearly counterbalanced by a cast-iron ball.

Referring to Fig. 1, showing the interior mechanism as arranged for tank service, the small wooden balls *A B* on the chain are adjustable and their position determines the variation of water level between operations of the pump. The switch is shown in the position occupied when the pump is in operation. As the float rises, the ball *A* comes into contact with the projection *P*, on the hammer, and carries it past the center. The hammer then falls to the other side of the pulley shaft by gravity, and in so doing the lug *L* strikes a projection on the switch and disengages the knife switch, thus stopping the motor and pump.

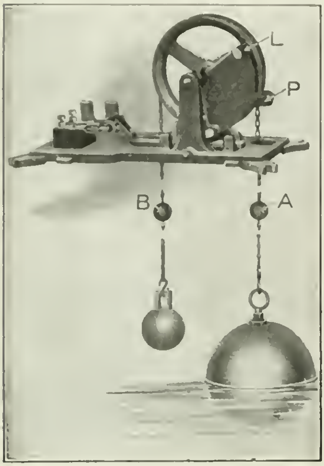


FIG. 1. INTERIOR MECHANISM

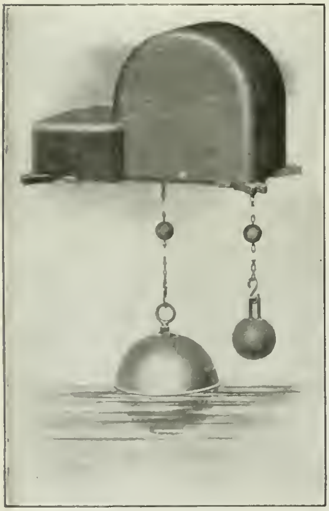


FIG. 2. ARRANGEMENT FOR DRAINING SUMPS

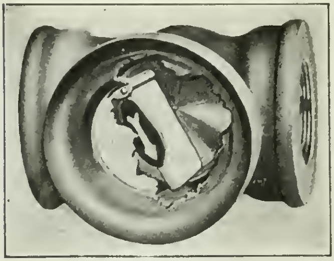
As the switch movement is quick, there is no chance for arcing, and as the hammer remains in contact with the switch arm, there is no rebound. The hammer holds the switch arm in this position until the falling of the water level brings the other wooden ball *B* into contact with the hammer lug, which reverses the hammer, throws the knife switch into contact and starts the pump again. The wheel acts merely as a carrier for the copper chain, and plays no other part in the operation of the switch.

When arranged for draining sumps, the copper float and iron ball are reversed as shown in the exterior view, Fig. 2. This reverses the switch action to start the pump when the water level becomes too high. It is said that dampness does not affect the working qualities of the switch. The device is made by the Watson-Stillman Company, 50 Church street, New York City.

## A Flow Indicator

An instrument for inserting in pipe lines to indicate at a glance what flow of water is taking place is known as the flow indicator, handled in this country by A. W. Lilienthal, 25 Broad street, New York City. The illustration shows its design and indicates its method of operation.

The device is made of brass and is comprised of a body with an inlet and outlet for pipe connections. In the valve body, and facing an aperture in the side, is a pivot ring carrying an indicator or flap. The pivot ring can be moved to any position, allowing the device to be operated in either a horizontal, vertical or angular position. A ring nut holds a glass disk in position in the aperture, thus allowing a clear sight of the flap from quite a distance, the flap having on its edge a red face with a black arrow. When liquid is not flowing, the flap falls to a position at rest on the bottom of the body and can readily be seen in that position.



FLOW INDICATOR

An electrical contact is furnished with the device, if desired. When connected to a battery or the source of power, and the flap falls to a position at rest when liquid is not flowing, a circuit is closed, lighting a lamp or operating a buzzer. It is claimed that the flow of liquid is in no way impeded by the use of the indicator.

This indicator is found useful where a battery of boilers are fed from the main feed line, if an indicator is inserted in the branch of each boiler to show at a glance whether the feed water is flowing into the boiler, serving as a check on the water gage. It can also be connected in the discharge line of pumps in the gas intake of gas engines, to indicate the pulsation of the gas, or connected to a water-jacket discharge pipe to show whether the cooling water is flowing or not. It is also suitable for connecting into the water jacket of air compressors in the discharge from both the low- and high-pressure cylinders, and in fact wherever it is desired to know whethe the flow of water is being maintained o not.

## Personal

A. Bement, of Chicago, has been ap pointed, by Governor Deneen, delegate t represent the State of Illinois at th American Mining Congress at Goldfiel Nev.

Dickerson G. Baker, formerly consult ing engineer for Samuel M. Green, Inc has been appointed works manager of th Blake & Knowles Steam Pump Work East Cambridge, Mass.

Louis L. Johnson, formerly with th Westinghouse Machine Company, h been appointed gas engineer of the ele trical department of the Southern Paci Company, San Francisco, Cal.

William T. Donnelly has been appoint official representative of the Manufa turers' Association of Brooklyn on t inspection trip to the Adirondacks, und the auspices of the State Water Supp Commission. This trip is being made inspect the available water supply, wi regard to power, storage and flood co ditions.

The Pratt Institute, of Brooklyn, N. has instituted day and evening courses machine construction and toolmaking. entrance examinations will be requir Certificates are given to those who co plete a course with high standing. F further information call at the office Ryerson street, or send a postal card Arthur L. Williston, director of School Science and Technology, Pratt Institute

## Book Review

STEAM POWER PLANT PIPING SYSTEMS: THEIR DESIGN, INSTALLATION AND MAINTENANCE. By William L. Morris. Published by McGraw Hill Book Company, New York. Cloth; 490 pages, $6\frac{1}{2}$x$9\frac{1}{2}$ inches; 389 illustrations. Price, $5.

Of the many practical books treating f the design and operation of steam- ower plants few, if any, devote more han a few pages, or a chapter or two at nost, to the design of piping systems. n this book the author treats only such arts of the power-plant system as relate irectly to the piping. The book is divided nto 31 chapters.

In the introduction the author favors he practice of letting piping contracts ased on nothing more substantial than iping diagrams, and condemns the per- ntage system of contracting for such ork. Chapter II deals with piping dia- rams, a form of drawing which should pecially appeal to the operating engi- eer taking charge of a new station. apters III to VIII, inclusive, are de- ted to a detailed description of the veral different piping systems in use roughout the modern power plant. The ustrations are in diagram form, show- g each complete system and apparatus ne view. All auxiliary apparatus in way pertaining to the system are scribed and their general design and eration discussed.

Under Oiling Systems, the author con- mns the sight feed as wasteful and for eater economy suggests the use of rced-feed lubricators directly connected the moving mechanism of the machine be lubricated. Throughout the book mention is made of vertical-turbine p-bearing oiling systems, which de- rve a place in an uptodate work of this d.

Chapter X, containing 59 pages, is de- ted to live-steam details, showing cor- t and incorrect methods of piping en- s, boilers, auxiliaries, etc., to and m the main header. Expansion, con- tion, vibration and water hammer are sidered and provided for. In this re- t the author condemns the "far pro- ting bend" as a badly vibrating de- Twelve pages of this chapter are ted to Engine and Pump Governors, al Pressure Regulators, several types which are illustrated and described. economical methods of governing and stoker engines are also described illustrated.

en pages are given to Water Columns Steam Gages and their pipe connec- tis. A novel high- and low-water elec- -alarm column is described and illus- ed, having a lamp at each boiler, a "ll alarm" in the boiler room, and a "lzzer" in the chief engineer's office. Fr pages are devoted to safety valves safety-valve connections, and the chapter closes with a brief discussion of superheaters, superheated steam and live steam branches to steam turbines. No attempt has been made to show detail in pipe connections, steam joints and other such details, and no mention is made of the new system of welded headers.

Chapter XI treats of vacuum exhaust-piping details. The required sizes of mains are treated, together with the effects of "High Vacuum" on operating and fuel economy. The loss of one inch, from 28 to 27 inches, of vacuum on a steam turbine, the author states, will increase the steam consumption about 6 per cent., whereas this same loss on a compound engine causes an increase in the steam consumption of less than one per cent. Vacuum traps, for draining vacuum-exhaust lines, are condemned as troublesome devices. Three pages are devoted to the economical disposal of exhaust steam from auxiliaries.

Chapter XII treats of atmospheric exhaust-piping details, connections to and from feed-water heaters, etc. A noiseless, cushioned back-pressure valve is described and the chapter closes with seven pages devoted to exhaust-steam heating systems.

Chapter XIII treats on boiler feed-water-piping systems, feed mains and branches. An ideal system for securing a uniform flow of feed water to all boilers is described and illustrated, along with a simple arrangement for double feeding. Four pages are given to a discussion of automatic feed-water regulators, controllers and relief valves. A thermostat controller is described, so designed that if the boiler should become cold, or the diaphragm in the feed valve break, the feed valve will immediately assume the open position, flooding the boiler. The general arrangement of feed-water branches to and from boilers, economizers, feed-water heaters, purifiers, injectors, meters, etc., are discussed and treated and the chapter closes with a brief description of boiler feed-water branches to hot-water plumbing fixtures.

Chapters XV to XVII, inclusive, treat of feed- and fire-pump suctions, heater water-supply piping and low-pressure water-supply systems. Considerable space is devoted to underground piping, suction wells, intake and overflow tunnels, screen and filter wells, etc. The effect of water hammer in suction pipes is discussed and provided for. Under the heading "Low-pressure Water from Economizers to Heating System" is given a description of a hot-water heating system with an economizer arranged for operation at low pressure. A pump serves to keep the economizer under pressure discharging hot water either to the boiler-feed pump, or to a circulating pump which circulates it through the heating system, returning it again to the economizers.

Chapter XVIII treats of condenser cooling water piping systems and details. The general arrangement of condensing apparatus, suction wells, intake tunnels, waterways, hotwells, screen wells, etc., is considered and each treated and illustrated in detail. Several diagrams are given showing the complete condensing system and connections. Eight pages of this chapter are devoted to condenser-water cooling towers and their pipe connections.

Chapter XIX treats of condensation, air and vacuum lines, wet and dry-vacuum pumps, etc. Chapters XX, XXI and XXII are devoted to city water, artesian wells and well water, and fire-service piping systems. Chapter XXIII is devoted to water-treatment apparatus and piping systems. Chapter XXIV treats of high-pressure water-piping systems for hydraulic elevators, lifts, etc. Chapter XXV treats of compressed air and air-piping details. Chapter XXVI is devoted to steam drips, and drip-piping systems, separators, steam traps, etc. The gravity return, automatic pump and receiver return, elevated-tank return, and steam-loop return systems, for returning drips to boilers, are described and illustrated in diagram form.

Chapter XXVII is devoted to oil-piping details, pipe joints, drip pots, atomizers, vaporizers, oil cups, filters, purifiers and oil-storage systems and kindred subjects. Chapter XXVIII treats of blowoff piping and details. The first two pages are devoted to blowoff basins and pipe trenches. The remaining pages of the chapter are devoted to boiler and economizer blowoff connections and blowoff tanks.

The concluding chapters of the book deal with grease sewers, tile sewers, roof and floor-drain connections, economizer cleanout drains, etc., and sundry gage-piping details.

The book as a whole is well written and thoroughly illustrated and indexed throughout and deserves a place in the library of all discerning engineers, designers, draftsmen, steamfitters, architects and, in fact, all those having to do in any way with power-plant piping of any description. The author covers the field of pipe work in a commendable manner.

There are several typographical errors in the book, such as the following: On page 86, fifth line, the words "as killed operator" should be a skilled operator. On page 133, twenty-seventh line, "A 4-15 Fig. 103" should be Fig. 103 (A 15-2). On page 157, twentieth line, "Fig. 132 (A 31-2)" should read: Fig. 133 (A 32-1). On page 159, seventh line, "Fig. 133 (A 32-1)" should read: Fig. 132 (A 31-2). On page 285, "Fig. 237 (H 21-1)" should read: Fig. 237 (H 12-1).

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The annual meeting of the American Society of Mechanical Engineers will be held in New York December 7-10. No details of program are yet available.

## Society Notes

Brooklyn Council No. 8, Universal Craftsmen Council of Engineers, of Brooklyn, N. Y., will hold an entertainment and reception November 6, to which the ladies are invited. The committee promises a good night's fun.

The twenty-fifth annual entertainment and smoker of James Watts Association No. 7, N. A. S. E., of New York, will be held in the new meeting rooms, 307 West Fifty-fourth street, Saturday evening, October 30. A "merrie" evening is guaranteed.

Robert Fulton Association, Illinois No. 28, N. A. S. E., of Chicago, opened its winter educational work Saturday evening, October 2, with a lecture on "The History of Science," by Joseph W. Hays. The lecture was interesting and the attendance large.

The Modern Science Club, of Brooklyn, N. Y., held a smoker Tuesday evening, September 28. The handsome club rooms at 125 South Elliot place were filled with members and friends. The "Bunch" entertained, and it was a most enjoyable occasion. Refreshments were served.

The fifth annual entertainment and reception of the combined councils of the Universal Craftsmen Council of Engineers, of New York and vicinity, will take place at Terrace Garden, New York City, Saturday evening, October 23. The committee has prepared an excellent vaudeville program and a most enjoyable night is anticipated.

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The College of Engineering of the University of Illinois began work for a new school year on Wednesday, September 23, with 1056 students enrolled. The courses which will be offered by the new department of mining engineering will be announced in the next two months and will become effective at the beginning of the second semester of February 7, 1910.

## Business Items

The Murray-Corliss engine operating at the Alaska-Yukon-Pacific exposition has been awarded a gold medal.

The General Electric Company has received grand prizes at the Alaska-Yukon-Pacific exposition in each class of electrical apparatus in which an exhibit was made by the company. General Electric turbines were also entered in the Government exhibit in which no awards were made.

C. A. Poe, well known in steam-practice circles in Pittsburg and adjacent territory, has disposed of his interests in that city and accepted a position with the Wright Manufacturing and Austin Separator companies, of Detroit, Mich., in charge of the mechanical department, succeeding H. H. Humphrey, deceased.

The Lakeside Forge and Wrench Company has acquired the plant of the Springfield Drop Forge Company, of Springfield, Mass., and began operations, with a full force of men, September 27. Eugene Childs, formerly with the Trimont Manufacturing Company, of Roxbury, Mass., is president and general manager of the company.

The Electro-Mechanical Engineering Bureau, of Chicago, has removed to 607-610 Manhattan building, 315 Dearborn street, increase of business making more commodious quarters desirable. The company is also enlarging its laboratory facilities and is better prepared than ever to meet demands along chemical, electrical and mechanical lines.

The B. F. Sturtevant Company, Hyde Park, Mass., has ready for distribution a new general catalog, No. 165, showing its complete line of fans, blowers, dust collecting and conveying systems, fuel economizers, engines, motors, turbines, etc. Principal dimensions and other useful information are given. Purchasing agents, engineers, superintendents, or anyone interested will be supplied on request.

Edward C. Brown, manager for the Dearborn Drug and Chemical Works in the Hawaiian islands and the orient, has been elected president of the Commercial Club of Honolulu. This club is similar to the chamber of commerce and association of commerce organizations in the large cities of the States. This is an honor highly esteemed. Mr. and Mrs. Brown recently made a trip in the interests of the Dearborn company to the orient, spending several months in China, Japan, Korea and the Philippines.

## New Equipment

The Winona (Mich.) Copper Mine is figuring on installing a steam turbine.

The Ford Automobile Company, Detroit, Mich., will erect a new power plant.

The Detroit United Railway Company, Detroit, Mich., has prepared plans for a new substation.

The Louisville (Ky.) Railway Company is building an addition to its power plant to cost about $70,000.

The Winona (Minn.) Railway and Light Company contemplate the purchase of boilers and coal-handling equipment.

The power plant of the municipal electric light and water-works system at Crowley, La., was destroyed by fire. Loss, about $15,000.

## Help Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

WANTED—Good mechanical designers and detail draftsmen for machinery manufacturer located in Wisconsin. Box 98, POWER.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

AGENTS WANTED to sell Burgmann celebrated engine packings in territories not yet covered. See our advertisement on page 86.

WANTED—A good all-round mechanic; one who has had experience with hoists, boilers, fans, engines, coal chutes and screens, motors, electric mining machinery and generators; permanent job for right man, but must prove ability first; job open October 15, 1909, salary $125 at start; if right man for place, salary increases to $150; married man preferred to live at coal mine in southern Wyoming. Box 42, POWER.

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NEED the part time services of draftsm and designers? Years of experience on stea and power pumps, gasolene engines, hoist etc., at your command at reasonable pric S. S. Engr. Co., Elgin, Ill.

ANY FIRM or engineer in charge of steam plant that is troubled with scale in t boilers can get absolutely free, the best in cator and reducing wheel made, with velv lined mahogany case. For particulars, dress Great Lakes Chemical Works, Mani woc, Wis.

AUTOMOBILE auxiliaries pay large p fits; we have something every owner sho have; liberal commission; any serious-min energetic man who would look after our terests can add considerable to his income. draulic Oil Storage Company, 602 Penobs Bldg., Detroit, Michigan.

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FOR SALE—One 400-h.p. Hoppes feed wa heater, cast iron type; used one month. C S. Lewis & Co., Granite Bldg., St. Louis,

FOR SALE—20x48 Wheelock engine two 72"x18' high pressure tubular boilers good condition cheap. Address "Enginee Box 2, Station A, Cincinnati, Ohio.

FOR SALE—500-horsepower tandem c pound Fleming single valve, automatic; two small engines, cheap for cash. S Manufacturing Co., 1801 Third National B Bldg., St. Louis, Mo.

FOR SALE—250-horsepower Lane & ley Corliss engine, 18x42 cylinder; engine small for our work and will be replaced with one of greater power. Wm. A. Coo Milling Co., Coldwater, Mich.

FOR SALE—One 75-horsepower eng slide valve, Nordberg cutoff, in perfect or three rope drives complete, A. & F. Br make; one open heater, 75 horsepower; oil separator. All above replaced by la power plant. Est. S. H. Condict, 26 rence St., Newark, N. J.

FOR SALE—One 15-H.P. Nash gas en direct connected to 12½-kilowatt Bul direct-current generator, 115 volts; exce condition. One 15-kilowatt General Ele direct-current generator, 125 volts, 1200 lutions per minute. This machine in exce condition. Gould storage battery consi of 56 cells, partially new and recently hauled. Formerly operated in conjun with gas engine generator set. Address Box 40, POWER.

FOR SALE—12-inch Morris belt-driven trifugal sand-dredging pump complete 21x42-inch friction pulley with open e and flap valve. One Dobbie belt-driven h ing engine with single drum and do winch head swinging gear. One 6x6-inc gersoll & Sergeant belt-driven air compr with 100 gallons pressure tank with safety valve. One Dobbie friction with 21x26-inch pulley. One Dobbie fri clutch with 21x42-inch pulley. Two 6-ply inch endless rubber belts, 70 feet long. Morris belt-driven, 3-stage centrifugal p 1½-inch suction, 1-inch discharge; 80 fe inch wrought-iron pipe. Two 12-foot len 12-inch rubber suction hose. One 36x6-foo right James Beggs & Co. steam boiler. 6x8-inch double Lidgerwood single-drum ing engine with winch head. One 36-in 6-foot Wickes Bros. pressure tank. On 36x36-inch open water tank. One mast and boom socket 12-inch. One pa inches long bend socket elbow, flanged. Dobbie swinging boom derrick, 8x10-inc ber with 10 by 12-inch by 30-foot mas 50-foot boom. One Dobbie swinging derrick, 8x10-inch timber, with 10 by 1 by 30-foot mast, 36-foot boom. Apply to Schulze, 1170 Broadway, New York Ci

# Power House of the Rock Island R. R. Shops

## Alternating-current Turbine Plant That Is Featured by Water Supply, Simple Coal and Ash Handling Facilities and Electrical Distribution

BY OSBORN MONNETT

An interesting example of the progress made in the design of power plants in connection with railroad-repair shops, is to be found in the power house of the new locomotive- and car-repair shops of the St. Louis & San Francisco Company, at Springfield, Mo. These shops were completed in June of the present year and have a normal capacity of 35 to 40 locomotives and about 35 coaches per month. The shops comprise the following main buildings: locomotive, machine and erecting shop, boiler and tank shop, blacksmith shop, coach-repair shop, coach paint shop, storehouse and office buildings.

Light, heat, water and power for these buildings are furnished by a power plant conveniently located on the shop site and housed in a separate building. In addition to supplying the new shops the power plant also furnishes power to the old Frisco shops located about two miles distant. At present the plant has a capacity of about 2000 horsepower in boilers, but the building is designed to house 3200 horsepower, and ground space is available for further extension whenever it becomes necessary.

### The Building

The exterior design of the power-plant building conforms to the general design of the shop architecture, and though simple, it has a pleasing appearance thoroughly in keeping with its purpose. The building is a self-supporting steel structure, with brick walls erected on concrete foundations. It is absolutely fireproof, the only inflammable material used being in the window and door construction. In ground plan the power house is 118 feet wide and 145 feet long, being divided into three rooms by two 17-inch fire walls.

The turbine and boiler rooms are on the same level, about 4 feet above grade, and each is provided with a 10-foot basement communicating with the pump room through a series of arched openings. The floors are all concrete, the basement floor being laid on a well-tamped cinder fill, and the upper floors on steel beams. In the turbine room the floor is finished with a mixture of lampblack and cement, which gives a neat appearance and does away with the dust common to concrete floors. This feature illustrates the careful thought which has been given to even the small details of design. The finish of the turbine room is enhanced by a 6-foot white enameled-brick wainscot extending around the four sides of the room. The cement floor is carried up on the sides to a hight of 9 inches in a graceful curve of 12-inch radius, meeting the wainscoting. This construction gives a neat effect and one easy to keep clean. The roof over all three rooms is of concrete 2 inches thick covered with a five-ply tar and gravel roofing and reinforced with a new material known as "Hy-Rib."

In the design of the building special care was taken to have ample light and ventilation. To this end a monitor was put over the pump room, provided with center-pivoted windows operated by a gang-throw device. In addition to these windows circular windows open into the

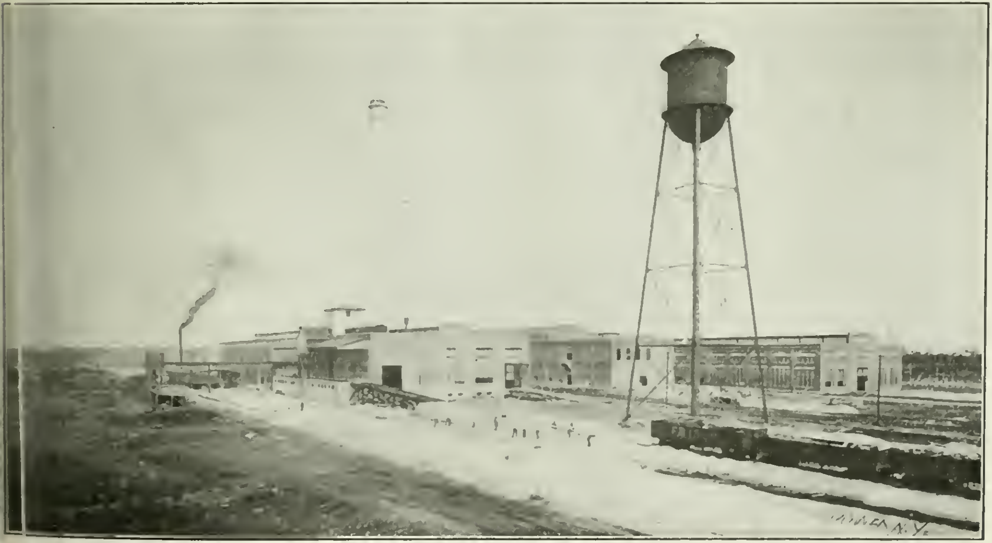

FIG. 1. ROCK ISLAND SHOPS WITH POWER PLANT IN FOREGROUND

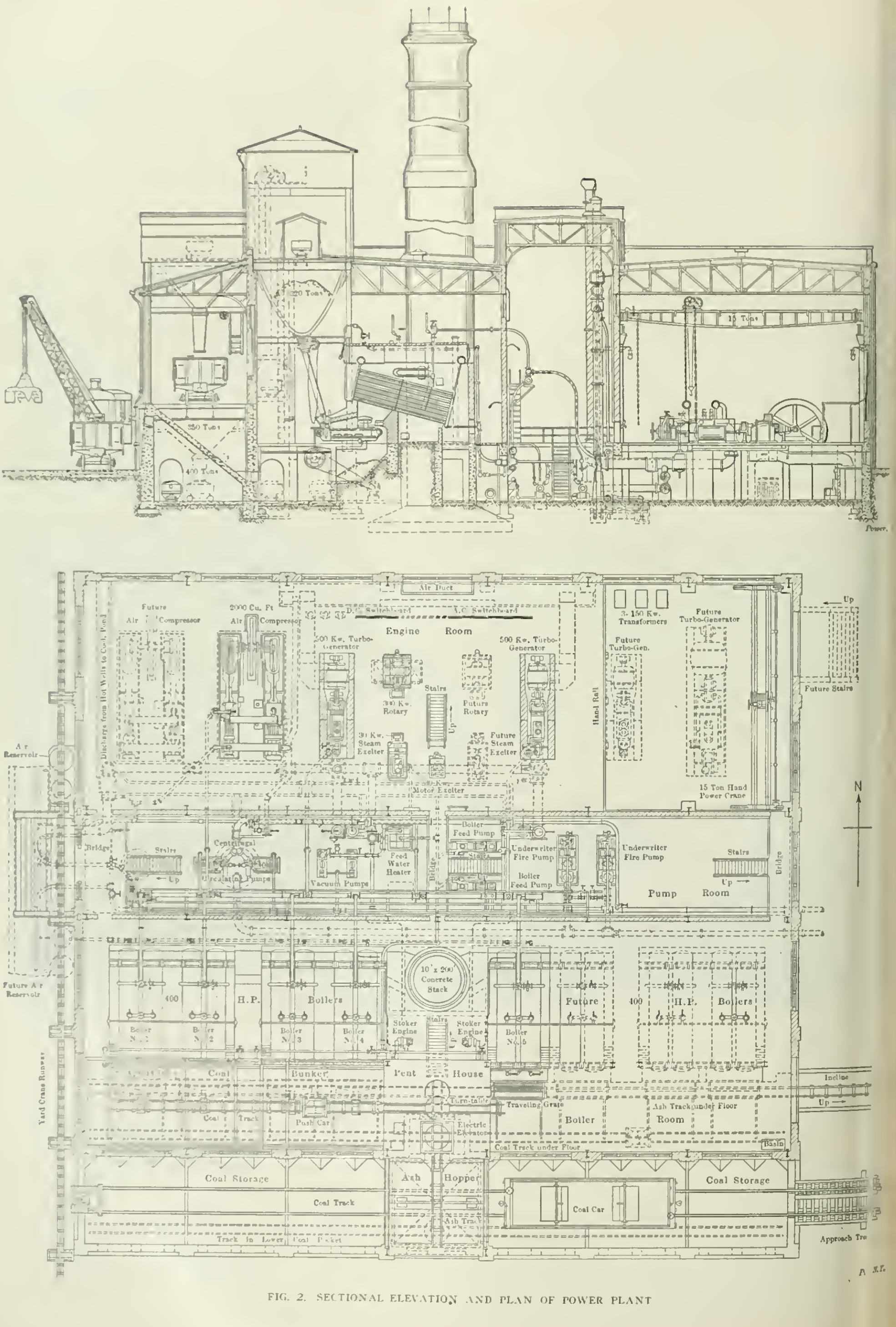

FIG. 2. SECTIONAL ELEVATION AND PLAN OF POWER PLANT

rbine and boiler rooms, with a view ward further increasing the light and ntilation in the three rooms. Over the nter of both boiler and turbine rooms ır Burt glass-top ventilators are in ice, those over the turbine room being inches, and those in the boiler room inches in diameter. Repairs and the ndling of heavy parts in the turbine om are facilitated by the installation of 15-ton hand-power Whiting crane.

### Handling Coal and Ash

The design of the coal- and ash-handling paratus of this plant is such that one n can handle both coal and ashes, and a low expense. The equipment comses a system of narrow-gage tracks and n tables, electric elevator, and manually rated bottom-dump coal and ash cars. vision is also made for a coal crusher found necessary. There is practically thing about the equipment to deteriorate, all storage pockets are of reinforced ncrete. In handling coal and ash all erations are assisted by gravity with the ption of the electric elevator used in sing to the overhead bunkers.

Referring to the cross-sectional drawing the power house, Fig. 2, the main features of the coal-handling system will be rent. The storage capacity for coal the main outside bunkers is 350 tons. l may be unloaded into these bunkers ctly from bottom- or side-dump standcoal cars, or may be unloaded from lola cars, either directly by hand or means of a clam-shell bucket and locoive crane on an adjacent track. There also provided beneath the main bunkers ergency coal pockets in which can be ed an additional 400 tons of coal h can be handled almost as ecoically to the boilers as from the regustorage compartment. This coal must, wever, be unloaded by hand from gonla cars through covenient steel coal rs. It is not intended to use the lower kets regularly for coal storage, and the is therefore available for the storage miscellaneous materials such as are l about the plant.

Coal, after being unloaded into the r hopper, is spouted into small push s in the basement, either direct or gh a crusher as necessary. The car en run on a down grade, to the ele-, which raises it to the cupola above, re by means of a turntable it can be tched over any part of the coal bunk- If it is desired to take coal from the le storage bunkers, the coal is delivered the small cars through gates conniently placed, as shown in Fig. 5. In moving coal from the emergency storage der the elevated track it is necessary to hd the small cars by hand.

Storage capacity in the overhead bunks is 320 tons, from which point coal ws by gravity directly to the stokers. ese overhead bunkers are of the new spension type, patented by the Brown Hoisting Machinery Company. The material, which is of steel and concrete, hangs from the supports in the shape of a parabola, thus placing the weight so as to throw practically all the steel in tension, and in this way take advantage of its maximum strength. Furthermore the shape of the bunker is advantageous from the standpoint of discharging all the contents through the outlets by gravity. That is, there can be no pockets formed to retard its downward movement.

Ashes fall into a closed ashpit in the usual manner, from which they are raked into cars and elevated to the ash hopper in the same way that the coal is handled. The overhead ash bunker has a capacity of a carload of ashes, which can be discharged by gravity directly into a car on the coal-storage track below. The small coal and ash cars each have a capacity of one ton.

One noteworthy feature of the coal-handling arrangements is the complete isolation of the overhead bunkers by means of partitions. This excludes all dust from the boiler room and makes it possible to keep the latter as neat and clean as any other part of the plant.

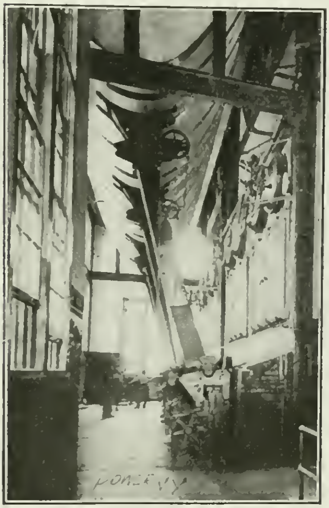

FIG. 3. BOILER ROOM

### The Boiler Plant

In this department the equipment consists of five Babcock & Wilcox water-tube boilers, rated at 400 horsepower each, and provided with superheaters of the same make. These boilers operate under a normal working steam pressure of 150 pounds per square inch, and a temperature corresponding to 100 degrees Fahrenheit of superheat. They are equipped with Green traveling link grates, operating from a line shaft in the basement. Duplicate steam engines belted to this shaft provide against breakdowns. The boilers are provided with vertical baffle walls, the gases passing three times through the bank of tubes and entering the stack through flues under the boiler-room floor, of concrete construction, with proper provision for expansion and contraction of the walls and roof. A Weber reinforced-concrete stack 200 feet high by 10 feet internal diameter takes care of the waste gases. During construction the stack was subjected to careful inspection, particularly with regard to finish. On completion the surface was treated with dilute acid, then washed with water, and a brush coat of white Berkshire cement was applied. This gives a fine permanent white finish to the stack, making it very attractive.

### Piping

Great care was exercised in the design of the piping system throughout the plant. Reliability and convenience in operation, accessibility in case of repairs, and also appearance, were the factors considered. Particular attention was given to providing for the necessary increased expansion due to the use of superheated steam. Long radius bends are used wherever possible, and pipe lines are properly anchored and supported. In selecting material for high-pressure steam lines, it was decided to use ferro-steel for all cast parts of valves, fittings and separators. Flanges on pipe lines above 6 inches in diameter are wrought steel, the remainder being ferro-steel. On the superheated-steam lines the pipe covering is double thickness 85 per cent. magnesia covering, canvas-jacketed, while that on the exhaust lines is standard thickness. From the superheated-steam nozzles branches lead down to the main header in the pump room, convenient to an iron-grating runway which facilitates repairs and inspection. From the top of this header steam is led through long-radius bends down under the engine-room floor and up to the turbines and air compressor. An auxiliary superheated steam header is tied to the main header with three 4-inch drop connections, and furnishes steam to the pumps, so that practically all the auxiliaries operate with superheated steam.

The feed-water equipment is located in the pump room and consists of a 2000-horsepower open-type feed-water heater and two American boiler-feed pumps, each with a capacity for feeding 2000 boiler horsepower. In the normal operation of the plant exhaust steam from the auxiliaries is used in the heater, but the piping is so arranged that the exhaust from the main units can be so utilized if desired. Provision is also made in the piping connections for a cold-water suction for the feed pumps, in case of necessary repair to the heater.

### Electrical Equipment

The present full-load capacity of the

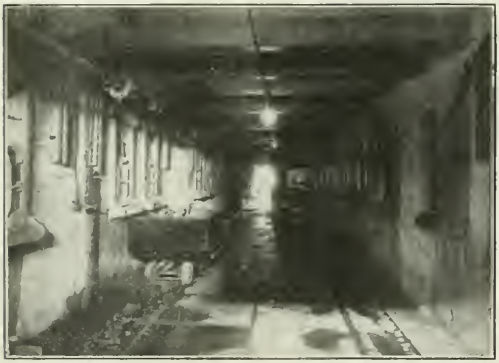

FIG. 4. ASH TUNNEL

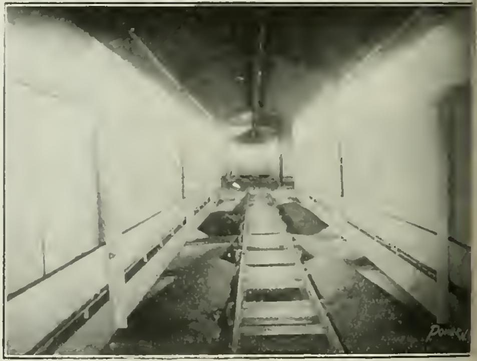

FIG. 5. ABOVE THE COAL HOPPERS

plant electrically is 1000 kilowatts, which is contained in two Westinghouse Parsons turbo-generators of 500 kilowatts each. In addition to these two main units the electrical equipment includes a 300-kilowatt rotary converter, one 30-kilowatt steam-driven exciter, one 30-kilowatt motor-driven exciter, three 150-kilowatt transformers and a 13-panel switchboard. All the above equipment is of Westinghouse make. The main generators operate at a speed of 3600 revolutions per minute, and deliver three-phase 60-cycle current to the switchboard at 440 volts. This current is distributed throughout the shops at 440 volts to induction motors and the lighting system. The total connected load in motors is 722 horsepower, while the total connected lighting load is 87 kilowatts, composed mostly of Cooper Hewitt lamps. The main generators also supply current to the rotary converter, which furnishes the direct current necessary for the variable-speed motors and cranes which add 830 horsepower to the load. Three 150-kilowatt transformers feed the transmission line to the old shops previously mentioned, raising the potential to 6600 volts for transmission, and dropping it again at the end of the line to 440 volts for distribution. At night, when there is no occasion for running the plant at the new shops, the old plant takes care of the yard lighting and saves operating a 500 kilowatt unit for this purpose.

The switchboard, which is located in the center of the plant on the turbine-room floor, is of 2-inch black Monson slate, with a dull finish. All cables from the generators are carried on the under side of the floor beams in the basement and are brought up through a slot in the floor behind the switchboard. The outgoing feeders are handled in the same way and leave the power house in underground tile ducts. As shown in the plan of the plant, space is available for an additional 1500 kilowatts in turbo-generators, another 300-kilowatt rotary converter and one 30-kilowatt exciter, thus providing for 150 per cent. increase in the capacity of the plant.

Alternating current is used for all lighting and constant-speed motors, and as far as possible the loop system of circuits has been followed. The feeders leave the building in underground conduits and tap the distributing loops in manholes under the shop floors, being controlled from locked steel cabinets at convenient points on the walls. From the loops, which are also in underground tile conduits, are taken leads to the constant speed motors driving groups of belt-driven tools and such individually driven tools as can be operated by this type of motor, such as punches, shears, grinders, presses, etc.

### LIGHTING SYSTEM

Autotransformers, or balancing coils, are connected to the 440-volt mains of the lighting system, and as adjacent outlets are connected to different phases, there is little danger of serious unbalancing of the circuits. The balancing coils have a capacity for taking care of any unbalanced load up to 33 per cent. of the entire lighting load on the loop, which is sufficient to meet any conditions likely to arise.

For lighting the yards an extremely simple system has been installed. It consists of two series circuits of tungsten lamps hung from ordinary series film sockets under reflector hoods, the sockets in turn being supported from the pilasters of the various buildings, or from poles wherever required.

Two panels control the lighting circuits, each equipped with a double-pole switch, a standard 8-inch dial ammeter, and sockets carrying three extra lamps. The circuits are tapped on separate phases directly across the 440-volt busbars. Thirty-two 60-candlepower lamps are connected in each circuit, each lamp taking 5.5 amperes at 13.6 volts. The ammeters read to 10 amperes, and above the normal current value of 5.5 amperes are calibrated to re in lamps. Thus if a lamp burns out th will be a corresponding increase in t ammeter reading, and the attendant me ly screws in one of the switchboard lan to bring the current down to normal. T defective lamp can then be located leisure. As the permissible ampere ra of the lamps is from 5.1 to 5.9 amper they are not seriously affected by the casional variation in current due to burned-out lamp. In practice it has b found that replacements are necess only at infrequent intervals.

### MOTOR LOAD

On the direct-current system 220 v are supplied by the rotary converter machines requiring a wide range of spe such as heavy lathes, boring mills, ra drills, shapers, millers, etc. All altern ing-current motors are provided w autostarters, and all direct-current mot have drum-type controllers, all being p tected by circuit-breakers of stand types. Tirrell regulators control the v age of the generators.

Crane and variable-speed circuits h been combined in a novel and effic manner. Extending entirely around machine shop in a loop are the varia speed mains, laid in lead-covered cabl underground ducts, leads to the mo being taken off through Dossert taps concrete handholes located at conven columns. Two crane trolleys reach full length of the shop. These are ported on the center columns and s cranes in each bay of the shop. At end these trolleys tap the variable-sp loop through double-pole switches, so the variable-speed and crane circuits in parallel. It is well known that load factor on crane circuits is very and in order to get the benefit of copper installed, they are utilized in way in carrying some of the varia speed motor load.

Each side of the loop may be isola

for purposes of testing or repairs, without affecting the other side. Furthermore the trolleys are so cross connected that should one side of the variable-speed circuit become disabled, the trolley on that side may be fed with current from the other side of the loop, so that its operation will not be interrupted.

### Compressed Air

An important part of the equipment of a railroad shop is the air compressor. In this plant a 2000-cubic foot Laidlaw-Dunn-Gordon compressor has been installed, and space has been provided for a d heate future unit. It is of the hori- z l cross-compound type, both in steam a air ends, with heavy rolling-mill f ne, Corliss steam gear, mechanically rated inlet and outlet air valves, and w er-jacketed intercooler of the surface-c denser type. This compressor operates o superheated steam and requires about 35 horsepower. Air is discharged at 100 p nds pressure per square inch, and after p ing through two 5x20-foot steel-tank r rvoirs, is carried out into the shops th ugh a pipe tunnel. The air intake fo the compressor is combined with a ve ilating duct in the basement for the turbo-generators, which is provided with a protected opening in the exterior of the building.

### Exhaust Steam Heating

Each main unit has its individual Baragwanath condenser, and is also cross connected to an exhaust steam-heating main leading to the shops. It is thus possible to operate any unit condensing or noncondensing independently of the others. This is of considerable advantage, since the climate is such that all exhaust steam available will not be required for heating except at rare intervals.

Leaving the power house, the exhaust steam is led through a large pipe line located in a concrete tunnel connecting with the various buildings. This tunnel is 7 feet wide by 5 feet high. In addition to the heating mains, lines for high-pressure steam, compressed-air and condensed-water returns are placed in this tunnel. The machine and erecting shop and boiler and tank shop are each heated by means of a combined hot-blast and direct-radiation system, and either or both these systems can be operated in various degrees to suit requirements of the weather. The blast fans, motor-driven, are designed to make a complete air change every thirty minutes, which materially benefits the ventilation of the buildings. Direct radiation, so arranged as to take care of exposures in the most economical way, is used in the remainder of the buildings. Condensation from the entire heating system is returned to the power house by the Van Auken system, with duplicate vacuum pumps discharging into the heater.

### Water Supply

Water for the plant is obtained from two sources, and provision is made for a third. First, three 8¼ inch wells 900 feet deep delivering 150 gallons per minute by means of motor-driven Downie double-acting deep well pumps. These pumps discharge into a gravity pipe line leading to a cistern in the pump room of the power house, called the well-water cistern. The second source of water supply is a pond covering 15 acres, with a capacity of 20,000,000 gallons. This water is impounded in an area arranged for the purpose on the shop property. It has been found from experience in this district that the normal evaporation from a pond just about equals the rainfall, but while

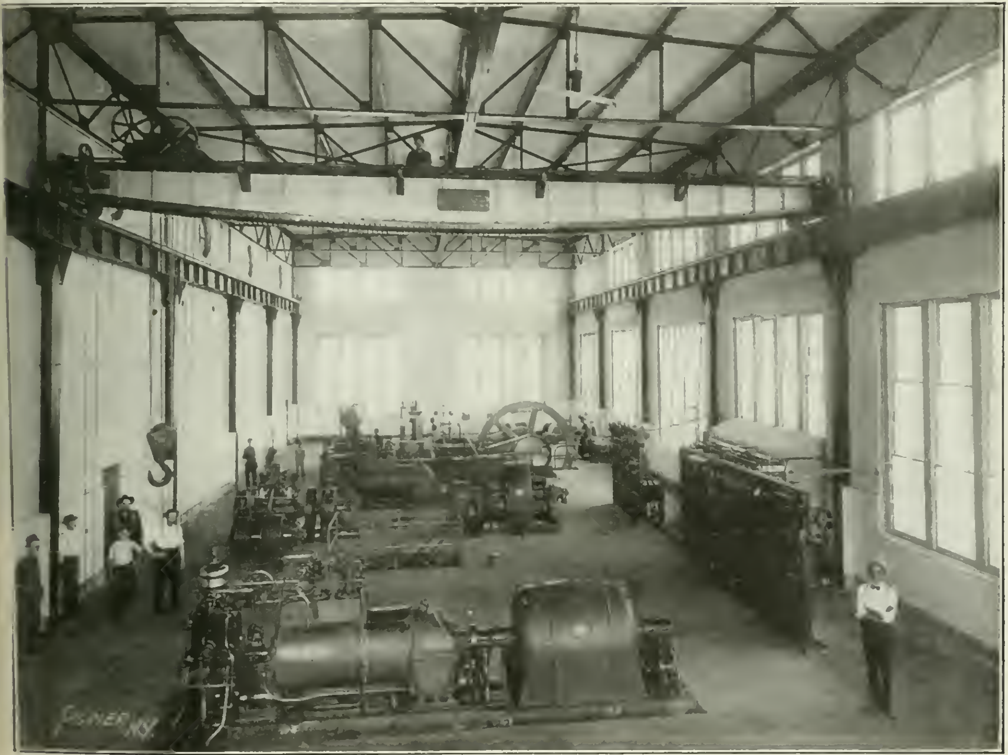

FIG. 6. THE TURBINE ROOM

the exposed surface of the pond is only 15 acres, the rainfall from about 200 acres flows into the pond from the roofs of the buildings and shop site, and in this way it is estimated that a considerable part of the water requirements of the plant for steam and general purposes is provided for. An 18-inch tile gravity pipe line conducts water from the pond to a cistern in the power house adjacent to the well-water cistern, and a pipe connection is provided between the pond water cistern and the well-water cistern, which can be regulated to suit requirements.

The circulating water required for the condensers is supplied by two Buffalo steam-driven centrifugal pumps, each pump having a capacity of 2440 gallons per minute. They are located in the pump room directly above the concrete pond-water cistern. After circulating through the condensers, the water flows by gravity from the hotwells through the main storm sewer and back to the cooling pond, thus completing the cycle.

Water used for general service and fire purposes is pumped from the pond-water cistern by means of two Knowles duplex tandem-compound steam pumps of 1000 gallons per minute capacity each, into a 100,000-gallon elevated steel water tank on a steel tower. The top of the tank is 160 feet above the ground. Water is distributed from the tank by means of a network of cast-iron underground mains covering the entire shop site and serving all departments. The gravity pressure on the system with the tank about full is 65 pounds per square inch. There is a separate underground distributing system for drinking and lavatory purposes, water for which is taken directly from the well-water cistern.

All pumps in the power house are so cross connected and provided with valves, that in case of emergency service can be interchanged on circulating, general-service and drinking-water pumps.

The two service pumps conform in every respect to the Underwriter's rules, except in the matter of the steam ends, which are compound, as noted above. However, they are provided with a switch valve, so that in case of fire the cylinders can be worked simple, thus giving the necessary cylinder ratio to comply with requirements. For fire purposes these pumps may draw water direct from the 20,000,000-gallon pond, or from the 100,000-gallon tank, by a system of valved cross-connections, the pressure being raised to 100 pounds.

In ordinary operation one of these pumps supplies general service and one drinking water alternately. This keeps steam on both of them ready for instant use, and gives them just enough to do to keep in good condition for fire protection. There are 25 outside fire hydrants located at suitable points, each hydrant being provided with a $2\frac{1}{2}$-inch hose connection. Inside the building there are a total of ninety-seven $2\frac{1}{2}$-inch hose valves, 52 of which have a hose rack and 50 feet of Underwriter's fire hose and nozzle.

The Arnold Company, of Chicago, were the consulting engineers and constructors of the entire work, and it is to them that the author is indebted for the information given here.

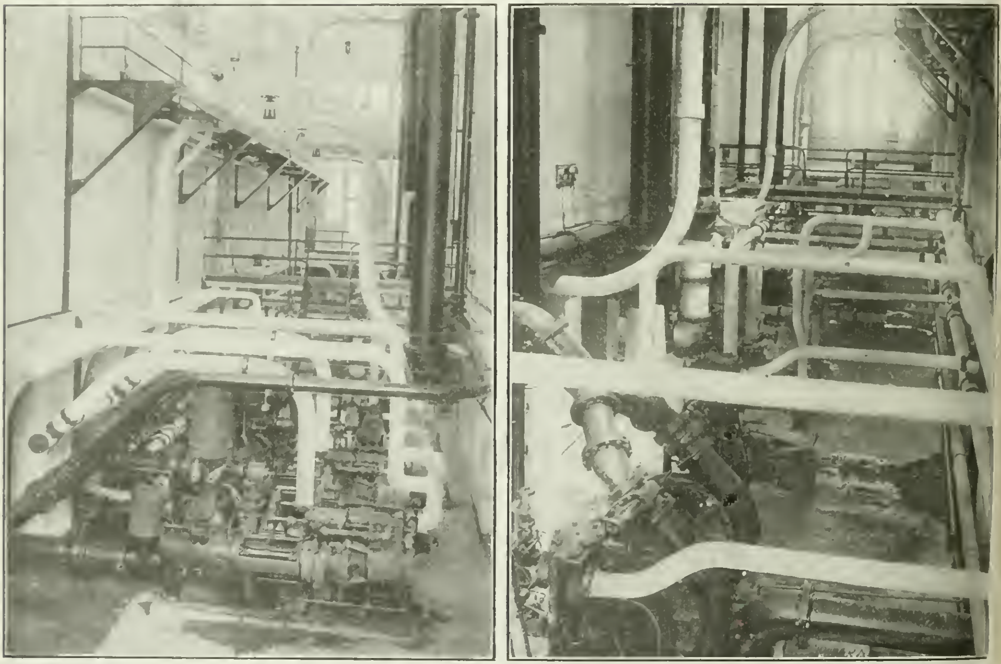

FIG. 7. VIEWS IN PUMP ROOM

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The Spokane, Walla Walla & Western Railway Company has been incorporated under the laws of Washington with a stated capital of $3,000,000 to build line through Spokane, Columbia, Wa Walla and southern Washington count to Umatilla county, Ore. E. M. Symon of Spokane, is president; M. S. Parker, Spokane, is vice-president and chief en neer; and L. H. Hoffman, connected w a railway-supply house, is secretary a treasurer. The company will develop large power plant 18 miles east of D ton, Wash.

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There is all the difference in the wo between an attempt to study by m reading and a real study through actual doing of work.—PROF. Jo PERRY.

# Primer of Electricity

## Parallel or Multiple Circuits

several pipes are connected to a tank ining water and elevated above the r nd, water will run out of all of the , no matter what their sizes may s long as the supply holds out. Simi- r if several electrical circuits are con- ed to a source of electricity, such as a mo or battery, current will flow in all

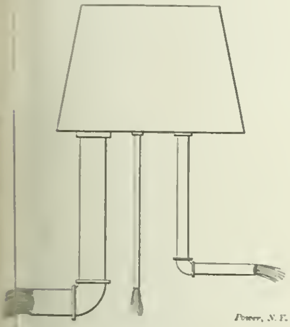

FIG. 4

i rcuits so long as the supply holds There is an important difference, er, between the water system and e trical system; in the former, the need to be connected to the tank t one end, as in Fig. 4, while in trical system the circuits must connected to the dynamo at both a in Fig. 5.

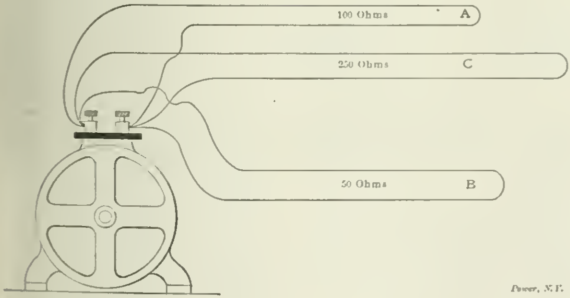

FIG. 5

A explained in a previous primer les- n, h current that flows in any circuit p s entirely on the pressure applied e resistance of the circuit. There- f when several circuits are connected a ingle source, the current in any one f m is determined by the resistance f circuit and the pressure applied it terminals. For example, in Fig. 5, the sistance of the circuit *A* is supposed to be 100 ohms; that of *B*, 50 ohms, and that of *C*, 250 ohms. If the pressure at the terminals of the circuits is 500 volts, the current in the first circuit will be

$$500 \div 100 = 5 \text{ amperes};$$

the current in the circuit *B* will be

$$500 \div 50 = 10 \text{ amperes},$$

and the current in the third circuit will be

$$500 \div 250 = 2 \text{ amperes}.$$

When several circuits are connected to the same dynamo in such a way that the pressure is practically the same at the terminals of all the circuits, they are said to be "in parallel" or "in multiple."

In practice, parallel circuits are not connected exactly as Fig. 5 might suggest. Fig. 6 is a better diagram of parallel distribution. Here, the small circles represent incandescent lamps and the little machine at the right is supposed to be a motor.

The circuit wires *w w* are so large that their resistance is very low and the e.m.f. at the points *a*, *b* and *c* is about the same as that right at the dynamo.

There is always some loss in the main circuit wires, no matter how low their resistance may be, and this has to be considered in actual working. For example, suppose that in Fig. 6 each lamp takes one ampere and the motor takes 8 amperes. Also suppose that the wire *w* is No. 10, which has a resistance of practically 1 ohm per 1000 feet. The distance from the dynamo to *a* is 100 feet, and the length of wire in that stretch is 200 feet; consequently the resistance will be

$$200 \times 0.001 = 0.2 \text{ ohm}.$$

All of the current has to pass through this first stretch of wire; therefore it will carry

$$1 + 1 + 8 = 10 \text{ amperes}.$$

Now, according to Ohm's law (page 260, August 17 issue), the e.m.f. required to force 10 amperes through 0.2 ohm is

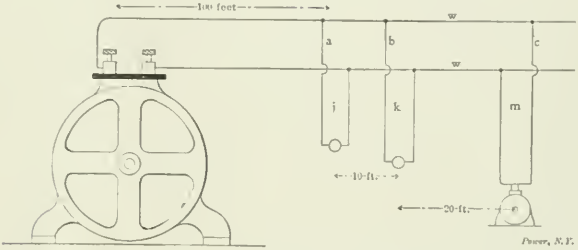

FIG. 6

$$10 \times 0.2 = 2 \text{ volts}.$$

Therefore the e.m.f. at *a* will be 2 volts less than it is right at the dynamo. This is known as "drop;" that is, the "drop" in the main wires from the dynamo to the point *a* is 2 volts.

From *a* to *b* the wires *w w* carry only 9 amperes, 1 to the lamp and 8 for the motor. The distance being 10 feet, the current passes through 20 feet of wire, the resistance of which is

$$20 \times 0.001 = 0.02 \text{ ohm}.$$

The "drop" from *a* to *b*, therefore, will be

$$0.02 \times 9 = 0.18 \text{ volt}.$$

From *b* to *c*, the motor current of 8 amperes has to pass through 40 feet of wire which has a resistance of

$$40 \times 0.001 = 0.04 \text{ ohm},$$

and the "drop" from *b* to *c* will be

$$0.04 \times 8 = 0.32 \text{ volt}.$$

Adding these "drops," from the dynamo to *b* there is

$$2 + 0.18 = 2.18 \text{ volts};$$

from the dynamo to *c* there is

$$2 + 0.18 + 0.32 = 2\tfrac{1}{2} \text{ volts}.$$

Therefore, if the dynamo maintains the e.m.f. at its terminals at 115 volts, the e.m.f. at *a* will be

$$115 - 2 \text{ (volts drop)} = 113 \text{ volts};$$

at *b*

$$115 - 2.18 = 112.80 \text{ volts},$$

and at *c*

$$115 - 2\tfrac{1}{2} = 112\tfrac{1}{2} \text{ volts}.$$

Now suppose the resistance of the branch wires *i* from the main wires to the [illegible] the resistance of the branch wires is 2.8 ohms and the resistance of the branch wires is 5 10 of an ohm. Then the e.m.f.s and drops would work out this way:

| | | | |
|---|---|---|---|
| E.m.f. at | $a = 113$ | $b = 112.8$ | $c = 112\frac{1}{2}$ |
| Drop in | $j = 3$ | $k = 2.8$ | $e = 2\frac{1}{2}$ |
| E.m.f. at lamps & motor | 110 | 110 | 110 |

Such an ideal combination would be impractical in actual work. The example is given merely to give the reader a clearer idea of the principles of current distribution and voltage drop in parallel circuits.

In any system of parallel connections the positive terminal of each conductor or piece of apparatus is connected to the positive terminal of every conductor or piece of apparatus in circuit with it.

This is exactly the opposite of the rule for series circuits, where the positive terminal of each piece of receiving apparatus must be connected to the negative terminal of any other receiving apparatus in circuit with it.

In both systems, the positive terminal of a dynamo or other *source* of current must always be connected to the positive terminal of any receiving apparatus which it supplies, such as motors and arc lamps.

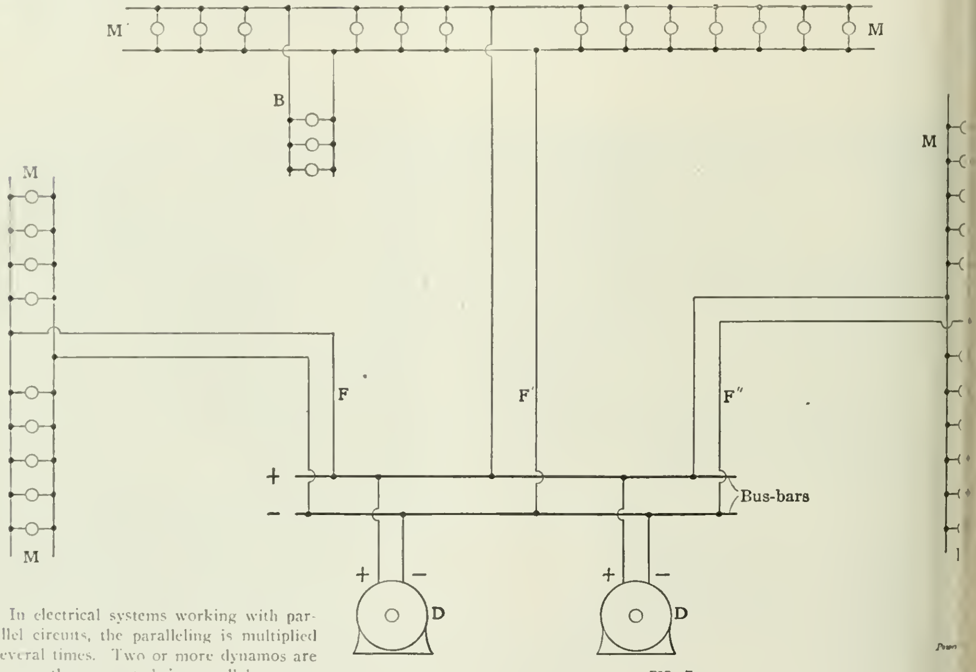

FIG. 7

In electrical systems working with parallel circuits, the paralleling is multiplied several times. Two or more dynamos are frequently connected in parallel to two heavy conductors known as "busbars." Several circuits are connected to these busbars in parallel, several other circuits are connected in parallel to each of the first circuits, and lamps, motors, etc., are connected in parallel to each of these second circuits. This arrangement is illustrated diagrammatically by Fig. 7, where two dynamos *D* and *D* are shown connected to "busbars." To these busbars three pairs of wires *F*, *F'* and *F"* are also connected; these are known as "feeders," because they "feed" current to the "mains" *M*. From the main *M'* a branch circuit *B* is led to supply three lamps.

It must not be supposed that this diagram represents an actual layout. It is intended only to illustrate the principles of extended parallel distribution. The feeders take current in parallel from the busbars; two mains take current in parallel from each feeder and a number of lamps are supplied in parallel from each of the mains.

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## Coal Briquets in Belfast, Ireland

Vice-Consul Paul Knabenshue supplies the following information relative to the peculiar economic value of the coal briquets manufactured in Belfast:

The manufacture of fuel briquets from slack coal is a large and increasing industry in Belfast. The machinery used is of English manufacture, and is patented, but there is no patent on the process employed. The material is clean slack coal, combined with from 5 to 10 per cent. of pitch. These are mixed by mechanical means, and the mixture is ground to a fine powder in a disintegrator.

This powdered material is fed into a cylindrical steel "pug," to which su heated steam is admitted through a n ber of jets, and the material mixed revolving arms. The pitch becomes from the heat of the steam and by adhesiveness binds the particles of together.

The mixture passes from the "p into a receptacle, from which it is fo into steel brick-shaped molds, the po in each mold being subjected to a p sure of 10 tons. The briquets so for are 5x5x3 inches in dimensions. briquets are automatically ejected an endless-belt carrier, which d them to the stack room.

The operation of the machinery tirely automatic, and it turns out briquets per hour, which is between 5 tons. These briquets retail at 50 cents per 100 (by count), or ab per long ton of 2240 pounds.

The characteristic of these briq that, if laid upon the grate unb their combustion is slow and while if broken up a hot fire is pro One or two placed upon the hou grate will burn slowly through the or day and upon being broken u produce a splendid fire. They ar chiefly by the poorer classes for d purposes. Owing to the quality o combustion, when unbroken, the are more economical than coal, and a estimated to last, for household pu ses, as long as 1½ tons of English co

# Discoveries of Engineers

## Some Interesting Experiences of Operating Engineers, Describing Causes and Remedies of Defects Met with in Practice

## BY W. H. WAKEMAN

The title of this article does not refer to what is generally known as great discoveries of eminent engineers, which have proved beneficial to the world at large and immortalized the names of those who possessed the genius to discover new principles and the courage to apply them to [illegible] service. It does apply to working steam engineers, who were in trouble because their plants could not be operated [illegible] owing to unseen defects. They possessed sufficient perseverance to enable them to discover and remove the defects which caused them trouble, and by presenting the following facts in relation to the circumstances, the writer hopes to aid many others who may find themselves in trouble under similar conditions.

Fig. 1 illustrates a Westinghouse engine that I assisted to erect and was about to start in a strange city, where the surroundings were far from congenial, owing to the jealousies of employees of the company that owned the machinery.

The engine was completed about 11 [illegible] the day, and the crank case filled with water to the hight required by the builder's directions, after which one gallon of [illegible] West Virginia oil was poured in, that it might float on the surface. The cranks dip into this oil at every revolution, thus providing copious lubrication for the boxes at both ends of the connecting rods. Steam was to be turned on and the engine started at 1 o'clock, but while at dinner I was suddenly impressed with the idea that some vicious person had opened a cock and allowed both oil and water to run out of the crank case. On returning to the engine room, I examined the cock in the outlet pipe, but found it closed. I was not satisfied, but went into the cellar and there found the floor covered with water and black oil.

[illegible] part of the crank case is removed, showing no provision for lubricating the connecting rods, hence the crank pins would have been scored and the boxes spoiled in a short time if steam had been turned into the cylinders under these conditions, as there was no gage to indicate the absence of the lubricating mixture. More water and oil were put into the crank case, after which the engine was started and run without trouble.

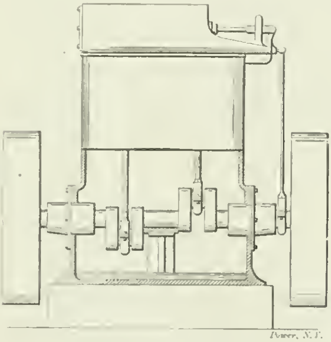

Power, N.Y.

FIG. 1

Fig. 2 illustrates the valve gear of a Corliss engine, with the jim crank which operates the exhaust valve on the crank end turned downward, when it should appear like the head-end crank. A certain engineer who was not familiar with Corliss engines secured the position of engineer for this plant, which consisted of a double engine with cylinders 18 and 20 inches in diameter and the stroke of both was 42 inches. He employed a so-called expert engineer to start this engine and give him all necessary information concerning its operation. After the "expert" had left the engine, the regular engineer discovered it in the condition shown, although it continued to run, because the other side was in good order, but the speed was not steady. Of course this caused great waste of steam, as there was nothing to prevent it from blowing through the crank end with full force, and this action called attention to the defect. By unhooking the valve rod and rocking the wristplate as far forward as possible, the jim crank was turned back to its proper position, which proved a complete remedy, as nothing was bent or broken.

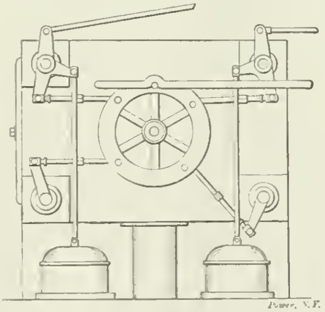

Power, N.Y.

FIG. 2

An engineer was employed to operate a certain plant, to succeed one who had been discharged for incompetency. He oiled the engine properly the first day that he had charge of it, warmed the cylinder, turned on steam and brought the machine up to full speed. In about two minutes the engineer discovered the babbitt metal flying out of the crank-pin box, as shown in Fig. 3, making it necessary to shut down for repairs.

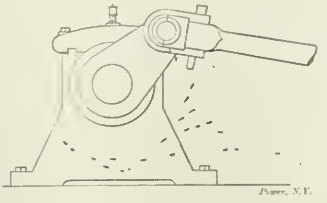

Power, N.Y.

FIG. 3

This incident shows the necessity for watching the bearings very closely during the first hour that an engineer runs an engine with which he is not familiar. Nothing definite could be proved concerning the actual cause of this failure, but the fact that the discharged engineer was working around the crank with a hammer and monkey wrench after he had shut down this engine for the last time was very significant.

The writer was employed to operate a certain plant and ordered to report at the office for duty while the plant was in operation. The superintendent took me into the engine room, ordered the other engineer to leave the premises at once and never return, after which he turned the plant over to me and left the room. This was very unpleasant for both the old and the new engineer, but inasmuch as I found them to be very just and honorable people to deal with, the cause for this abrupt action was not a great mystery, as it was plain that they distrusted their former employee.

Fig. 4 illustrates the position in which an engineer left the governor of a Corliss engine when he shut it down for the last time, as he was forced to find another situation. The flyballs are in their lowest possible position, as the pin which is used to hold them higher is now in its place of rest at *A*. Just before this engine is shut down, this pin ought to be taken from its present position and put into a hole prepared for it, that is now covered by the lever at *B*.

The retiring engineer did not do anything to injure the machinery, therefore he could not be charged with a misdemeanor. He only failed to put this pin in the column where the lever could rest on it and thus prevent the flyballs from falling as low as shown in the illustration. As the stop motion was in good order the latches would not hook onto the steam-valve cranks, hence no steam could pass from the steam chest into the cylinder, consequently the engine would not start when the throttle valve was wide open.

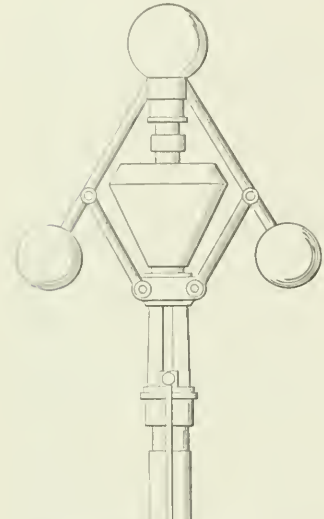


FIG. 4

The new engineer was not familiar with Corliss engines, hence did not close the throttle valve, raise the flyballs, change the pin from $A$ to $B$ and then hook the latches on by rocking the wristplate from one extreme point of its travel to the other. He waited until another engineer came and performed this simple operation for him, after which the throttle valve was opened slowly, the wristplate moved back and forth a few times to admit steam to warm the cylinder, the valve rod hooked on and soon the engine was running at full speed, after a delay which cost several dollars, as none of the men could go to work until the machinery was ready for use.

Several years ago the Twiss engine was put on the market. It is similiar to the original Wheelock, as shown in Fig. 5. A prospective customer asked the builder if any ordinary good engineer could run that kind of an engine, and was quickly assured that he could, as it was a very simple machine that anybody could understand. The engine was purchased and installed, after which the engineer was instructed concerning its peculiarities. A simple device is used to prevent the governor balls from falling to their lowest position when the engine is shut down. Failure properly to use this device would cause the safety-stop motion to operate and thus prevent the latches from hooking on and opening the valves, as shown in Fig. 5, consequently steam could not enter the cylinder.

The engineer learned to connect this device just before he shut down at night, let it remain in position until the next morning, start his engine and secure full speed with the throttle valve wide open, after which he removed the device in order to permit the stop motion to operate in case of accident to the governor belt. All went well until the engineer was told to slow down the engine for a few minutes, and then run at full speed again. He did not consider it necessary to connect the above-mentioned device under these conditions, consequently he closed the throttle valve, waited until the flywheel was revolving at a low rate, and then slowly opened the throttle valve, expecting to maintain that speed, but although he opened the valve to its full capacity the engine stopped, and he could not start it. After waiting a few minutes to see what the engineer could do, the owner sent to the maker and told him to send a man to start that engine, as nobody at the works could do it. In due time the man arrived, and in five minutes the machines were running full speed.

A heated discussion followed, in which the owner claimed that through deception he had been induced to buy a complicated engine, when he expected to get a very simple type. The builder resented this charge of insincerity, claiming that he had not misrepresented facts in the case, as any ordinary good engineer could run and take care of this kind of an engine, and he proved his claim, too. The engineer discovered that when he wished to secure a low speed in order to put on a belt or for any similar purpose, it is necessary to treat the engine just as if it were to shut down at night, so far as this po is concerned.

The engineer of a certain small pl desired to convince his employer that was the only man who could run t particular engine. On several occasi he managed to be absent when it was ti to start the machinery, consequently so body else tried to perform this duty, the flywheel did not move even when throttle valve was wide open. After w ing a short time the owner would send the engineer to start the engine. He w not do this as long as anybody was wat ing him closely, but after he had been alone for a few minutes the engine w start and run to the satisfaction of concerned.

After this had happened several ti the owner resolved to discover the ca for these failures, consequently he b a hole in the floor above the engine, proceeded to watch the engineer thro it, after another man had failed to s the engine one morning. The first ac the engineer, as discovered by the ow

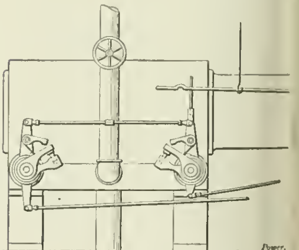


FIG. 5

was to loosen a set screw in the v gear side of the engine as shown Fig. 6. He then slowly opened the th and brought the engine up to full spee

He had bored this hole in the cyl and cut a thread in it for the set without being discovered. By bri the crosshead to a certain position o guides the piston was directly op this screw, then it was an easy matt clamp it there, as shown in Fig. 6. sequent events caused the engineer t cover that while he was smart enou deceive his employer for a short tim employer was smarter because he covered the true state of affairs. after this engineer will probably not ready to attempt to prove that his se are valuable by the adoption of suc honest plans, as he has discovered is not a good investment.

Fig. 7 illustrates a throttling gov the stem of which is made in two for convenience in assembling. Th connected by a coupling just belo horizontal bevel gear, and this c is fastened to each part of the ster tapering pin. In the illustration these pins is shown just clear of the coupling from which it has been removed

A certain engineer was employed to run an engine, the speed of which was controlled by one of these governors. On attempting to start this engine for the first time, the engineer discovered that the piston would not move when the throttle valve was wide open with the highest pressure of steam allowed to the boiler. Owing to the extreme simplicity of the engine there seemed to be little chance for successful investigation, hence the engineer felt helpless for a few minutes, but a careful search for defects enabled him to discover that the above-mentioned pin was missing, and the balanced governor valve was in a low position, completely closing the passage for steam, thus fully explaining the failure to start in the usual way The lower part of the stem was not tirely separated from the coupling, which rendered the defect much less nent than if there had been a space ft between them.

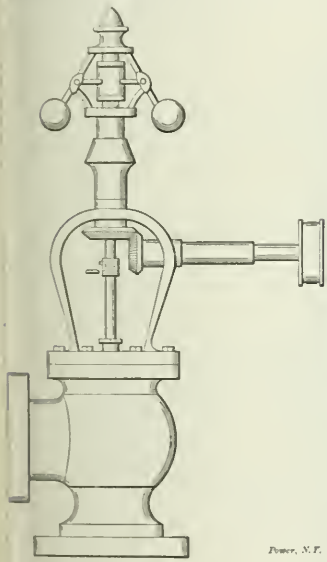


FIG. 7

In another case the engineer of a mill was forced out of his position because he property had been leased to other arties, who brought a new man to take arge of the machinery, including the engine This engine had only been running short time under the new conditions hen the engineer discovered that the wheel had come to a sudden stop, and hen its motion was reversed. It continued turn nearly a revolution in one direcon and then quickly go the opposite way ntil steam was shut off, allowing it to reain at rest.

The new engineer was not well educated the design of engines, and had not thoroughly examined this one, which was a peculiar specimen, as an examination of Fig 8 will demonstrate It ran "under," as the arrow indicates, and the eccentric follows the crank because there is a rocker operated by the eccentric rod, which imparts motion to the valve rod, therefore the motion of the latter is reversed from what it would be if the engine was fitted with a direct-connected slide valve, as indicated by the arrows, in which case the eccentric would precede the crank. The cylinder was fitted with a semirotary valve at each end, which admitted steam from center to center and then allowed it to escape to the exhaust pipe, consequently there was no cutoff. These valves were driven by a nonreleasing gear, although their motion could be controlled at pleasure by unhooking the valve rod and operating the wristplate by hand. The speed was regulated by a throttling governor

Under these conditions it is not surprising that the new engineer did not know where to look for the cause of the trouble, although very anxious to avoid the disgrace which naturally follows defeat along this line. The old engineer was induced to set the valves for a fair consideration. He turned the eccentric on the crank shaft until its position was satisfactory, tightened a set screw and the job was done. By observing these proceedings the new engineer discovered that there was no mystery about the "accident," and although nothing more was done at that time, the engine operated perfectly when steam was turned on.

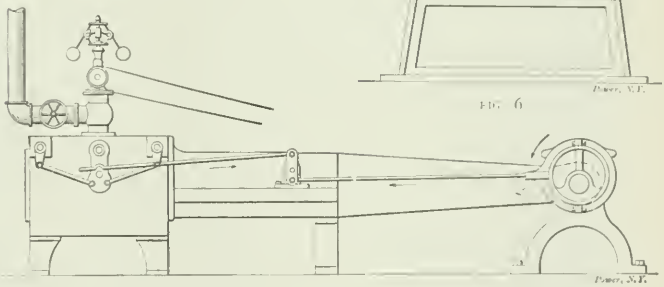


FIG. 8

An analysis of the action observed results in the following conclusion concerning its cause: The eccentric was not fastened securely to the crank shaft, hence when a heavy load was put on the engine, by starting a machine that required the whole available power at times, the eccentric slipped and admitted steam in front of the piston instead of behind it. This reversed the flywheel, but its motion was not continued in this new direction because the eccentric was still comparatively loose on the shaft, hence it did not remain in one position in relation to the crank This plant was run by the same engineer for several years, but that eccentric never slipped again.

Fig. 9 illustrates a brick chimney with a steel flue discharging into it. When a new engineer took charge of this plant he found a very poor draft, therefore he could not maintain the pressure necessary to run the engine at full speed. While standing in the engine-room door one day, trying to devise a plan for improving his draft, and feeling discouraged because it seemed impossible to secure what he desired, a trivial incident called his attention to the base of the chimney. He discovered that the cleaning door was open, thus admitting a large volume of air where it was not wanted. As the chimney took its supply from the nearest source, none was drawn from the boilers until after the full capacity of this door was taken, which accounted for the poor circulation through the furnaces. Perhaps it is unnecessary to say that whenever the draft in that plant seemed to decrease, the first place visited in a search for the cause of it was the base of that chimney.

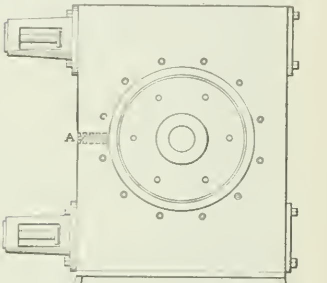


FIG. 6

In another case the draft was always good while the regular engineer (who was also the fireman) was on duty, but occasionally he wished to be absent for a day or two Whenever a substitute was in charge of the plant there was not draft enough to secure bright fires This was a mystery until an exasperating failure to secure sufficient steam to run the engine caused an energetic substitute to make a thorough examination of everything connected with the boilers He discovered an extra damper in the chimney that was nearly closed, leaving space for the escape of smoke, in order to prevent it from attracting [illegible] [illegible] giving draft enough to cause the fires to burn briskly. The original engineer would nearly close this damper when he was going away, and slyly open it when he returned, as this was his plan for demonstrating his superior abilities as an engineer.

The lower part of Fig. 10 illustrates the water end of a direct-acting pump with all valves removed. The upper part shows the deck which carries the discharge valves. In order to bring the discharge port *A* directly over *B* where it belongs, the deck must be given one half of a turn, thus allowing the water to be discharged freely. An erecting engineer set and piped one of these pumps, and when everything was apparently ready for service he turned on the steam, expecting to see the pump deliver water, but it only moved through one stroke, then stopped so suddenly that the engineer concluded that heroic measures must be adopted to start it again. He removed the water box and found that the deck had been put on backward, as indicated by the illustration, therefore no outlet was provided below *A*, as the triangular hole *B* was covered by solid cast iron, ¾ inch thick. When the central nut was removed, the deck raised, turned and placed in proper position, the pump delivered water freely, but such a mistake in assembling a pump might cost several dollars and cause a plant to be shut down long enough to prove very annoying. Was this an accident, or did somebody do it to cause trouble?

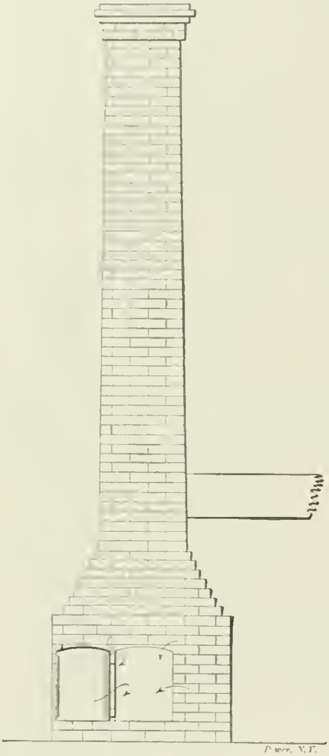
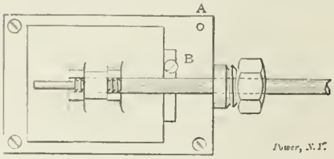

Power, N.Y.

FIG. 9

The engineer of a large office building was informed that his services would not be required after a certain date. Just before leaving the premises he took a pin out of a valve rod head on one of the duplex pumps and laid it on the steam-chest cover, as shown in Fig. 11. One end of the small valve-rod link was thus freed, and it dropped down out of place. The new engineer did not understand why this pump failed to work, so he proceeded to call in the proprietor of a repair shop for advice. This man belonged to the class that will put six or eight new tubes in a boiler, when only two are required, and charge double time for the labor in addition to a large profit on the stock used. Happily such men constitute a small minority of the great body of engine and boiler repairers, who conduct their business according to approved principles. He came to this plant, examined the pump, took note of the fact that a new and inexperienced engineer was in charge of it, reported that the old pump was worn out and offered to install a new one at short notice. As it was necessary to keep the plant in operation, and the owner supposed that the report was an honest statement of facts, the new pump was purchased of the repairman and erected. Of course it was better than the old one, but the latter would have done good service for several years under the care of the former engineer. In this case the new engineer did not discover the true state of affairs, but the old one told of the result.

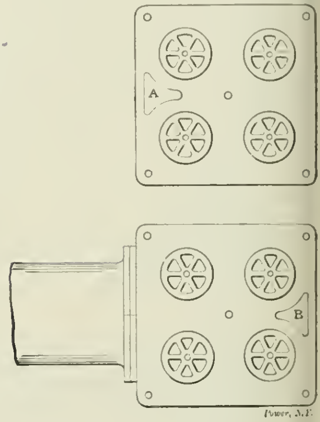
Fig. 12 is a plan of the flat valve and valve seat of a steam pump used for creating a pressure of about 300 pounds on special machinery which required intelligent supervision. While this pump did not always give the best possible results, it did not completely fail to work until one engineer left the plant and a new one took charge of it. The latter could not make it go, although as far as he could judge by its external appearance it was in good order. On proceeding to investigate the internal parts, his first move was to remove the steam-chest cover. The valve seat was not cast with the cylinder, but was made in a separate piece and fastened on with four screws, the object of which is to facilitate repairs, as it is much easier and cheaper to remove four screws, take out a detachable seat, put it on a planer, secure a perfectly true surface for the valve to travel on and put it back in place, than it is to file and scrape a solid seat, especially if it is below the surface of the steam chest, where it becomes necessary to use special tools.

Three of these screws were in place, but the fourth one was not where it belonged, at *A*, Fig. 12. He discovered it at *B* in the nearest steam port, with the valve hard against it, thus preventing further movement of the pump. Did vibration of the machine shake this screw out of place? Did it then fall into th port as shown? The new engineer foun it in perfect order, and it went back int place as easily as when the pump wa first assembled. Could it have worked ou slowly, and fallen into the port withou being disfigured by the action of the valve Why did it get into the port just as th old engineer finished his labors, to b found by the new one during his first ex perience with the pump? While the questions were suggested by actual cond tions, when considered in connection wit the absence of definite information on th subject, nobody can give positive answe to them, which adds to natural interest i the matter. It is a source of satisfa tion to know that the engineer discover the defect before serious damage w caused, and that no delay to this part the works resulted from the obstructi screw.



Power, N.Y.

FIG. 12



Power, N.Y.

FIG. 10

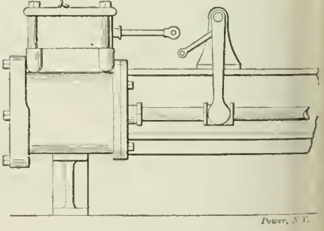

Power, N.Y.

FIG. 11

# A New Gas Producer for Low Grade Fuel

By Dr. Alfred Gradenwitz

I spite of the enormous strides made ... makers of steam engines and steam ...ls, suction gas plants, besides liquid-...combustion motors, are rapidly gain-...g round because of the extraordinary ... in fuel insured by their use. Now ...e Deutz gas-motor factory, Cologne, ...ken a further step in advance to...r reducing the cost of fuel by design-... improved gas producer for low-... fuel which appears to combine sim...e and safety of operation with dura-... and reliability. This producer takes ... cheapest classes of fuel, such as ...te dust, anthracite rubbish, coke ... smoke-chamber coal dust, etc., for ... no satisfactory use was pre-... available. Though the first cost ... a plant is slightly higher than ... a plant for gasifying the usual ... fuel, the advantage is very great ...f the extraordinary difference in ...st of the fuel.

T... coal-dust generator consists of a ...t ...r pit with a step grate and a ...c... fuel reservoir having an "over-...w ...e" on which the hight of the active ... depends; in the lower part is ... sump. Both above and below the ... slag doors; only the lower ones ... be kept open during operation. ... bed is kept at a constant hight ...arging, through the sump, the ... ashes which accumulate in the ... part of the step grate.

...mixture of steam and air admitted ... the step grate can be accurately ...d as to its composition by a regu-...ck, the steam being generated in ...-heat boiler by means of the ...t gases from the engine. This ... avoids the drawback inherent in ...rizers fitted into the generator, ... withdrawing heat from the gas-gen-... process. It is likewise superior ... generation from the heat of the ...cent zone of the generator, as ... the case of fuels containing large ...ges of ash (as in the present ...) quite inadequate, and involves ...sk of excessive heating and scori-... of the grate.

...ig 3 illustrates the arrangement for ... uniform distribution of the sup-...d to the whole of the grate area. ...nce has shown that in this type ... generator an excessive amount of air ...ay pass along the wall, so that the ...xygen is not utilized sufficiently, while ... formation of slag on the wall is as-...isted In order to do away with this ...rawback, the overflow edge of the fuel ...eservoir, on which depends the hight of ...he ... bed on the grate, has been so de-...igned as to bank the fuel higher on the walls, thus offering to the passage of air along the latter a greater resistance than in the center of the grate. This arrangement has in practice given excellent results.

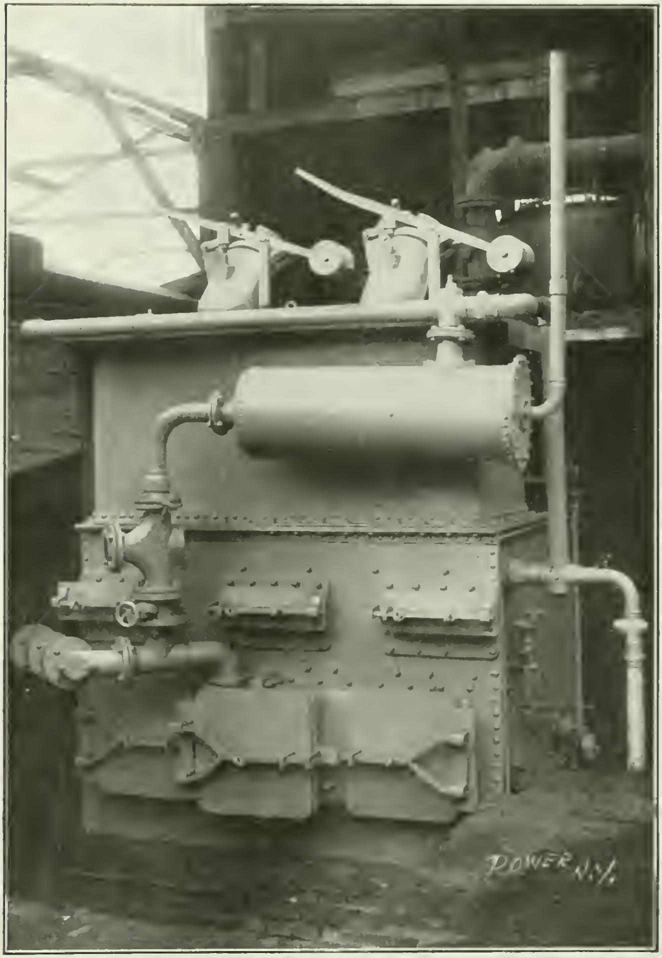


FIG. 1. DEUTZ GAS PRODUCER FOR LOW-GRADE FUEL.

In connection with tests recently made by Engineer Hildebrand at the suggestion of Professor Josse of the Charlottenburg Technical High School, there was used anthracite dust of from 3 to 8 millimeters and a heat value of 7300 calories (about 13,000 B.t.u. per pound), costing 8 marks per 1000 kilograms (about $2 per ton). After issuing from the producer, the gases passed through a dust separator, a scrubber and a purifier of the type generally used in connection with Deutz suction-gas producers. Those tests extended over three days, and only small quantities of slag discharged occasionally during operation, without any reduction in the output of the engine.

The weight of the ashes taken from the generator was about 10 per cent. of the fuel supplied. The consumption of anthracite dust was found to be 445 to 446 grams per horsepower hour (about 1 pound per English horsepower-hour), the amounts of material withdrawn during the discharging of slag being deducted. The cost of fuel thus worked out at 0.35 pfennig per horsepower hour (about 0.09 cent per English horsepower-hour).

In the case of coke dust, the cost was found to be even lower; a consumption of from 750 to 800 grams was obtained with coke dust of 5700 calories from the Stuttgart municipal gas works, the material withdrawn from the sump being left unutilized.

Especially remarkable results were obtained in connection with smoke-chamber coal dust taken from the smoke chambers of locomotives. This material, as used in connection with one gas producer of the above type in operation at Swinemund, forms a reddish-brown sandy powder, containing 55.6 per cent. of solid carbon and having a heat value of 4500 calories. Of this was consumed about 0.75 to 1 kilogram per horsepower-hour, and in tests made on delivered work a consumption of 1.28 kilograms was registered for each kilowatt hour, corresponding to a consumption of about 0.77 kilogram per brake horsepower hour

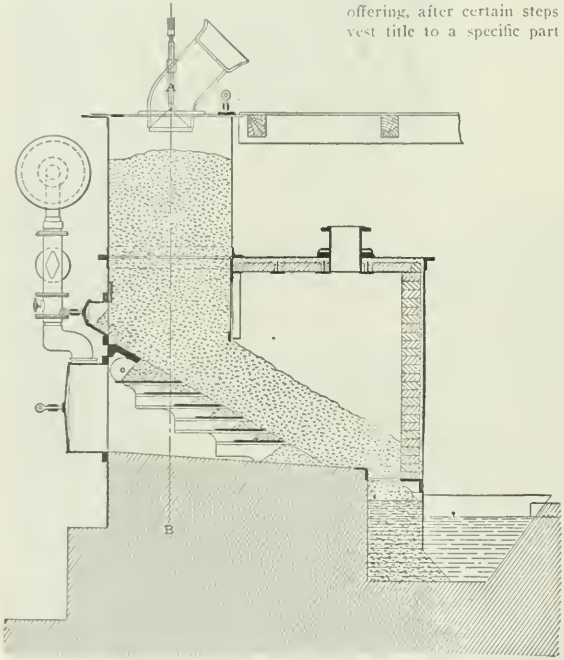


FIG. 2

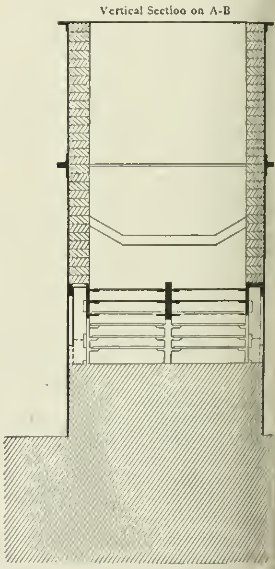

Vertical Section on A-B

FIG. 3

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At Yokkaichi, Japan, the electric-light company has installed a 750-kilowatt Westinghouse turbo-alternator in its Miye Ken plant, near Nagaya. The turbine operates at 200 pounds steam pressure, exhausting into a vacuum of 27 inches. Three-phase 60-cycle currents at 2200 volts, for lighting and power purposes, are supplied by the new generator.

Three 55-horsepower Westinghouse gas engines have been installed by the Furawaka Coke Works, of Tokio, to operate a coal-washing plant. These engines will use as fuel the surplus gas from the coke ovens, having an average calorific value of 460 B.t.u. per cubic foot.

## President Taft on Conservation

Outlining the Government's policy regarding the conservation of the nation's resources in an address of 45 minutes' duration in Spokane, where he was the guest of the Chamber of Commerce and the people of the Inland Empire on September 28, President Taft said, in part:

"When the Government became possessed of its public domain and took measures to secure its settlement by the passage of the homestead act and other acts offering, after certain steps prescribed, to vest title to a specific part of the public lands in individuals, the chief object of Congress seemed to be to secure development by inducing people to settle on public lands and acquire it for themselves.

"The thought of conserving the resources which were thus opened to private acquisition hardly occurred to Congress.

"The truth is that the needs of the country have developed so, and the demand for land has so much increased, that in order to secure a sensible, business-like disposition of the lands remaining in the public domain there must be an authoritative classification of lands by the proper bureau, so as to show whether they are agricultural lands, forest lands or lands available for water-power sites on the banks of rivers and other streams, or mineral lands, coal lands, oil lands or phosphate lands.

"Had this classification been
earlier it would have saved a
amount of litigation, and would
saved to the Government millions of
patented as one kind of land whe
fact, it was another.

"The classification is being rapidly
ecuted by the Geological bureau.

"After classification legislation sl
be, and doubtless will be, directed t
means by which such lands should be
posed of, and the restrictions specifi
the interest of the public on the t
and use to which the owner is to pu
lands.

"As to water-power sites, there
been such a change in conditions t
special provision should be made
interest of the public for their t
to private control.

"The development of electrical
ances and the transfer of power t
electric lines for long distances ha
the use of water power to produ
tricity one of the most important
of power we have in this count
will so affect the cost of productio
the fields of manufacture and pr
of the necessities of life as to req
Government to retain control o
use by private capital of such pow
it can only be exercised upon site
belong to the Government.

"Such sites can be properly part
under conditions of tenure and
sation, consistent on the one ha
reasonable profit to the private
invested, and on the other with t

of the public to secure the furnishing
f such power at reasonable rates to
very one.

"There should be a condition of for-
eiture if the owner of the power site does
ot, within a certain time, expend capital
ufficient to develop the power, and after
evelopment shall not charge rates to the
blic beyond what is a reasonable profit
n the capital invested in the improve-
nent to be regulated by the Government

"The amount of compensation that
ught to be charged by the Government
r the use of the water-power sites
ight perhaps be left to readjustment
very ten to fifteen or twenty years.

The compensation to be charged in the
set might well be purely nominal, but
ter the project has become a complete
cess and the profit has grown to a
nsiderable percentage of the amount in-
ested, then there would seem to be no
n why the public might not be bene-
ed by sharing in the profits of the trans-
on to an amount to be fixed upon
tration or in some other method at
end of a stated period of fifteen or
enty years.

This is an arrangement toward which
e tenure of all public utilities is tending,
I knew of no reason why it should
t be introduced into the Governmental
position of such sources of continuous
wer as the water sites upon public
ds are likely to be.

I know it has been the course in the
st under the bounteous and generous
sition of the Government to give
se water sites away under existing in-
uate acts; but we have reached a
e now when the importance of these
r-power sites has greatly increased,
there would seem to be no reason
it would interfere with a speedy de-
pment of the country to impose re-
rictions upon the use of such water
s equitable as between the public and
investor.

This is a matter which Congress must
up. The water-power sites are now
rally disposed of under the same kind
procedure as that by which agri-
tural lands are taken up, and there is
power on the part of the secretary
e interior in the disposition of such
to impose the conditions suggested.

is matter has become so important
nder the last administration large
of lands amounting to upward of
00 acres were temporarily with-
n from settlement in order to pre-
t the acquisition of water-power sites
r the general land laws.

"This amount has been reduced under
present administration to 450,000
s, which include even more ascer-
ned water sites than the original with-
awals.

"It should be understood that these
thdrawals are temporary and can only
justified as made in order to permit
Congress to legislate on the subject of water power sites.

"Should Congress conclude not to do so, it would be difficult for the executive to find the authority indefinitely to withhold these lands from settlement under the general laws on the ground that they contain water-power sites. The legislative power is vested in Congress and not in the executive.

"I shall, therefore, urge upon Congress, at its next session, the passage of a law authorizing the disposition of such water-power sites upon terms to be agreed upon by the secretary of the interior with the proposed purchaser of the character already indicated.

"It may turn out that restrictions of this sort are so burdensome as to discourage the investment of capital, and it may be necessary to modify the requirements on this account.

"But my own impression is that the demand for water power is going to be so great that these restrictions will not prevent the investment of capital but will ultimately bring to the public coffers a revenue from an entirely proper source and will secure the development of a power for manufacturing industries that will probably in time exceed the utility and value of coal, and become a substitute for it."

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## Wrecked but Nearly as Good as Ever

By R. L. Evans

The damage done in a recent engine wreck at De Ridder, La., is indicated by Fig. 1. The engine is a 22x30 and was run for four years and eight months at 140 revolutions per minute under 130 pounds of steam, with an average load of 460 indicated horsepower.

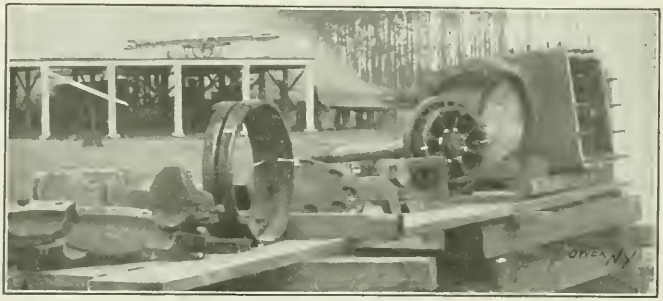


FIG. 1. THE WRECKED ENGINE

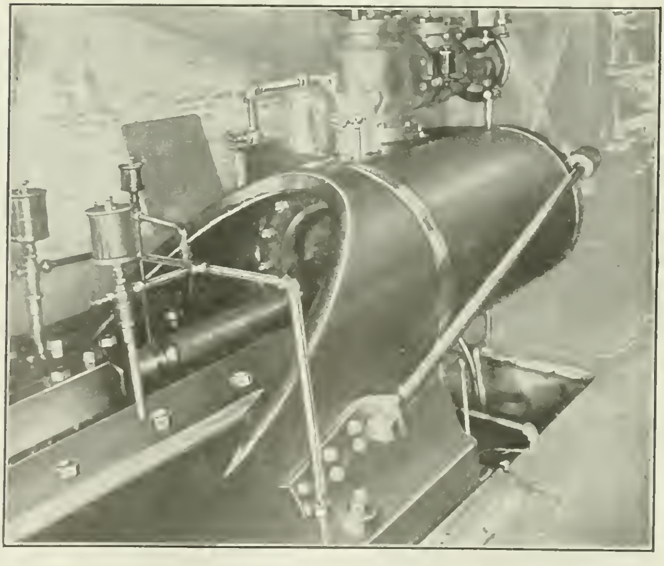


FIG. 2. HOW THE FRAME WAS REINFORCED

The connecting rod broke, and the other damage caused by that consisted of a broken cylinder and heads, piston junk ring and follower head. The frame was also cracked 14 inches, next to the cylinder. This crack made it necessary to reinforce the frame, which was done as shown in Fig. 2. We put in a new cylinder, both cylinder heads, piston and rod complete, and connecting rod. The repaired engine was started up: that was six months ago and it has been going steady ever since, giving no trouble. We reduced the speed to 130 revolutions per minute and took off about 60 horsepower of the load. It is showing 400 indicated horsepower with 120 pounds of steam at 130 revolutions per minute. I think this is good power for a 22x30 slide-valve engine.

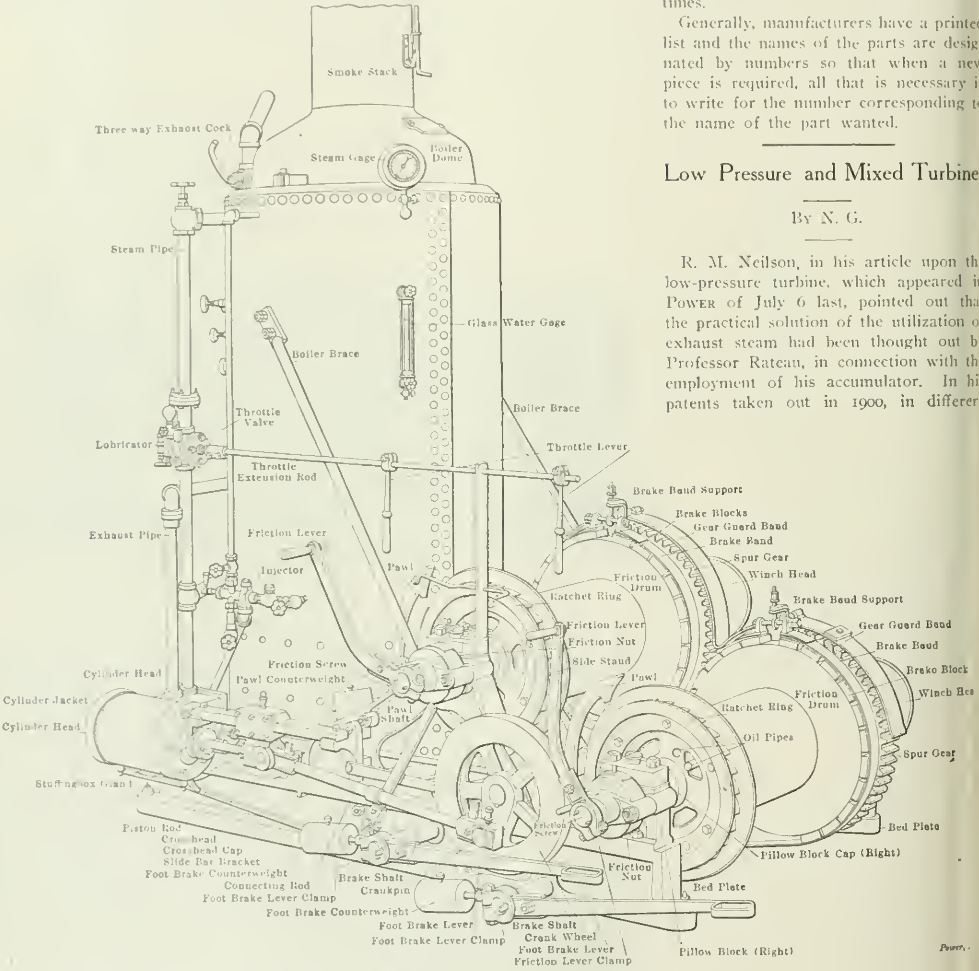


FIG. 1. NAMES OF BOILER AND ENGINE PARTS

## Designating Hoisting Engine and Boiler Parts

There is often a confusion of ideas as to the proper term to use when referring to any part of engineering apparatus, because a thorough knowledge of the machine is lacking. Often a false term is coined to designate some part, because the true name is not known, different engineers coining different names for the same part.

This applies to hoisting engines among other apparatus, and to assist the reader to know the correct terms to apply to the various parts of a hoisting engine and boiler the accompanying illustrations of a Lidgerwood hoisting engine of the double-drum type are presented.

In Fig. 1 are shown the engine and boiler complete, with all visible parts designated by their proper names. Figs. 2 and 3, on pages 657 and 658, show more of the parts in detail. In order that a new part may be secured from the maker of any type of hoisting engine, the engineer should familiarize himself with the correct names and then there will be no delay in getting the order filled without delay, instead of having to write severa times.

Generally, manufacturers have a printed list and the names of the parts are designated by numbers so that when a new piece is required, all that is necessary is to write for the number corresponding to the name of the part wanted.

## Low Pressure and Mixed Turbine

By N. G.

R. M. Neilson, in his article upon th low-pressure turbine, which appeared i Power of July 6 last, pointed out tha the practical solution of the utilization o exhaust steam had been thought out b Professor Rateau, in connection with th employment of his accumulator. In hi patents taken out in 1900, in differer countries, he showed the rôle wh masses of great heat-absorbing capac capable of condensing and regenerat the steam, according to the variations the flow coming from the exhaust the primaries, would play. With th use it became possible to transform irregular, and consequently unusa flow into a continuous flow capable running a turbine at a regular rate.

Professor Rateau foresaw also the different accessories necessary to render the low-pressure turbine completely independent of the primary machine, among others an automatic valve, designed to allow the exhaust steam from the primary machine to escape directly to the atmosphere or to the condenser if the turbine did not absorb it, this valve being capable of being regulated at will for a determined pressure. He also foresaw and provided for the use of live steam at a reduced pressure as a relay, but if the insufficiency of exhaust steam is of too long duration, the operation of the turbine with live steam at low pressure would not be efficient. Professor Rateau must, therefore, have been led from the very first to the conception of the mixed turbine, such as he indicated in his patents of 1901. The advantages of the low-pressure turbine, used in series with a turbine or piston engine at high pressure, were well understood before that time, but the originality of the system consisted in feeding such a machine simultaneously with two supplies of steam at different pressures, the low pressure portion receiving from time to time not only the exhaust steam of other machines, but also the steam which had already worked in the high pressure part of the turbine in such a way that these two supplies combined and worked together in the vanes of the low-pressure section. With the accumulator and the mixed turbine the practical solution of the problem of the utilization of exhaust steam is completely solved.

Professor Rateau had even conceived as early as 1903 a turbine using steam at three different pressures, an idea which he put into practice in the first mixed turbine constructed, that of the Mines de La Réunion, of which more below.

For the automatic control of the two currents of arriving steam, Professor Rateau took out a patent in 1904 (United States patents 830,318 and 891,371) for a process of regulation, consisting of submitting the admission valve to the simultaneous although independent action of a speed regulator on one hand and of a piston or diaphragm controlled by the pressure of the accumulator on the other.

The first installation of an accumulator alone was that of the Mines de Bruay (Pas de Calais, France), in 1902. The accumulator comprises four vertical reservoirs of sheet iron, inclosing forty tons of cast iron and about four tons of water. It receives the exhaust steam coming from a hoisting engine and blowers. The regenerated steam is furnished to a low-pressure turbine, which operates two continuous generators mounted on the same shaft. The energy produced amounts to 0 horsepower and serves in addition to the lighting to operate various machinery about the mines.

In the Mines de La Réunion, in Spain, the accumulator was made from the shells of old cylindrical boilers inclosing 55 tons of rails, which were procurable at a bargain. The exhaust steam comes from a hoisting engine and the steam pumps. The low-pressure turbines fed by this steam comprise two units of 300 horsepower each. They are peculiar in the respect that they are provided with a high pressure section, fed by two other steam supplies, one at 43 pounds and one at 170 pounds per square inch.

The installation at the Mines de Béthune is particularly interesting, because it contains the first high pressure multistage turbo compressor which has been put into service. This compresses 60 cubic meters of air per minute, to a pressure of 100 pounds per square inch absolute. The accumulator contains 36 tons of water and is fed by a hoisting engine, running intermittently, a fan engine and a pump engine, the steam furnished by these three machines amounting to 13,230 pounds per hour, about.

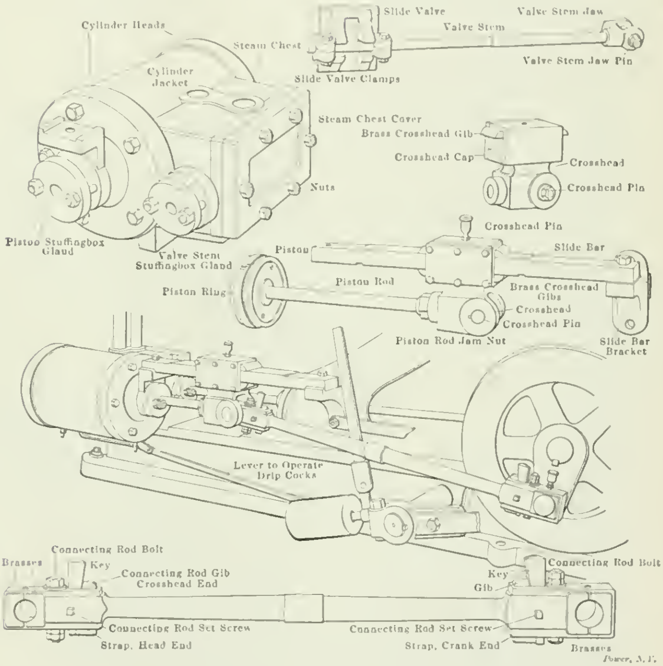


FIG. 2. PARTS OF ENGINE

These examples of installations made by the company formed for the exploitation of the Rateau apparatus, or by its grantees in the different countries, could be much extended. The number exceeds today 200, and the horsepower is at least 100,000, while at least 25 installations are in process of construction. All of the energy which they represent is obtained without the consumption of extra combustible and without other expense beyond that of the first installation, which is always less than that incurred by the installation of boilers and their accessories. In all iron and steel works and mines employing rolling mills, steam hammers and hoisting engines, it is generally preferable to retain the old piston engines, and to use exhaust steam for the production of electricity, rather than to put in an entirely new installation of reversible motors for driving the rolls and hoists, as has been recently proposed. If a central station is installed with turbines producing electric current for the operation of motors driving the rolls, etc., the steam consumption will amount to 12 to 15 kilograms per horsepower at the electric motor. By combining the reciprocating engines as they exist today with low-pressure turbines, a horsepower can be obtained from the combination, with a consumption of eight kilograms per horsepower-hour. It should be remembered in this connection that the installation of reversible electric motors is exceedingly expensive.

It cannot be denied that it is often convenient to group into a single station all the power service of an establishment, but on the contrary this concentration is not without inconvenience. In case of a serious accident at the central station the service may be completely disorganized so that it is of advantage to preserve the reciprocating engines, and to combine them with low-pressure turbines, producing either electricity or compressed air. The compressors will serve to replace small and inefficient machines by electric motors.

In the mines the system is particularly adaptable because compressed air is needed while the hoisting engines are running. Centrifugal compressors are destined to be much used in this connection directly coupled to low-pressure turbines, run by the exhaust steam of the hoisting engine. The turbine can also be used to operate the centrifugal ventilator fans.

In steel and iron works the use of exhaust-steam turbines gives the means for producing cheaply the compressed air necessary for the blast furnaces, cupolas and bessemer converters.

The low-pressure steam turbine can enter advantageously into the struggle with the internal-combustion motor. The system is more simple, more immediate, more dependable and less costly. By utilizing the steam which has already served in the primary motors the coal consumption is not greater than that required for gas engines, and the cost of installation and maintenance is much less. In round numbers, an installation of low-pressure turbines with accumulator costs one-half of the price of an installation of gas engines of the same capacity, while with the low-pressure turbine it is not necessary to have so many spares as it is with the internal-combustion installation. The cost of oil, which is very considerable in the case of the gas engine, is very much reduced.

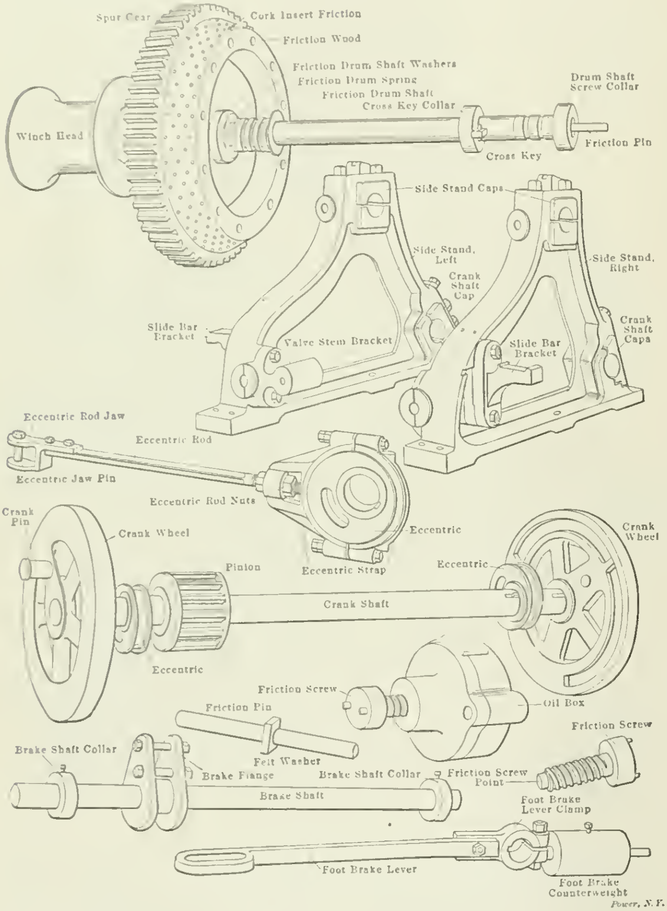


FIG. 3. PARTS OF CRANK AND DRUM SHAFTS AND FITTINGS

The system presents advantages even in the case of a piston engine already running condensing. Suppose for example that the machine consumes 6000 kilograms of steam when running noncondensing. The application of the condenser will effect a gain of 15 or 20 per cent., and make disposable 900 to 1200 kilograms of steam at the boiler pressure. By using this steam in a good ordinary reciprocating engine condensing, 90 to 120 horsepower would be generated. If, on the contrary, the large engine is run noncondensing and exhaust steam used in a low-pressure turbine, there will be disposable some 4800 kilograms of dry steam, for in the neighborhood of 2 per cent. of the 6000 kilograms will have been condensed. These 4800 kilograms will give in the low-pressure turbine 30 brake horsepower instead of 90 to 12 obtained by the other arrangement.

The economy resulting from the use o exhaust steam is indisputable. It arise not solely from the saving in coal an attendance, but also from the less cost o the first installation. In a mine workin only ten hours a day the econom realized is sufficient to pay the cost o installation in two or three years. In th case of a steel and iron works the economy is still greater, for the coal is i general more expensive and the machine usually work night and day instead of te hours per day, with the result that th installation will pay for itself in one an one-half years.

These figures, as well as the numerou applications which the low-pressure turbine has received, merit the attention o engineers and designers. Whenever it desired to provide for additional power o to reduce the demand upon an existin installation, the possibilities of the use o exhaust steam in a low-pressure turbi may well be considered.

## A Glaze for Commutators

The commutator of a dynamo or mot gives better results and wears less rapid if it can be made to glaze over. As is necessary in electroplating dynamos use copper brushes, it is more difficult glaze the commutator than when carb brushes are employed. Owing to the l conductivity of carbon, they would ha to be made much larger than those of co per to carry the same current. The f lowing composition, says the *Brass Wor* has been found excellent for glazing t commutators of electroplating dynamo Dissolve 4 ounces of caustic potash in pint of water, and then boil and add ounce of flowers of sulphur. Boil un the sulphur is wholly or partially d solved, making a yellow-colored soluti Then add lard oil and boil until a soap made. Cool, and add a mixture of eq parts of flowers of sulphur and graph (very fine, or that known as electrotyp graphite) until a thick paste is produc This is applied to the commutator, very little is needed to produce the sired results.

The next convention of the Inter tional Master Boiler Makers' Associat will be held at Niagara Falls, instead Cincinnati.

# Direct-Drive Electric Elevators

## Description of Two Mechanically Controlled Machines Built by a Standard Company, Showing How They Are Made and Operated

## BY WILLIAM BAXTER, JR.

vo Haughton floor-type electric-ele- machines designed for mechanical l are shown in Figs. 31 and 32. The difference between these two ma- s is that the first one is not provided the intermediate gears shown in The object of these gears is to e the lifting capacity of the machine necessary. In many buildings it is ary at times to lift extra-large loads, n 7000 to 10,000 pounds, and this machine is used in such cases. The re generally not in use and are ut of service by the movement andle *H* near the brake stand *E*. r these conditions the motor shaft cted directly with the worm shaft h rotate at the same velocity. If sired to lift a safe or other heavy e bolts are taken out of the coup- t connects the armature shaft worm shaft, and the handle *H* d over, from the position in which it own, the opposite side of the throwing the back gears into en- t, then the motion of the arma- ft is transmitted through the gear *G* h the result that the worm shaft at about one-sixth the rate of the re shaft. If the machine is de- lift, say, 2000 pounds when run- rect-connected, it will be able to or 10,000 pounds when driving the back gearing, but in this case d will be reduced slightly more lifting capacity is increased be- f the increase in friction losses. advantage, however, to have the reduced, because it makes it easier the starting and stopping of with its extra-heavy load. As the is not designed to run at full with such a heavy load, the brake r parts are not capable of con- the movement with such a load at speed as well as when running normal conditions.

In both these illustrations of the Haughton engine it will be noticed that the reversing switch *D* is mechanically connected with the operating sheave *A*, the connection being made by spur gearing in case, and in the other by sprocket wheels and chain. By using this type of connection it becomes practically impossible for the parts to get so disarranged that the movement of the reversing switch will not respond accurately to the movement of the hand sheave *A*, so that there is no danger of the operator in the car losing control of the elevator. The movement of the sheave *A* is kept within the proper limit by placing stops on the disk *A'*, at the side of the sheave, so that no matter how hard the operator may turn the operating wheel or lever, or how far he may try to move it, he will not be able to rotate the shaft so far as to injure the reversing switch *D*.

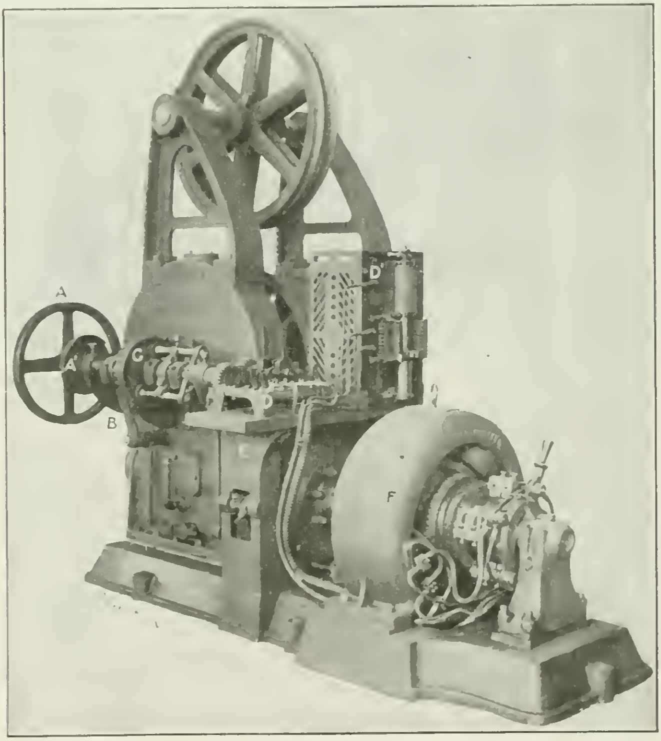


FIG. 31

The stop-motion machanism *C* as well as the slack-cable stop *B* can be fully explained in connection with the line drawings presented in Figs. 33 to 57 inclusive. Fig. 33 is a section through the stop-motion mechanism parallel with the shaft *S*. The operating sheave *A* and the disk *A'* that carries the stops to limit the rotation of the shaft are firmly keyed in position as shown. The clutch *B'* slides freely on the shaft, but is prevented from rotating by a feather which is also shown. The frame *C* of the stop motion can rotate freely around the shaft. When the elevator is running the bevel pinion *P*, mounted on the end of the drum shaft *S S*, rotates the frame *C* and thus the nut *C'* is rotated; the rotation of this nut causes it to travel along the shaft *S*, which has a thread cut on it at this point. At $C''$ and $C''$ are two nuts that are firmly clamped to the shaft *S*, so that when the traveling nut *C'* reaches either one of them it carries it around and thus rotates the shaft. When the shaft *S* is rotated, the gear *K* (or sprocket wheel, whichever may be used) rotates the shaft of the reversing switch so as to return it to the central or off position, all of which can be easily understood by reference to Figs. 31 and 32. At the same time the crank K' pushes down the brake rod and applies the brake. From this it will be evident that when the nut C' strikes either one of the fixed nuts C'', the reversing switch is returned to the central position so as to cut off the current that operates the motor, and at the same time the brake is applied to stop the rotation of the drum.

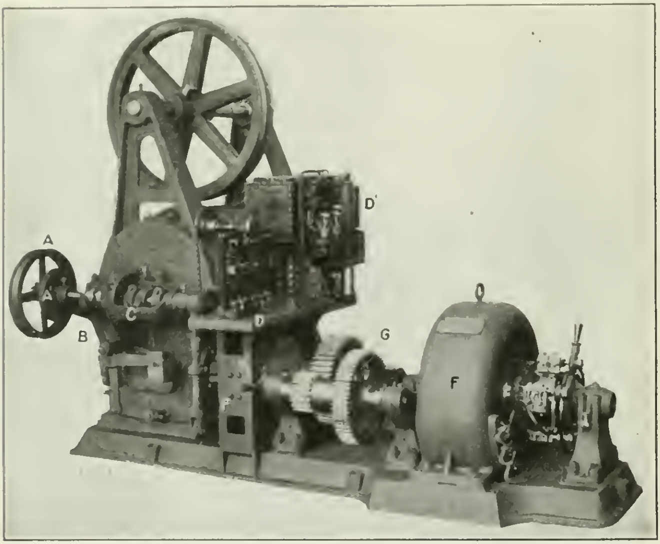


FIG. 32

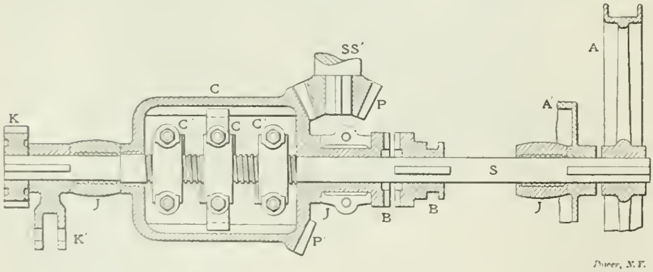


FIG. 33 AUTOMATIC PARTS ASSEMBLED

One of the nuts C'' and C'' is so adjusted upon the shaft S that it will be struck by the traveling nut C' just before the elevator car reaches the upper limit of travel; and the other nut is adjusted so that the nut C' strikes it just before the car reaches the lower limit of travel. The distance from the floor level at which the car may be when the nut C' reaches either of the fixed nuts C'' depends on the speed at which the car runs. In low-speed elevators the distance may be not more than a foot and a half, while in very high-speed cars it may be 8, 10 or more feet.

This mechanism shown in Fig. 33 is called an automatic stop motion because it acts to stop the car automatically at both ends of its travel if the operator fails to move the car lever or wheel at the proper time. It is not an absolute necessity, because the operator can always stop the car by moving the operating lever, but he may neglect to do so soon enough to prevent the car from striking the overhead work or the bottom of the well. In some cases a mechanical stop motion, that is, one that is mechanically operated, is not used, and reliance is placed entirely upon switches that are located in the elevator well at points where they will be moved by the car itself when it reaches the proper point in its travel. Such devices cannot be used if the machine is provided with a mechanically operated brake, because opening the switch will not apply the brake. In some c elevators are provided with both k of stopping device, mechanical auton stops and electrical stops, the latter ing generally called "limit switches, they limit the movement of the ca operating switches. If only one autor stop device is used it is preferable it be the mechanical stop motion, bec it is more certain to remain in proper justment.

The shaft S of the stop motion in 33 is carried in three bearings J, J, . shown in Fig. 32. The constructio the traveling nut C' is clearly illust in Fig. 34, which shows that it is it is so made because it could not h in position if solid. The fixed nut are of the same construction as the C' with the exception that they ar provided with the end guides tha on the ways in the frame C. The struction of the latter casting is shown in Fig. 36, which shows a s parallel with the shaft and a tran section; the letter A indicates the upon which the guides of the tra nut C' slide. At B'' is shown the end with which the clutch B' of the cable stop engages. The face P' ha teeth that mesh with the pinion P t mounted upon the end of the drum S S.

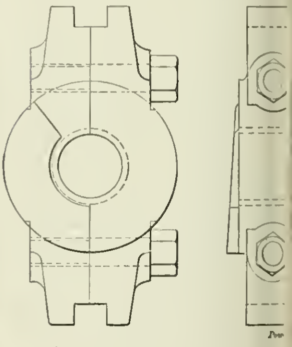


FIG. 34. TRAVELER NUT

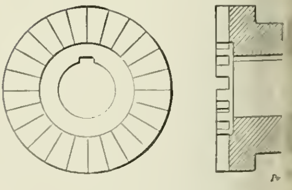
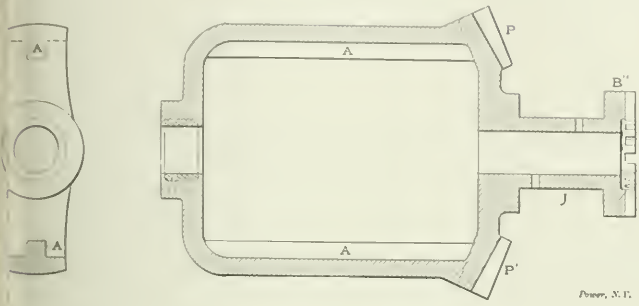


FIG. 35. SLACK-CABLE CLUTCH

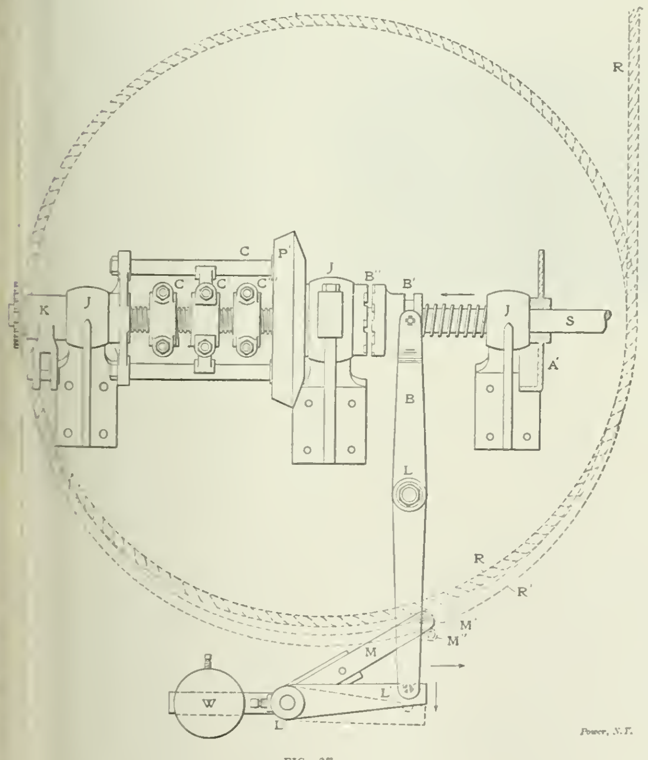
The slack-cable stop is a devic acts to stop the elevator motor if any cause the lifting ropes become The way in which this operates understood by the aid of Fig. 37, in the stop-motion mechanism, the

c. e mechanism and the lifting drum are shown, the latter in broken lines. The h ng ropes $R$ are represented wound around the drum and running a short distance upward. The clutch $B'$ on the stop-motion shaft is held from engagement with the clutch $B''$ by the lever $B$, which swings around a pivot at $L$ but is retained in position by the engagement of a pin at its lower end in a recess in the upper side of the lever $L'$. This lever is keyed to a shaft $L''$ which extends under the drum to the opposite side of the machine. On this shaft there are two arms $M$ and these carry between their ends a rod $M'$ that normally is held just low enough to clear the ropes $R$, wound on the drum. If the car when coming down should be stopped in any way the ropes would slack up and sag down as indicated by the broken lines $R'$ and their weight would depress the rod $M'$ to the position $M''$ and thus rotate the shaft $L''$ sufficiently to carry the lever $L$ down to the position shown in dotted lines, thereby freeing the pin at the lower end of the lever $B$, and leaving the latter free to be moved in the direction indicated by the arrow, by the pressure of the spring on the shaft $S$ acting against the end of $B'$. As soon as $B$ is thrown into engagement with $B''$ the shaft $S$ will start to rotate, because the box $C$ is being revolved by the pinion $P$ on the end of the drum shaft, as shown in Fig. 33; therefore, as soon as the slack-cable stop comes into action and the lever $B$ is released, the shaft $S$ will rotate and return the reversing switch to the stop position and at the same time apply the brake to stop the machine.



Power, N.Y.

FIG. 36



Power, N.Y.

FIG. 37

## Addition to Quarry Street Power Station, Chicago

Plans for the east section of the new Quarry street plant of the Commonwealth Edison Company have been completed by Shepley, Rutan & Coolidge and figures for the work are now being taken. The building will cover a ground area of approximately 200x220 feet, will be two and three stories high, and without the machinery will cost about $400,000. The west section of this plant which was completed about a year ago, is considerably larger than the one now to be erected, and cost nearly $700,000. The completed plant, which is at Quarry and Twenty-fifth streets across the river from the main plant at Fisk street and the river, west of the Halsted street bridge, will contain eight turbines altogether, and independent of the machinery will represent an investment of about $1,000,000.

The main plant, which was completed about 1902, has ten turbines and was thought ample to meet the needs of the company's business for a good many years to come, but about three years ago it became evident that the capacity of the plant must be increased and, accordingly, the site of the present Quarry street plant was purchased and work on the first, or west, section was begun as soon as possible.

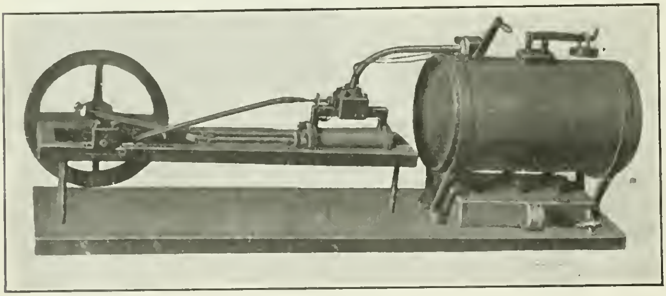
## Real Cause of Boiler Explosions

William Sellers, the famous machine-tool maker, was not noted as a public speaker, but when he ventured to say anything at engineering meetings his words were remembered. At one time years ago Philadelphia was much excited on the subject of boiler explosions, several accidents to boilers having wakened the natives. William Sellers attended one of these meetings, and was asked to explain his theory of the cause of boiler explosions. The reply came promptly: "Because the pressure inside is greater than the strength outside."—*Railway and Locomotive Engineering.*

# The Engine of Fulton's "Clermont"

From information obtained from original documents there is little doubt that the engine of the first "Clermont" was built by Boulton & Watt, in England, and shipped to this country, and yet the following statement is made in the *Iron Age* in its issue of September 23:

"It is an interesting historical fact that Robert Fulton, who first made the steamboat a commercial success, was not the designer of the engine which propelled the famous 'Clermont' on the Hudson river, ushering in the era of steam navigation. The engine was designed by Henri Frederic de la Frasse, who about 1803 had a machine shop on Fair street, now Fulton street, New York, where he made models and did other work calling for the utmost precision. He was the only machinist of note then to be found in the city of New York. Capt. George W. Church, a grandson of Mr. Frasse, and who resides in Newark, N. J., has in his possession a small engine handed down from his grandfather, which he treasures as the model of the engine used in the 'Clermont.' The accompanying illustration is a reproduction of a photograph of this model. * * * * * * After the model engine was perfected it was taken by Fulton to England and followed in detail by Boulton & Watt, the result being the engine which served as motive power for the 'Clermont.'"



MODEL OF ENGINE DESIGNED BY FRASSE

It is not claimed from any authentic source that Fulton built the engine that was used in the "Clermont," let alone invent one, but that he applied the design of engine then in common use in England is a certainty. There is today in the possession of George Tangye, of Birmingham, a letter written by Fulton, under date of November 4, 1794, to Boulton & Watt, asking for information regarding a steam engine to be placed in a boat. This shows that Fulton had in mind the purchasing of a steam engine, or the application of a steam engine to steamboat practice, several years before the "Clermont" made its first successful run. Again in 1803, under date of August 6, Fulton wrote to Boulton & Watt, a letter, which is also in the possession of George Tangye, in which he states that if there were no law prohibiting the exportation of a steam engine to the United States, they were to make a cylinder of sufficient size to develop twenty-four horsepower, also the valve movement, air pump, piston rods and the condenser, with its parts, these apparatus to be sent to Brockhurst Livingstone, Esq. The letter in itself is an order for an engine.

As a confirmation of its being authentic, Robert Fulton under date of November 3, 1803, wrote to James Monroe, and the letter is at present in the Lenox library, New York City, to the effect that he had written Boulton & Watt, of Birmingham, to forward a steam engine, and also mentioned the fact that they were unable at that time to export the engine without permission of the government. While there is no written proof that Boulton & Watt did ship an engine to Fulton, notes from Fulton's notebook, which is in the possession of Robert Fulton Ludlow, show that various sums of money were paid to Boulton & Watt for cylinders and parts of the engine, also a boiler, and a fee to the treasurer for permission to ship the engine to America.

There are also Fulton's original drawings for a steamboat, which were submitted to the commission appointed by Napoleon in 1803, which are now in the Conservatoire des Arts et Métiers, Paris, which conform very nearly to the design of engine found in the new "Clermont," and which without doubt are reproductions of the engine used in the first successful "Clermont."

As Fulton is known to have experimented with engines for steamboats for some years before his successful run up the Hudson, there is no reason to doubt that the model shown herewith was the work of Henry F. Frasse and Fulton, as stated in the *Iron Age*, but that it is a model of the engine used by Fulton in the "Clermont" is not to be entertained, there being too many proofs to the contrary in the form of letters and original drawings.

# Two Explosions in San Francisc

By W. G. Talbott

A sectional cast-iron heating boiler, lo
cated at 2151 Gerry street, San Francisc
Cal., exploded at 10:45 a.m., Monda
September 13. The boiler was connect
to a tank for the purpose of heating th
water for the tub baths conducted by t
Olympic Salt Water Company. Fuel o
was used and the boiler was not equipp
with a safety valve, as it was intend
that the boiler would not be under a
more pressure while hot than while co
Valves were evidently closed by mistal
allowing pressure to accumulate.

The front and side of the building we
blown out, a generator wrecked and
second generator of the same size a
kind was blown out of position. Portic
of the boiler and other débris were thro
across and into the street and a passi
baker was seriously injured. A ho
tied in the street was injured so that
was necessary to kill it. The attend
happened to be immediately above
generator and the concussion wreck
the floor allowed a heavy bathtub to co
down through the floor, carrying the
tendant with it and breaking his col
bone. Workers in a laundry next d
were slightly injured by falling gla
etc. There were several bathers in
establishment at the time, but fortunat
all escaped injury. The possibilities
injuring a good many seems to have b
great. The damages amount to proba
$500. The old generators are being
placed by an approved boiler. It is
dently desired that the cause be announ
as "one of those mysterious accidents.

On Monday, September 20, in the
home of the Pacific Gas and Electric C
pany, a small Rudd hot-water heater
ploded. No damage was done outsid
the heater and plumbing, although a
was present in the room at the time.
heater consists of brass-pipe coils,
was heated by illuminating gas. In
case, too, no pressure above that in
water mains was supposed to be abl
accumulate.

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The Engineering Standards Commi
of Great Britain, has issued a stan
specification for charcoal-iron lap-we
boiler tubes. The chief mechanical
in connection with the specification
that the tubes should be annealed at
ends, and that strips cut from them sh
show a tensile strength between the li
of 19 and 24 tons per square inch,
clusive, with a contraction of area of
less than 45 per cent. Samples of t
should also stand bulging to a diamet
per cent. greater when hot and 10
cent. greater when cold, than the no
diameter, while a piece of tube 2 in
long placed on end should stand ham
ing down until it is 1⅜ inches
without showing crack or flaw.

# Sixteen Months' Record at Redondo

## Actual Operating Results at the Reciprocating-engine Station Which Earned the Largest Bonus That Was Ever Paid For a Power Plant

## OPERATING AND TEST RESULTS

Our readers will recall the Redondo wer station of the Pacific Light and wer Company as one for which reciprocating engines were chosen at a time practically nothing but turbines as being bought to drive large generators, and as one which so far exceeded guaranteed efficiency as to earn for engineers and contractors the largest us ever paid upon a central-station t.

Much interest has attached to the coned operation of this station. Assers were made at the outset that the t results would not be maintained in mmercial service, and rumors are rife t effect that the economy has fallen dly. The accompanying statement the results obtained during sixteen months of continuous running will, therefore, be gladly received. It is furnished b R. Weymouth, of Charles C. Moore &, engineers, the contractors, and ved by E. R. Davis, electrical engineer of the Pacific Light and Power Company.

he guarantee was based upon oil having a thermal value of 18,500 B.t.u. per pound, moisture not to exceed one per cent., sulphur not to exceed one-half per cent., 334 pounds to the barrel. The figures given in the table are those of the oil actually fired without any correction for moisture or otherwise, and as the oil was from the same wells as that used in the official test a reduction to the standard of the guarantee would doubtless have made a similar reduction in the results.

According to this statement, the average uncorrected economy of the station for the first sixteen months of its operation in the hands of the owner was 220.59 kilowatt-hours per barrel of oil. It will be remembered that the results of official tests of this station have been given in the *Transactions* of the American Society of Mechanical Engineers.* The official 15-day test of a 5000-kilowatt unit, except the circulating pump, showed an uncorrected economy of 235.64 kilowatt-hours per barrel of oil; this result is equivalent to an actual oil consumption of 1.42 pounds of oil per kilowatt hour; corrected according to the contract, this result becomes 1.32 pounds of oil per kilowatt-hour, 24,438 B.t.u. per kilowatt-hour, and 252.84 kilowatt-hours per barrel of oil. A similar test for one day on the complete plant of three units, including circulating pumps under an average head of about 35 feet, a deficient quantity of circulating water, and when operating a number of external auxiliaries not common to the average central station, gave an uncorrected economy of 224.80 kilowatt-hours per barrel of oil; this result is equivalent to an actual oil consumption of 1.49 pounds of oil per kilowatt-hour; corrected according to the contract, this result becomes 1.37 pounds of oil per kilowatt-hour, 25,349 B.t.u. per kilowatt-hour, and 243.76 kilowatt-hours per barrel of oil. Both of these official tests were on a power factor more favorable than that shown by the average for sixteen months. This table does not show the absolute operating economy of the Redondo plant, but merely its performance relative to that as indicated by the official tests.

SIXTEEN MONTHS' PERFORMANCE OF THE REDONDO STATION.

| Month.<br>1 | Load Factor. Net Output Referred to 15,000-kw. Rating 24 Hours per Day.<br>2 | Station Record Uncorrected; Based on Net Kilowatt-hours Sold and Total Barrels of Oil Purchased. | | Special Conditions Other Than Load Factor Influencing Plant Economy.<br>5 |
|---|---|---|---|---|
| | | Kw.-hours per Bbl. Oil.<br>3 | Lb. of Oil per Kw.-hour.<br>4 | |
| 1908. | | | | |
| [illegible] | 50.90 | 216.10 | 1.55 | Occasional loss vacuum. |
| [illegible] | 49.10 | 212.60 | 1.57 | Frequent loss vacuum. |
| [illegible] | 53.40 | 228.13 | 1.46 | |
| [illegible] | 63.20 | 216.45 | 1.54 | Occasional loss vacuum. |
| ber | 66.60 | 221.04 | 1.49 | |
| er | 53.20 | 214.21 | 1.56 | Firing cold oil. |
| ber | 58.20 | 219.60 | 1.52 | |
| ber | 60.11 | 225.08 | 1.48 | |
| 1909 | | | | |
| ary | 47.60 | 209.66 | 1.59 | Frequent loss vacuum. |
| ary | 56.54 | 210.25 | 1.59 | Frequent loss vacuum. |
| [illegible] | 51.73 | 222.89 | 1.50 | |
| [illegible] | 48.40 | 222.29 | 1.50 | |
| [illegible] | 53.00 | 227.41 | 1.47 | |
| [illegible] | 50.69 | 221.68 | 1.51 | |
| [illegible] | 56.68 | 228.88 | 1.46 | |
| [illegible] | 57.05 | 230.12 | 1.41 | |
| al average | 54.77 | **220.59** | 1.51 | |
| 21-22, '08* | 59.79 | 221.80 | 1.49 | |
| 5-day official test† | 59.57 | **235.64** | 1.42 | |

*Official 24-hr. test, complete plant. †On one 5000-kw. unit, without circulating pump.

The monthly economy records given are under all the exigencies of a station furnishing current for a railway and lighting load, involving a peak load greatly exceeding that handled during the official tests, and a slight falling off in the engines at overload, including the loss due to inevitable scale in boilers, the heat loss due to cutting in cold boilers after cleaning, and to occasional periods of excessive standby while the plant was carrying less than its regular load, the greater portion being on the connected water-power plants. It is frequent that the generators are run at a poorer load factor than during the test for the purpose of line and load regulation, this in turn causing a slight reduction of generator efficiency.

A very disturbing factor relating to economy was the occasional reduction or total loss of vacuum due to clogging of circulating-water mains and condensers by seaweed, a practical difficulty to which a beach plant in a southern latitude is subject to a degree to which engineers upon deeper and cooler waters are strangers.

The record for the month of August, 1909, shows if anything an improvement in economy rather than a falling off as rumored. It will be noted that the uncorrected economy for five whole months has exceeded that for the complete plant, for the one day's official test. It will also be noted that the average economy for the sixteen months is very close to that shown by the official test of the complete plant, in spite of the causes for falling off, as above indicated. These figures demonstrate conclusively that the intrinsic efficiency of the individual apparatus has not fallen off in the slightest during this period of operation. This information is of material interest in view of the claim often made by turbine advocates that the economy of the reciprocating engine depreciates rapidly with wear.

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*Vol. 30, page 775.

The plant, since it has been turned over to the customer, has not suffered a single interruption due to failure of the engines, notwithstanding the fact that there is not an item of reserve capacity except the inherent reserve due to the fact that there are four cylinders to each engine with a probability of damage to but one cylinder at a time, and the possible operation of the unit with the remaining three.

The practical immunity of damage from water in the cylinders was demonstrated in the early days of breaking in the station when water was carried through the piping in quantities, owing to an improper connection to the superheater within the boiler. During this short period the engines were run practically on suds. The gridiron valves of the McIntosh & Seymour engines lifted to relieve the cylinders, the engines groaned a little, water shot out of the piston-rod packings in streams, but the engines kept right on with their work.

Owing to the inevitable occasional loss of vacuum, it is gratifying to the owners to know that the engines are capable of driving the generators at their maximum load when running noncondensing as well as when running condensing; the contractors maintain that such operation is possible only with reciprocating engines.

To the results as furnished by Mr. Weymouth, we have added column 4, giving the results in pounds of oil per kilowatt-hour, based on 334 pounds per barrel.

The load factors given in column 2 are the net outputs for the several months divided by the product of 15,000 (the full rated capacity) and the hours in the month. Many stations define their load factor as the quotient of the average divided by the maximum load. Since the peak load averages considerably over 15,000 kilowatts, the average load factor upon this basis is considerably lower than that given in the table.

No information is as yet available as to the separate efficiencies of the boilers and engines, and this is looked for with unabated interest.

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## Throttling Steam to the Engine

Charles N. Cross

In a paragraph under the above title, A. A. Blanchard asks in the August 24 number, page 321, whether an increase of speed will increase the economy of the engine.

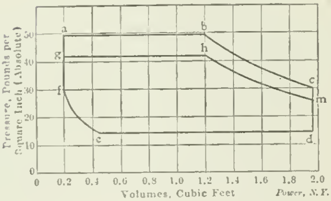
In a case like this, where so few data are given, several assumptions are necessary, some of which may not be true for the actual conditions. The following is on the assumption I have made: Since the governor is of the throttling type, the engine probably has an ordinary slide valve. The cutoff then is not less than 50 per cent. of the stroke. The load is to be the same for both speeds, and the speed is to be increased from 156 to 200 revolutions per minute. If some other speed, such as two or three times 156, had been chosen for the second value, the results arrived at might be far different. I have also assumed diagrams nearly ideal, but that ought to be immaterial as far as the comparison goes, since all the conditions are the same for the two cases except the speed. If the load is constant when the speed changes, then the mean effective pressure must change, for in the formula:

$$H = \frac{PLAN}{33,000}, \qquad (1)$$

where

$W$ = Horsepower,
$P$ = Mean effective pressure,
$L$ = Length of stroke in feet,
$A$ = Area of piston in square inches,
$N$ = Number of strokes per minute,

if $W$, $L$ and $A$ remain constant and $N$ varies, then $P$ must vary also.



THEORETICAL DIAGRAMS TO DETERMINE EFFECT OF THROTTLING

For the diagram I have assumed that the clearance equals 11.85 per cent. of the stroke, cutoff 56.8 per cent., compression 12.5 per cent., expansion to be hyperbolic, and the back pressure to be 14.7 pounds absolute.

Of course if these values are not the same as those from an actual diagram of the engine to which Mr. Blanchard referred, the final results will be different.

I have also assumed the steam pressure given, viz., 35 pounds, to be gage pressure, so the absolute pressure is about

$$14.7 + 35 = 49.7$$

pounds.

Then I have drawn an assumed diagram, *a b c d e f*. By means of the planimeter I find the mean effective pressure to be 29.8 pounds. Substituting in equation (1):

$$\frac{29.8 \times \frac{22}{12} \times 153.9 \times 156}{33,000} = W = 39.75 \qquad (2)$$

This would be the horsepower of one end of the cylinder at 156 revolutions per minute.

Now in

$$\frac{P \frac{22}{12} \times 153.9 \times 200}{33,000} = 39.75$$

$$P = \frac{39.75 \times 33,000}{\frac{22}{12} \times 153.9 \times 200} = 23.24 \qquad (3)$$

or, the same result can be obtained thus:

$$29.8 \times \frac{156}{200} = 23.24.$$

Therefore, 23.24 is the mean effective pressure when the speed is 200 revolutions per minute, and the load the same as for 156 revolutions per minute.

To get a diagram showing a mean effective pressure of 23.24, the initial pressure must be lowered by throttling. Thus by trial I constructed diagram *g h m d e f* so that its mean effective pressure is 23.24. It actually is 23.27, but that is quite close enough for the purpose. This gives the initial pressure as 42 pounds absolute.

Now we can determine the diagram water rate from the following formula:

$$W = \frac{13,750}{M} [(C + E) W_c - (H + E) W_h], (4$$

where

$W$ = Weight of steam per indicate horsepower per hour,
$M$ = Mean effective pressure pounds per square inch,
$C$ = Proportion of stroke complete at cutoff,
$H$ = Proportion of stroke durin which compression takes plac
$E$ = Proportion of clearance,
$W_c$ = Weight of one cubic foot steam at cutoff pressure,
$W_h$ = Weight of one cubic foot steam at figuring of compre sion.

The last two are taken from the stea tables.

The values from the diagrams a steam tables substituted in equation ( are as follows:

For 156 revolutions per minute,

$$W = \frac{13,750}{29.8} [(0.568 + 0.1185) 0.1181 - (0.125 + 0.1185) 0.0376] = 38.45;$$

for 200 revolutions per minute,

$$W = \frac{13,750}{23.27} [(0.568 + 0.1185) 0.1009 - (0.125 + 0.1185) 0.0376].$$

$$W = 41.48.$$

From this theoretical consideration the matter it is seen that the steam c sumption will be increased. This is only if the conditions I have assumed the same as are found in the actual gine; but this method of investigating problem is perfectly applicable, and results found would be an indication what might be expected from a test the engine. Since the temperature ra for the smaller diagram is less, the inder condensation would be cut d and consequently the actual water would be smaller than for the larger gram.

# Use of the Indicator in Gas Engine Operation

By Peter Eyermann

Referring to L. J. Buschman's letter in the August 31 number, I call attention to some points which might be of interest connection with steam engines as well gas engines.

In general I find Mr. Buschman's notes mixtures and igniter adjustment to be K., but the readers of Power will prob-ly criticize the absence of the atmo-pheric line in the diagrams, which were ade with the high-pressure spring. On account of the absence of this line it is impossible to analyze the diagrams, and the impression given to gas engineers is that the engine in this case must have been of very old make, as the diagrams show hardly any compression. If his diagrams are reproduced my remarks will be more clearly understood Fig 1 cannot be considered a good diagram of a gas engine. Mr. Buschman's remark concerning Fig. 2 is correct, but the thick part of the diagram proves that the gas engine must be a gas eater

Both 20-pound spring diagrams (Figs. 5 and 6) show the cam setting all right, but there is no reason for missing the upper lines of the diagrams. These lines are just what we want to see, the beginning of the falling off of the exhaust line.

I submit some diagrams of my own. These were taken from a Du Bois tandem gas engine, direct connected to a 50-kilowatt generator All of these were made with a 120-pound spring, which is generally used on steam engines. The diagram shown in Fig. 7 was taken with a half load, that in Fig. 8 with a full load, that in Fig. 9 with an overload.

The governing with these loads was qualitative only, and in the diagrams the round tops which Mr. Buschman mentions are shown, but my engine has high compression while his had low compression. I also show some diagrams, Figs. 10 and 11, that were taken with a 20-pound spring, but which nevertheless show the upper lines. These were taken under the same load as the other diagrams.

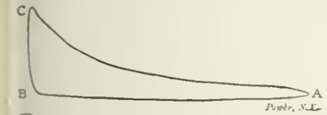


FIG. 1. REPRODUCED

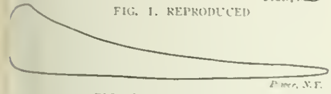


FIG. 2. REPRODUCED

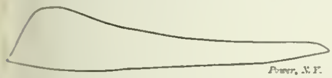


FIG. 3. REPRODUCED

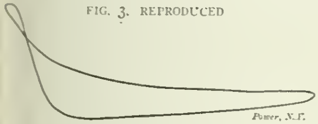


FIG. 4. REPRODUCED

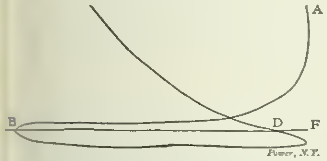


FIG. 5. REPRODUCED

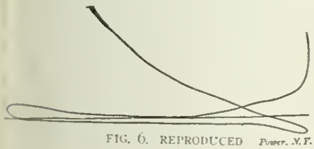


FIG. 6. REPRODUCED Power, N.Y.

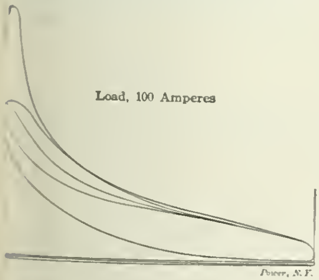


FIG. 7.

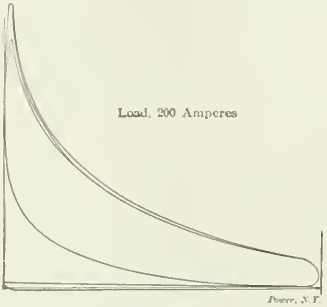


FIG. 8

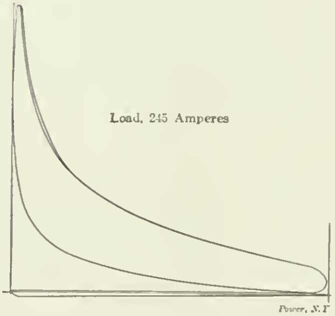


FIG. 9

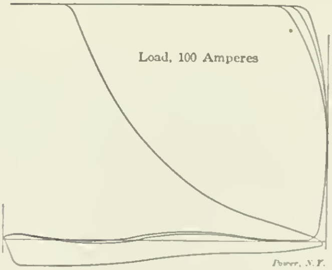


FIG. 10

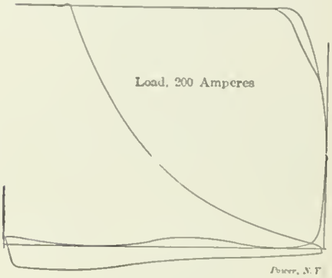


FIG. 11

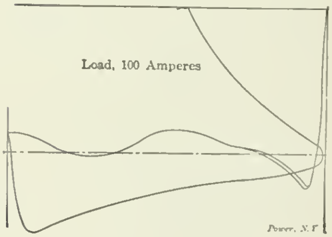


FIG. 12

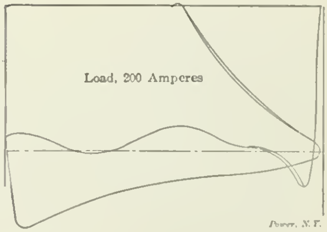


FIG. 13

Compare these with Figs. 5 and 6 submitted by Mr. [illegible]. I consider these better diagrams because they more correctly show the rapid falling off of the expansion line.

I also submit diagrams in Figs. 12 and 13. These were taken with 8-pound springs and show the cam settings much better than if a 20-pound spring were used. I suggest that readers think over the matter of the vacuum in the exhaust line of this gas engine.

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# High Initial Pressure on the Crank End

By A. C. Waldron

In the September 14 number, A. C. Browne shows indicator diagrams with the crank end the higher and wants to know why.

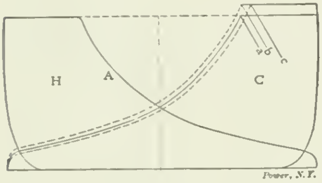


FIG. 1

Indicator diagrams have been published which have shown perfect conditions as regards valve setting, and yet the only trouble that worried the engineer was that one end showed a higher initial pressure than the other. Nor was this defect confined to a particular type. It is rarely that an engineer need fail to distinguish the crank end from the head end, if he is familiar with the underlying principles, because it is an established fact that with engines having a direct valve motion, in which the eccentric does not follow the crank but leads it, the crank end will measure the highest, while with indirect valve motion, such as piston valves taking steam in the center and exhausting over the ends, if no reversing rocker arm is used it follows the crank. The defect, though not entirely obliterated, is greatly improved, except where the connecting rod is very short compared with the length of the crank, which causes the angular effect of the connecting rod to be more in evidence, as shown by Figs. 2 and 3. The angularity of the connecting rod is the cause of the piston moving more slowly on leaving and approaching the crank end, and traveling faster on leaving and approaching the head end. It is this slow movement on the crank end which enables the pressure to assume a higher plane, because it surely takes time to attain boiler pressure. We also have the area of the piston, which takes up so much room, making less space to fill and more time to fill it because of the slow movement of the piston.

An eccentric is really a crank and is subject to distortional movements the same as the connecting rod, only in a less degree. The action of the eccentric causes the valves to move very irregularly, as the crank does the piston. When the head end is taking steam the valves are moving very slowly, while on the other end the conditions are reversed. With the piston starting on the crank end and the eccentric moving on its head end with great rapidity, is another reason for getting so high an initial pressure in the crank end, because when the piston moves fastest the valves move the slowest.

If there is a reversing rocker arm between the eccentric and valve, the angularity, as affecting the hight of the diagram, practically equalizes the initial pressure on both ends, causing a fast-moving valve when the piston moves fast and a slow-moving valve when the piston moves slowly. Figs. 2 and 3 show how the angular effect increases as the connecting rod decreases in proportion to the length of the crank.

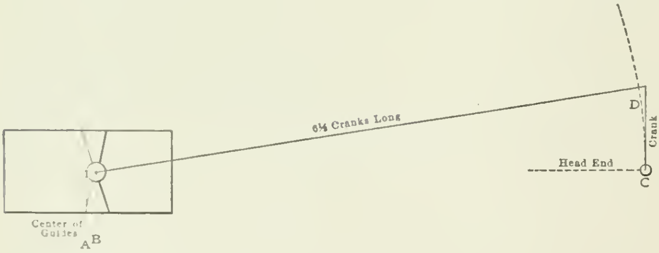


FIG. 2

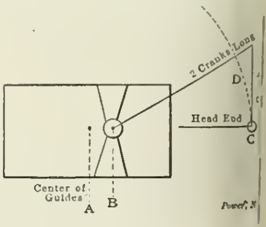


FIG. 3

Suppose we place the crosshead in the center of its travel, which would be at *A*, and use the rule of making the connecting rod the length of *A* to *C*. If we place the crank on the half stroke, or 90 degrees from the head end, and try to connect the rod to the crank pin, it will follow the arc *D* and be too short, necessitating advancing the crosshead from *A* to *B* to meet the crank pin. Hence, while the crank turns half a stroke the crosshead has to move more than half a stroke, as shown by the distance *A* to *B*, consequently the crosshead has to travel a longer distance from the head end for the crank to make half a stroke than for the crank to complete the rest of the stroke. This is why it travels faster in the first part, or from the head end, as the crank turns at the same speed all the time. In Fig. 3 the same idea is shown, except that the connecting rod is made only two cranks long. The angular effect is increased as shown by *A* and *B*, Fig. 3 which is nearly three times that of *A-B* Fig. 2.

There is a type of connecting rod an crosshead combined (Fig. 4), which woul remedy the angular effect as far as th piston travel is concerned, but where th valve is operated by an eccentric, w would get the slight effect due to the ec centric-rod angularity.

In Fig. 1 the full line *A* represent ideal conditions because of equal cutoff equal areas and equal hights on both th head and crank ends. I often wonde how others get them, because in measurin numerous diagrams from a large num ber of engines, having different valv gears, with speeds ranging from 50 t 300 revolutions, I have invariably foun from 1 to 5 pounds higher pressure c the crank ends except where the ren edies mentioned have been applied.

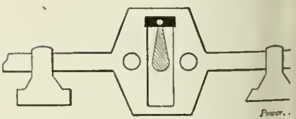


FIG. 4

through ignorance of these defects we to get equal cutoffs, we will get the *B*, Fig. 1, which with the increased hi and full expansion line is sure to prod a greater area for the crank end. since we have the area of the piston which decreases the square inch at end, the effective work on each en practically balanced because the hi initial pressure makes up for the los piston-rod area. Hence the absur of the common practice of subtracting area of the piston rod in computing rsepower of the engine. From Fig. 1 is apparent that equal cutoffs and equal as, and equal steam lines to the point f cutoff, rarely exist in actual practice.

It is true that the expansion line may rt from the theoretical expansion rve, either above it, due to leaking m valves, or below it, due to leaking n or exhaust valves, or, excessive densation may to a certain extent make the unequal card areas. If we hope to t equal diagram areas we must cut off er to make up for the higher initial sure as shown at c, Fig. 1, and this ld unbalance the work done by each t that due to the piston-rod area. So arrive at the conclusion that it is bad feature to have a higher initial sure on the crank end, as the piston takes up piston area (which is not the n the opposite side of the piston), wing the head end to do as much on s initial pressure, if the angular effect increasing the hight of the crank end t too great.

## afety Telltale for Signal Lamps

By R. H. Fenkhausen

ere are many locations about a power where incandescent lamps are used ls and water-level indicators, and t illuminate dark corners, etc. In case one of these lamps burns out unknown to the power-house attendants, the desired signal or alarm will not be transmitted a service delay may occur.

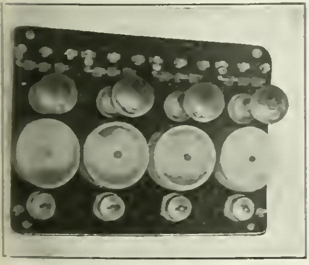


FIG. 1

Fig. 1 shows a device designed originally to notify the man in the pilot house in case one of the running lights should go out aboardship. The device may be used to advantage in power-plant work to notify the attendant, should any signal lamp burn out, or the wiring become open-circuited.

Two magnets, Fig. 2, are arranged inside the gong of an alarm bell, the magnet *A* being in series with the signal lamp. When the signal lamp is lighted the magnet *A* attracts its armature and opens the contacts *2*. If the signal lamp burns out, the magnet *A* will drop its armature, closing the contacts *2* and completing the circuit through the lamp *C* and alarm bell *B* which rings and attracts the attendant's notice. The double throw switch *D* is then thrown over, putting the duplicate signal lamp in circuit, and the burned out lamp is replaced when convenient. The apparatus may be tested at any time by opening the switch *D*, which should light the lamp *C* and ring the bell until the switch is closed on one of the two sides.

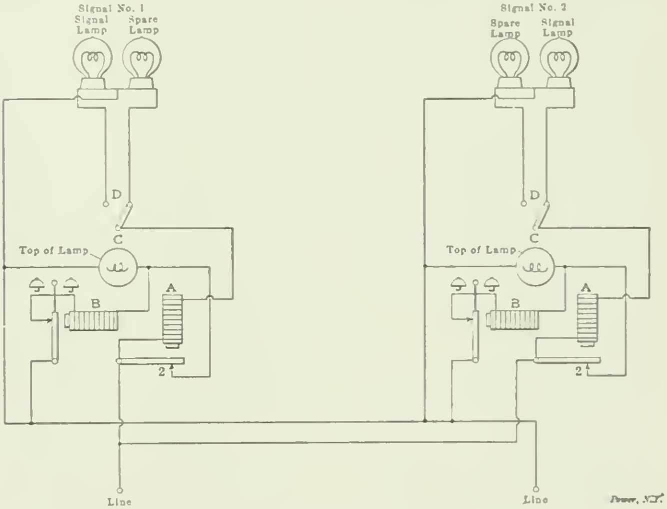


FIG. 2

## Compression Outside the Main Cylinder

By William Westerfield

I noticed something under the above caption on page 485 of the September 21 number, by S. Kirlin. As I read this contribution, I thought of that old fellow who said: "There is nothing new under the sun," and the thought occurred to me also that the saying does not apply to this age, for this idea is certainly new.

Whatever may be thought of the utility of the device described, I am sure that no one will dispute its gracefulness. While it is not universally conceded "that compression obtained in the usual manner, by closing the exhaust valve when the piston is yet several inches from the end of the stroke, is economical or desirable if the same results could be obtained otherwise." I believe that this is so nearly the case that there will be a very limited application of the device, if it is put on the market. Those best informed seem to agree pretty generally that it is better to fill the clearance space by compression than completely to exhaust the cylinder and have the same space to fill with live steam from the boiler. In making this statement I have the satisfaction of having with me every designer and builder of steam engines that I know of, for their engines are designed with a view to accomplish just this thing. If the device described is better than compression obtained in the usual manner, it is reasonable to suppose that some builder would have adopted it long ago.

This device is merely an adaptation of the "air spring" used so long on printing presses that all the patents have expired, so that no one need have any fear of suits for infringement of patent rights if he desires to apply it.

It may be admitted that "if the exhaust valves were allowed to remain open until the piston had reached the end of the stroke, or nearly so, practically all of the wrecks due to water in the cylinder would be avoided," yet it may be said, too, that with intelligent design water in dangerous quantities will not be likely to get into the cylinders while running. It will be impossible for many long years yet so to install power plants that ignorance or carelessness cannot damage or wreck, but with good design and skilful operating the dangers from water in the cylinders need cause no nightmares to the engineer.

In this connection, I may say that I have seen many plants that were apparently designed with a view to getting all the water possible into the cylinders of the engines. In such places we have a right to look for trouble, for it is as certain to come as the sunset and the sunrise. This is a condition that can be corrected only by having power plant equipment installed under the close supervision of men who understand the work.

I think that it is pretty generally agreed that compression represents just so much negative work done in the engine cylinder in the case of a steam engine. I think that it is about the most generally conceded fact of all that have been considered in connection with the discussions on compression. While this is the case, it is also pretty generally conceded that the power absorbed in compression is practically paid back in expansion of the steam compressed into the clearance space. Then, as is agreed, compression is required to bring the reciprocating parts of the engine to rest without shock or jar. Now in getting compression in this manner in the main cylinder of the engine, we derive power from the steam compressed. In the case of the device described by Mr Kirlin, we would get but little if any benefit.

In regard to the claim that with this device clearance might be safely reduced, I think the engineering world will desire better proofs than are offered before accepting the proposition. Let us see in case of a loose piston what the result would be. In case we have compression and lead in the main cylinder, as soon as this occurs a noise will occur in the cylinder due to the piston being driven back and forth between the nut on the end of the rod and the shoulder, but compression coming before the end of the stroke is reached will prevent the piston from hitting the head until the nut had probably allowed the piston to come off the rod. In case the compression was outside the main cylinder this would allow the piston to hit the head as soon as the nut had slacked a very little, as there would be no compression acting on the main piston.

In a general sense, I do not think that it is likely that the clearance in high grade engines will be reduced much below present practice. One of the factors that determines safe clearance between piston and cylinder heads is the character of the attendance the engine is likely to have. Hence on the high grade engines that are to be installed where the attendance is expected to be high grade, the clearances are less than in engines designed for saw mill service, where the fireman and the engineer are the same, and both may be green from the plow.

It might be mentioned, too, that in these engines having the greatest amount of clearance, the trouble is not due to the space between the piston and cylinder heads, but that embraced in the steam passages between the steam chest and cylinder. In the Corliss engines this is generally much less than in engines of the slide-valve type. The efforts of engine designers during the past few decades have been directed toward reducing the clearances in the steam passages, seeking to make the passages as direct as possible, and as short, rather than to reducing the clearance between the piston and cylinder heads, seeming to have come to the conclusion that the safe limit has been reached some time ago.

Let me say that it is not my desire to throw cold water on the spirit of investigation. I think though that efforts toward simplicity and away from complication will be better for the public and the engineers, and worse for the makers of packings and lubricants.

## Use of Gas Engines for Boosting Gas Pressure in Transmission Pipes

An installation of Westinghouse gas engines for boosting the pressure in its illuminating-gaspipe lines, has recently been contracted for by the Public Service Corporation of New Jersey. At its Hoboken and Passaic plants, four 13x12 Westinghouse vertical gas engines, equipped with special regulating mechanism, will be employed to drive direct-connected Root blowers delivering gas at pressures varying from ¾ pound to 4 pounds per square inch, as desired.

The delivery of gas by the blowers is automatically made to conform to the demand on the gas lines by increasing the speed of the engines as the pressure in the mains tends to fall. To accomplish this, a special controlling valve has been added to the engine equipment, which throttles the fuel admitted to the engine, adjusting its speed between 290 and 125 revolutions per minute, as the demand for gas varies. The controlling valve is operated by a piston, to which pressure from the gas reservoir line is admitted, and which moves against the compression of a helical spring to close the fuel valve as the line pressure rises.

The controlling valve is fitted with a positive stop so adjusted that even though the line pressure reaches its full value, the fuel valve cannot close beyond a point where the engine will continue to turn over on light load, thus avoiding the necessity of restarting the engine when the blower pressure is again required. While it is estimated that the minimum demand on the pipe lines will probably absorb the delivery of the blower at its lowest speed (125 revolutions per minute), any possible abnormal rise in pressure is prevented by the provision of relief valves which automatically open a bypass around the blower, enabling the engine to run light while performing no other work than circulating the gas in its local circuit.

A standard governor device has also been supplied with these engines, designed with considerable play or backlash, so that the governor does not control the gas admission until the engine speed exceeds 250 revolutions per minute. Above this, the governor travel takes up the backlash, throttling the gas and preventing any possibility of overspeeding in case the pressure in the transmission li should suddenly be relieved.

The location of the boosting equipme dictated the use of a magneto generat driven from the main engines, for suppl ing the ignition current. In order to tain approximately constant speed for ignition generator driven from an engi of widely varying speed, a Holtzer-Cal magneto equipped with a governor pull is employed. The magneto is the ty used for automobile service, giving l voltage direct current. It is driven friction contact with the side face of flywheel rim, which varies in speed fr 125 to 290 revolutions per minute, governor acting to withdraw the pul momentarily when its speed exceeds n mal rating, so that whatever the speed the engine, the magneto runs at appr mately constant speed.

The engines are each of 90 brake-hor power capacity, and use illuminating from the supply lines, with a heat va of approximately 600 B.t.u. per cubic f The engines are direct-connected to blowers through flexible couplings.

A Westinghouse single-phase altern ing-current motor drives a 3x4-inch be air compressor supplying storage ta from which air is taken to start the gines.

## American Electrical Engineers Argentina

Consul-General R. M. Bartleman Buenos Aires reports concerning the portunities in the Argentine Republic American electrical engineers:

There certainly is an opening for class electrical engineers, as well structural engineers, and they will be cessful if they conform with the cust of the country to a certain extent, they must remember that electrical other engineers in Argentina are fully 20 per cent. less than the usual of engineers in New York.

The principal difficulty to be enc ered by American engineers in getti foothold in the important construc lies in the fact that these construc are almost wholly financed by En German or French capital, and nat the important posts fall to the engi of the countries furnishing the ca This does not mean that there is no for American engineers, whose tra and methods of work are acknowl to be the best in the world. Alread matter of building construction afte styles and methods employed in United States has received good in in two or more buildings, now rly completed, which have been erected ter the designs and methods used in the United States, the structural stee and ornamental ironwork having been ur- nished and erected by American firs.

# Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think,
Know or Want to Know About Your Work, and Help Each Other

## WE PAY FOR USEFUL IDEAS

### A "Perfect" Handhole Plate

A few years ago two new 72-inch by f t return-tubular boilers had been ning but a short time when one of the k hand plate gaskets blew out.

I found that the handhole had been cut

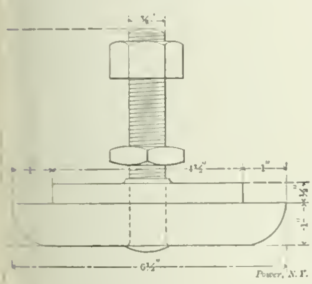


FIG. 1

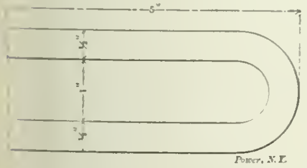


FIG. 2

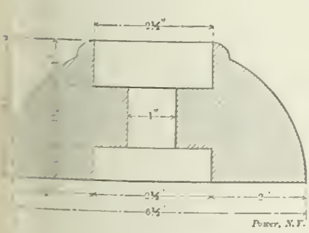


FIG. 3

ar to the outside of the head the plate ca in contact with the round part of h head, where it was flanged to fit the h and, the plate being flat, prevented it om touching the head at the ends.

rounded the bottom edge of the plate to f the flange on the head and had no further trouble.

afterward had a set of patterns made for a new handhole-plate outfit, which the accompanying sketches will explain.

Fig. 1 represents the plate. This I had cast solid, and a 1¼-inch hole drilled with a deep countersink on the back side. I chipped a groove through the countersink, and had the stud turned and driven into this hole, and riveted, which insured a tight job, the groove in the countersink preventing the stud from turning in the plate.

I put two nuts on the stud, one thin, made by cutting a regular nut in halves. The object of the thin nut was to hold the plate in place before the crab was put on, by screwing the thin nut with the fingers up against a U-shaped strap, Fig. 2, slipped over the stud and against the boiler head, holding the plate in position so that it could be seen that everything was right before putting on the crab.

This strap was made of 1½-inch square iron, and the thread on the stud was cut far enough to allow the nut to pinch it. The crab I made like Fig. 3, the slot through it being large enough to go over the strap easily. When the crab was put in place and the outside nut screwed up, the strap dropped out, the nut holding this strap being only screwed up with the fingers, as stated.

The pocket for the outside nut was made large enough to get a wrench on easily. After screwing up the nut the pocket was filled with asbestos, completely covering the nut, which prevented the nut from burning.

LEON H. WILLIAMS.

Philmont, N. Y.

### Eccentric Strap Repair

The accompanying sketches show a repair made on a large eccentric strap. It is somewhat different from the one usually made on this particular part of an engine. Two plates were bent to conform to the shape of the strap and were screwed and brazed fast. The brazing prevents the screws from working loose When these plates were in place, as shown at *M*, Fig. 3, the halves of the strap were placed together, bolted, put in the lathe and the sides turned away, the section of the strap being like that shown in Fig 1. The overlapping shoulders were turned away and the section *B*, Fig. 2, shows how two pieces were riveted on each side at *E E* by a through rivet, which when in place formed the overlapping shoulder. These rings are shown in Fig. 4. They were made from wrought iron turned and riveted in place on the eccentric strap, leaving a slight finish at *D*, so that a finishing cut could be taken in the lathe after the whole had been riveted. Then this was finished in the lathe. The

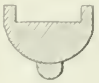


FIG. 1

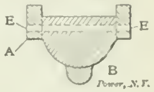


FIG. 2

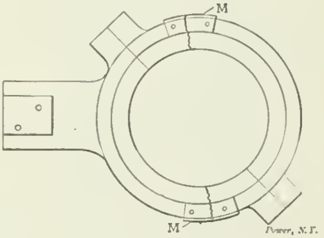


FIG. 3

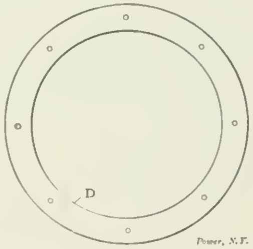


FIG. 4

two rings were of steel, solid in the circular form, and having the necessary liners in the jaws of the eccentric strap. It was then necessary to saw these rings apart, which was done with a hacksaw, then finished with a file, when the job was complete. This made a strong repair.

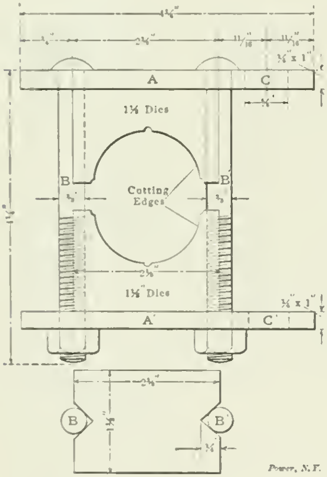
C. R. MCGAHEY

Richmond, Va.

## A Handy Die Holder

The following description is of a die holder for use in constricted spaces, where the stocks will not swing, or, if there are no stocks, this little tool can be made in a few minutes to fit the dies.

Here is one for my 1½-inch dies. Two pieces of 1x⅜ inch steel (*A* and *A*¹ in sketch) are cut, each 4¼ inches long. In *A* are drilled two ⅜-inch holes, one ¾ inch from one end and the other 2⅛ inches away from it. In *A*¹ two corresponding ⅜-inch holes are drilled. Get two ⅜-inch bolts, cup-headed preferably, 4¼ inches long under the heads and threaded about one-third of their length. Make them tight fits in the holes in *A* and ream out the holes in *A*² so that the strip will slide on the bolts. The width of my 1½-inch dies is 2⅛ inches overall, but other sizes must be made accordingly. By taking light cuts the dies can be turned by hand, but if there is room to use it, a tommy-bar can be put through the ⅝-inch holes *C C*¹ drilled in *A A*¹ as shown.



Power, N.Y.

DETAILS OF A HANDY DIE HOLDER

John S. Leese.

Manchester, England.

## Engine-Room Record Holding Device

For some time I have been using a device for holding engine-room records that I think will interest some of your readers. I use for the required blank, a finished ⅞-inch board of the proper size, that has a strip across the end to prevent warping. Across each end of the board cut a groove ¼ inch wide and of the same depth. Take a piece of new tin 2½ inches wide and the length of the board, and wire it along each side with ⅛-inch iron wire, making a loop across each end of the tin. Bend these loops so that the strip will engage the grooves in the ends of the board and the tin clear the paper. This device gives the engineer a sliding rest for his hand, so as to write without soiling the paper. The paper can be fastened to the board with thumb tacks.

H. K. Wilson.

Edgartown, Mass.

## Running a Wornout Pump

Instances are not rare where it is necessary to run pumps which should have been consigned to the scrap heap long ago. Conditions will not always admit of the operator's resorting to the use of a ten-pound sledge hammer, as his inclination prompts him to.

There are times, also, in the practical engineer's experience, when it would be worth almost anything to him to be able to make certain pumps run.

With the ordinary duplex steam pump for handling water, for instance, it is quite customary to "set the valves." Generally the trouble is not in the steam end, but in the water end. Being assured that the water end is O. K., however, the wornout pump will frequently get balky spells and have to have "the valves set" again. This is probably resorted to by two or three different men, until it would not run if it were a brand-new pump.

A couple of instances of this kind come to mind. Both pumps were worn out but had to be run, as emergency required. As the second dilemma was overcome by what was experienced in the first case, I will tell it. The pump was used to circulate water over ammonia condensers. There was no duplicate pump. What seemed to be mysterious was that the pump would run for a day or two and then balk, sometimes giving plenty of trouble. The "valves" had been "much set," but evidently not set right. After the pump had had a thorough going over as to the water end, and was put in as good condition as possible, the steam-chest bonnet was removed and the "valves set" as nearly as possible like one would set the valves on an unworn pump.

When given steam the pump refused to run more than half a dozen strokes and then stopped. After starting it up several times, by tapping one of the valve-stem connecting rods, I noticed that it always stopped at the same place. Accordingly I took the bolt out and lengthened the valve rod by simply turning it in the gland leaving the bonnet in place.

After several experiments the proper lead was struck. The old pump ran all the rest of the season.

This is what a carpenter would call a "try-up" rule, but it is pretty sure work, and that is what most of us a after. Running is running.

Edward T. Binns.

Philadelphia, Penn.

## Kerosene in Boilers

Kerosene is not listed as a scale solve and an analysis of the feed water is a solutely necessary in order to treat successfully. By this I don't mean to s that kerosene is of no use in keepi boilers clean, because if that were there has been a large quantity of g oil wasted. Most everybody uses it a cure for rust, on other iron, therefor don't see why it won't cure the sa thing, although called corrosion, on inside of a boiler.

We used to put kerosene in our boil in homeopathic doses. But we started sell steam for heating purposes and customers complained of the odor, so discontinued the practice. We now a compound made to fit our case.

First in the list of the impurities t cause scale or incrustation are sedim mud and clay. The remedy for thes filtration or blowing; and let me add that sometimes one can blow down u the operation costs more money tha filtration plant, and not get as good sults.

Second come bicarbonate of lime, and magnesia scale. The remedy i good heater, adding caustic soda, lim magnesia.

Third, take sulphate of lime scale; carbonate of soda or barium chloride careful not to get in too much sod it will cause foaming; the additio barium chloride will prevent this.

Fourth, sulphate of magnesia will c rust or corrosion; the remedy is bonate of soda.

Fifth, mine waters contain acids will cause corrosion; alkali shoul added.

Sixth, the dissolved carbonic acid the editor says is a good thing to in the smokestack will cause corrosi the boiler when combined with the giver, oxygen. The remedy is a heater, caustic soda and slaked lime

Seventh, oil, animal or vegetable, cause corrosion. We generally g from the engine exhaust. The re is slaked lime and filtering carbona soda or kerosene oil. Here is kerosene is good; and in no other pl

Eighth, sewage causes foaming and rosion. The remedy is to treat it alum or ferrous chloride, and filte

A word of advice: If one starts t use a compound to take off the scale an re-vent foaming, do not wait a month ore opening the boiler or boilers to appl the treatment.

Alfred Grisw

Adams, Mass.

## A Motor Repair

is is how we repaired a 220-volt 15-h epower direct connected motor It a ed very badly, burned the brushes roughened the commutator, so that a time flat spots appeared. The man harge could only stop the flashing n short time He adjusted the brushes,

H CKSAW FOR REPAIRING MOTOR

d the commutator, then took it out t rned it down and put on softer es, but in a few days it would be the sa old story. A good motor man was s t r and said the machine was over-loa d, but the firm did not want to buy a rg one, so the operator settled down nding and putting on new brushes eve few days. Each machine operator t are of his own motor. One Sunday rning I happened along, and this ope r asked me to help. I told him to w e mica between the bars down to 3 ch and to break a hacksaw into p eces and insert the saw in a short piec wood. He did this and assembled t chine and the next morning the t ran absolutely sparkless, and does so th s day, about a year later. Of u , it has had proper care in the mean-

**Charles L. Juneau.**

Milwaukee, Wis.

## Wh Exploded the Air Chamber?

n plant situated in a gulch 3000 feet a at the bottom are two pumps 25 t w the surface in a pit 75x100 eet. h y are triple-expansion pumps, e 300,000-gallon 280-foot lift and one 1,50 00-gallon 150-foot lift. One night e ter in the gulch overflowed into h er house, extinguishing the fires ng the space above the header be-wee the wall and the ground, the pit re eing about 10 feet wide by 100 eet , it broke the wall, making it al ardly on top of the pumps, but t g any damage beyond breaking h ee the suction pipes and a few minor arts the valve gear. The pumps had een ut down just before the accident app d. Now comes the strangest part: ne the air chambers of the 11,500,-00-g on pump, situated on the discharge etwe the high and intermediate pump ham rs, exploded with a loud report nd l ded on top of the wall, breaking he co ugated-iron side of the house and ravel g for 25 feet at a hight of about 0 fe Then the same thing happened o on of the air chambers of the 7,500,-000-gallon pump, it landing in the boiler room behind one of the boilers, also breaking through the side of the house. The metal in the neck of the air chamber, where it broke, was $1\frac{1}{2}$ inches thick and showed a new break, there being no flaw to be seen. The size of the chamber was 14 inches in the neck, opening out to 2 feet, by 5 feet long, and it weighed between $\frac{1}{2}$ and $\frac{3}{4}$ ton. What I want to know is what caused the explosion?

**W. Ellerbrock.**

Honolulu, H. T.

## Air Compressor Troubles

We were having a good deal of trouble trying to keep up air pressure for our cranes and ice elevators. All kinds of reasons were given, but here is my reason, which I think is right: When the men are on watch and the ice pullers are stopped to wait for water, the air compressor is shut down by the oiler or engineer, as either happens to be around. He comes along, closes the throttle and that's all. The drips are left closed. And the man holds a license at that. When the water is high enough in the tank he starts the compressor in this way: With drips closed he yanks the throttle open, and if it is on center he gives the flywheel a pull, and she's off until next time to stop. All the water that was in the cylinder comes through the stuffing boxes, gaskets and wherever. They see all this, but pay no attention.

In our case, after a while they blew the gasket on the jacketed head and of course the jacket water leaked through into the compressor to the receiver. It wouldn't be long before the receiver would be half or three-quarters full of water, and of course when a lot of air was taken out of the receiver the pressure would drop. It would not be so bad when lifting ice out of the tank, but when running the elevator it would raise it only half way.

The water took up so much room in the receiver that there was not enough air stored up to keep the pressure from dropping too much. I went to blow the receiver out, as I occasionally do, and it took 4 or 5 minutes to drain out the water and oil, whereas it should have taken only a few seconds. The head was taken off the compressor and just as I thought, the gasket was leaking. They will fix it up but will they ever "get wise?"

Our valves give us trouble by sticking or hanging up frequently, and their method of fixing is to take a heavy hammer and give the valve bonnets some good healthy wallops until they do work.

If about once a week they would lubricate the compressor with soapsuds for a whole day, much better results would be obtained than by the present crude method. By the way, never use kerosene. The flash point is low and the compression will surely ignite it and [illegible].

**Edgar G. Schindler.**

Roxbury, Mass.

## Natural Gas

Ohio natural gas, according to Gill, has 980 B.t.u. per cubic foot. Some authorities give it 1000 B.t.u. per foot. It is therefore evident that 27.95 cubic feet contains 27,950 B.t.u.

A boiler horsepower is the evaporation of 34.448 pounds of water per hour, from a temperature of 212 degrees Fahrenheit into steam at 212 degrees Fahrenheit. It is also generally conceded that it requires 965.7 B.t.u. to evaporate a pound of water from 212 degrees into steam at 212 degrees. Now, it is evident that the total heat units required to generate a boiler horsepower will be the product of 965.7 and 34.448. ("Power Catechism") or a sum total of 33,266.4336 B.t.u, and since there are available in the fuel 27,950 B.t.u., the combined efficiency of the furnace and boiler will be

$$33{,}266.4336 \div 27{,}950 = 119$$

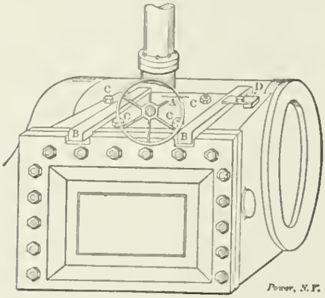
per cent.

**E. H. Lane.**

Kansas City, Mo.

## A Steam Chest Repair

A cracked steam chest in the 700-horsepower Atlas engine in the Conway Company's sawmill here was repaired, as shown in the sketch, by putting on straps



TEAM-CHEST REPAIR

*B*, the clamp *D* and studbolts *C*. The straps were shrunk on, thus closing the crack *A*. Each studbolt was tapped into an interior shelf or web over the slide valve which forms the intake port. This shelf stays the top casting, in which the crack *A* is 9 inches long on the outside and longer on the inside.

**T. A. Knowlton.**

Conway, N. H.

## Pound in an Engine

The engine in question is an old Atlas, working at a pressure of 80 pounds, and she knocks horribly as soon as the throttle is closed. The knock appears to be at the crosshead and the engineer thinks that there is too much play between the crosshead shoe and the guide. The engine is running under, which is wrong in the opinion of the engineer, who says that the shoe is driven downward against the bottom guide at each forward stroke. If this is the case why doesn't the engine pound as hard when working under steam as it does after the steam is shut off and the engine is running under its own momentum, which it does not? It seems logical to suppose that the pound would be more pronounced when the engine is working under pressure than when it is not, if the cause of the pound is as the engineer believes.

In my opinion the wristpin brasses need taking up, as I think the wristpin is thrown violently against the brasses at each stroke as soon as the pull on them is relieved by shutting off the steam, and the piston becomes a dead weight. The momentum of the flywheel drives the brasses alternately against the wristpin, which has too much lost motion in the brasses.

Which reason for the pound seems the more plausible?

LE ROY SCOTT.

East Jordan, Mich.

## A Boiler Experience

I had an experience recently with a battery of two boilers which were supposed to be 52 inches by 16 feet, and were bricked in a common furnace. They were supplying steam for an 18x36-inch slide-valve engine and a number of pumps driving a woodworking plant. I was not at all satisfied with the service the boilers and engine were giving, for I figured that with the grate surface and heating surface of the boilers, the size of the engine and the amount of machinery it was driving, the shavings and waste from the mill should be sufficient fuel, but it was necessary to burn 1½ tons of coal per day. I made up my mind that the engine was in bad condition, and determined to give it a thorough overhauling during the holidays. When examined, the engine was found in as good condition as it was possible to make it. I then turned my attention to the boilers, and found that I had instead of two boilers 52 inches by 16 feet, one boiler 52 inches by 16 feet and one 52 inches by 12 feet, so I saw the cause of my trouble at a glance. The boilers being different lengths, in one furnace, with the short boiler next to the stack, the combustion was invited to the rear of the short boiler, even from directly under the front of the long boiler, so there was no heat returning through the tubes of the long boiler. This also explained why it was so difficult to keep water in the short boiler when we rarely ever had to put water in the long one, notwithstanding that they were connected by a 2-inch supply pipe at the bottom and a 5-inch steam header at the top.

I called for a brickmason and had built a two-brick-wide wall, beginning at the middle of the grates, stepped to the rear, and I closed the rear of the combustion space of the short boiler to the same length as the long one. The result was all that could be desired, and in the course of ten days we were advertising shavings for sale and had cut out the coal bill altogether.

W. A. GARRIGUS.

Chattanooga, Tenn.

## Felling a Smokestack

The accompanying view is of a 140-foot smokestack which was struck by lightning three times. The last time the bolt cut a furrow 4 inches wide from the top to the square base, 125 feet. This made it unsafe and it was decided to pull it down and build a new one. Three courses of brick were taken out at the bottom for a little more than half way around, and 4x6-inch timbers were driven in their place. When ready to fell it, these 4x6-inch timbers were set on fire. As they burned out, and with the aid of three sets of falls attached to the top of the stack, she came down without doing damage.

FELLING A SMOKESTACK

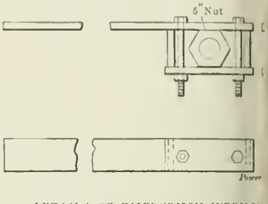
OAKS KYGER.

Danville, Ill.

## An Emergency Wrench

It was necessary to tighten a :
locknut, but I could not find a w
large enough for the job, therefor
was made as follows:

Two pieces of flat iron, one piece
2 feet long and the other 7 inches
were obtained. Two holes were c



DETAILS OF EMERGENCY WRENC

in each piece 6 inches apart and
slipped through, connecting the two
Then two pieces of iron, 5 inche
were cut and placed between the
pieces, tightening down on the nuts
wrench did the work very nicely.

WALTER C. I

Philadelphia, Penn.

## Lubricator Trouble

We have three Lunkenheimer sig
lubricators, attached to three wet-
pumps, that had been working
factorily for about four years. Th
of the single-connected type and
the steam valve had started to lea
ing the job of refilling a pretty I
so a short nipple and an ordinar
were placed between the lubricat
the steam pipe. It was quite a
that the three refused to keep i
good record, and they puzzled us f
time before we got them workin
again.

We blew them out with stean
ing that the inside piping might b
up, but without any result. We
sight glass with soap water, but
no good; in fact, we tried everyt
could think of, but only got the
tion of seeing them work for al
minutes after refilling, when no
of any kind would bring results
had to use the ordinary oil cup
steam chests.

The trouble was at last trace
fact that the short nipple (the th
being cut absolutely straight) ha
the lubricators to lean at a slig
from the steam pipe. By tur
valve and nipple half a turn we
to lean the opposite way and t
been working all right ever sinc

MILTON LI

Brooklyn, N. Y.

# Subjects Under Discussion

Comment, Criticism and Debate upon Various Articles, Letters
and Editorials Which Have Appeared in Previous Issues

BRING OUT YOUR IDEAS

## Throttling Steam to the Engine

horsepower constant of Mr. l rd's engine, on page 321 of the st 24 issue, is

$$\times \left(\frac{22}{28} \times 14^2\right) \times \frac{1}{33,000} = \frac{77}{9000}.$$

equal cutoffs, let the engine be 156 and 200 revolutions per minute. nt to 312 and 400 strokes per Assume 1 cubic foot to be the pen to steam-chest pressure up ff, which is approximately half With this cutoff and 35 pounds re inch steam-chest pressure, as- mean pressure, from an indicator , of 25 pounds per square inch. t the lower speed (312 strokes per

$$P. = \frac{25 \times 312 \times 77}{9000} = 66\tfrac{2}{3}.$$

strokes per minute:

$$66\tfrac{2}{3} = \frac{P \times 400 \times 77}{9000};$$

$$P = \frac{9000}{400 \times 77} \times \frac{200}{3} = 19\tfrac{1}{2}$$

n per square inch mean effective

With the above cutoff, a mean pressure unds per square inch would between 28 and 24 pounds per h as the initial pressure. Then volume of 1 pound of steam at 28 per square inch = 14.38 cubic r f Pullen's tables);

$$\therefore 1\ cu.ft. = \frac{1}{14.38}\ lb.;$$

$$400\ cu.ft. = \frac{400}{14.38} = 27.83$$

minute (b) The volume of steam at 24 pounds per square 62 cubic feet;

$$400\ cu.ft. = \frac{400}{16.62} = 24.07$$

minute. (c) The volume of steam at 35 pounds per square ch = 11.66 cubic feet;

$$\therefore 1\ cu.ft. = \frac{1}{11.66}\ lb.$$

$$312\ cu.ft. = \frac{312}{11.66} = 26.25$$

und er minute.

The result from (c), 26.75 pounds per is the economy at 156 revolu- minute. If run at 200 revolu- minute, for the same economy, i.e., 26.75 pounds per minute, the initial pressure is got thus:

$$\frac{400}{26.75} = 14.95$$

cubic feet = volume (approximately) of 1 pound of steam at 27 pounds per square inch.

Hence, for constant load and steam consumption:

$$\left.\begin{array}{l} \textit{Initial pressure} = 35\ \textit{lb. per sq.in.} \\ \textit{Speed} = 156\ \textit{r.p.m.} \end{array}\right\} = \left\{\begin{array}{l} \textit{Initial pressure} = 27\ \textit{lb. per sq.in.} \\ \textit{Speed} = 200\ \textit{r.p.m.} \end{array}\right.$$

If, in the second case, the initial pressure is above 27 pounds per square inch, the engine is not so economical as at the lower speed, but if it is less, the engine is more economical.

Of course, the figures given above are only approximate, as the writer does not know the mean pressure, cutoff, etc., on the engine at present. If Mr. Blanchard will work the problem out from his own indicator diagram by the above method he will, having assumed a speed, deduce an initial pressure lower than which it will be more economical to run his engine. I have purposely overlooked the effects of cylinder condensation and the like, also of relative operating and maintenance economies for the two speeds, because, being ignorant of the details of Mr. Blanchard's engine, it would be futile to go into an assumed case.

JOHN S. LEESE.

Manchester, England.

## Heater or Receiver?

In regard to the question by J. E. Terman, in the September 14 number, concerning locating a feed-water heater between the engine and condenser, I should say his advisers are all wrong. A heater so placed is practically a small surface condenser. Within certain limits we may increase condenser capacity by using either colder water or more water, or both. Neither colder water nor an increased quantity of cooling water would ever lessen the capacity of a surface condenser.

If we have a condenser too small for its work, the addition of a heater, or the circulation of more and colder water through one already in place, might add somewhat to the vacuum effective in the cylinder. The same might be true, also, in the case of an engine with a long reach of pipe between it and the condenser. In such cases, pumping more or colder water through the heater might add slightly to the capacity of the engine; but under favorable circumstances the addition would not be large. If the condenser is of ample capacity, it is improbable that any change possible in the normal operation of the heater would increase the vacuum or the capacity of the engine. But under no circumstances could the engine capacity be lessened as claimed by the "engineers" and "condenser men" mentioned by Mr. Terman. My belief is that under most circumstances the only effect on capacity would be found in the boiler room, and that there it would be very noticeable.

I have an idea as to the mistake these "experts" made, though it is so grotesque an error that it would seem no engineer would make it. But we all run up against funny things sometimes, and perhaps this is one of the times. I remember, on one occasion, an engineer acquaintance called on me at the power house where I was employed, and I showed him over the plant. The main engine, a large cross-compound, was so badly overloaded that the condenser could hardly do the work, and we had run a pipe across to connect to the condenser of a spare engine and we were running both condensers. The extra condenser was near the high-pressure cylinder; and to this day that "engineer" speaks of the "high-pressure condenser" and the "low pressure condenser." Another engineer happened in one day when we had just broken the piston rod on the low side. This man reported to several of my friends that we had broken the high-pressure piston rod and had the high-pressure side all stripped. I could hardly believe this until I had called on him and engaged him in conversation and heard the bull from his own lips. He evidently thought the large cylinder was made for the higher pressure. Probably some will put me in the "mechanical fakir" class for submitting these stories, but I can prove them if called upon. I have introduced them, however, to serve as buffers for what seems to me a possible mistake made by Mr. Terman's advisers. May it not be that these men mixed up in their minds a heater in the exhaust pipe and the receiver between the hight and low cylinders?

WILLIAM E. DIXON

Hudson, Mass.

## Economical Compression

In my letter entitled "Economical Compression" on page 400 of the September 14 issue, the typsetter has made me say, in next to the last paragraph, that the railroad people "make money by *compressing*." This should have read: "make money by compromising."

E. G. Tilden

Downers Grove, Ill.

## Remarkable Condenser Performance

In the September 28 issue, in an article entitled, "A Remarkable Condenser Performance," page 524, it is stated that in a Wheeler condenser installed in the Williamsburg power station of the Transit Development Company, Brooklyn, N. Y., the coefficient of thermal transmission in a test made November 27, 1908, amounted to between 800 and 900 B.t.u. per hour per square foot of condensing surface per degree of difference in temperature between the steam and the water. The authority for the statement in the article is not given. As chief of the testing bureau of the Transit Development Company, and the one who conducted the test, I am unable to confirm these high figures or to agree with the method by which they were apparently calculated. The equation for this coefficient as derived by Cecil P. Poole, in an appendix to the article of H. L. Hepburn on "The Transfer of Heat from Steam to Water through a Partition," printed in Power for December, 1901, page 18, is:

$$U = \frac{S}{A}\left(\frac{H - N}{T_d - T_o}\right) \log_e\left(\frac{T_s - T_o}{T_s - T_d}\right).$$

The symbols in this equation have the following meanings:

$U$ = Thermal coefficient transmission as defined above,

$S$ = Hourly steam delivered to the condenser in pounds,

$A$ = Condensing surface in square feet,

$H$ = Total heat per pound of steam delivered to the condenser,

$N$ = Heat of liquid of the hotwell water,

$T_s$ = Temperature of steam in degrees Fahrenheit,

$T_d$ = Intake temperature of circulating water in degrees Fahrenheit,

$T_o$ = Discharge temperature of circulating water in degrees Fahrenheit.

By using the hourly average temperatures, as measured by thermometers, of the steam in the condenser and the intake and discharge circulating water, the value of $U$ varies from 329 to 378 B.t.u.

H. Le H. Smith.

Brooklyn, N. Y.

## Cylinder Lubrication

I beg to submit the following data for May, 1909, from the Hotel Rochester plant, on cylinder lubrication:

| Engine. | No. 1. | No 2. | No. 3. |
|---|---|---|---|
| Size ........ | 15x14 | 18x16 | 11x12 |
| Make ........ | Ames | Ames | Amts |
| Average load per hour . | 56 kw. | 101 kw. | 38 kw. |
| Number days run during month. | 29 | 26 | 31 |
| Number hours run.......... | 178 | 153 | 113 |
| At per day-hours........ | 6¼ | 5.9 | 13¼ |
| Oil used........ | Capitol | Capitol | Capitol |
| Amount, quart, total......... | 10 | 17 | 12 |
| Number feet piston travel per quart oil.. .. | 527,827 | 331,117 | 1,197,700 |
| Steam pressure, pound....... | 100 | 100 | 100 |

William J. Bedard.

Rochester, N. Y.

In regard to cylinder oil I should say that it seems to me a very live and interesting subject and one that is not given the study that it deserves.

I am using a medium-weight, light-colored oil on a 17½x16-inch piston-valve engine running noncondensing at 220 revolutions per minute, with a gage pressure of 80 pounds.

The cylinder and valve are inspected at stated intervals and the surfaces are found with a rather dull polish and quite greasy, with no signs of excessive wear or deposit of any kind. The oil is fed by a Detroit lubricator at the rate of two drops per minute.

My requisition for cylinder oil was filled a few months ago with an oil with the very best of reputation, and, in fact, I have used the same brand with perfect success under different conditions, but it was a total failure under my present conditions, as I could not get enough through my lubricator to prevent the engine calling for more. The amount used was from ten to twelve drops per minute and after ten days' run the cylinder was opened and found to show practically no trace of oil. The surface had brightened up considerably and some fine iron dust was present, showing undue wear, but no scoring had taken place. This oil was returned and a supply of the former oil received, which has since been used with perfect satisfaction.

J. E. Hall.

Searsport, Me.

We have a 14x14 Robb-Armstrong automatic engine running 10 hours per day at 260 revolutions per minute on 125 pounds steam pressure carrying an approximate load of 150 horsepower. For two years I have used 1½ pints of "600 W" oil per day on this engine, and the cylinder and valves are in perfect condition. I feed the oil with a Detroit lubricator, with the feed pipe project to the center of the feed main and with the opening toward the throttle.

We also have a 13x17-inch eng (name and make not known), runnin hours per day at 105 revolutions per n ute on 100 pounds steam pressure. this engine I use one pint of the s oil, fed with a force-feed lubricator, the engine runs smoothly and without preciable wear.

W. C. Mage

West River, N. B.

I have read about running eng without cylinder lubrication. Anyone tempting to do such a thing should care and judgment. On engines balanced valves there might not be n danger, but most engines with unbala slide valves surely need plenty of cylinder oil, especially if the engin worked hard. The writer has charg such a machine. Carrying a heavy at high piston speed it is hardly sa put in a new lubricating glass wit shutting down. The valve has at or four different times started cu and, once started, would continue t until the valve was taken out and valve and seat thoroughly cleaned by ing their faces. The oil and grit are carefully wiped off.

Having done this I then paint white lead, wipe again and then with lead again and put together. this valve I keep the edges sli rounded by scraping to prevent bility of the sharp edges carryin oil off the seat.

E. M. Crawf

Saginaw, Ore.

The following data give the siz speed of engines and the amount o inder oil used for my plant:

Triple-expansion, 20 and 34 and 60, 65 revolutions per minute, 5 gall

Compound, 24 and 44 by 60, 65 r tions per minute, 4½ gallons.

Compound, 18 and 34 by 48, 85 r tions per minute, 3⅓ gallons.

Simple pair, 30x72, 58 revolutio minute, 4½ gallons.

Simple single, 16x42, 75 revolutio minute, 1 gallon.

Simple automatic single-valve, 15 275 revolutions per minute, 1 gall

These are all Corliss engines, the single-valve, which is an aut Fitchburg. The oil costs us 28 cer gallon, and the amount used is f week of 58 hours.

T. N. Kel

Lowell, Mass.

On a 24x42 noncondensing engi running at 93 revolutions per minute 120 pounds steam pressure we use ab t 12 gallons of 60-cent oil per 26 te hour days. On a 10x12 Atlas engine r ning

. 240 revolutions per minute we use half . int of oil per day of eleven hours. On . 12x21 Buckeye engine running at 165 r olutions per minute we use a pint of c per day. This engine requires more c than it should, possibly on account of i distance from the boilers and not having an attendant. We get along nicely wh 0.49 pint of good cylinder oil per ten h rs on a 14x36 Corliss engine running a 80 revolutions per minute.

believe that more oil is wasted on d ct-acting steam pumps than on eng s. We have receiver pumps on our h ng system that get no oil and there d not seem to be any undue wear. G engines use about the same quantity il as steam engines.

believe that a good oil pump is better th a lubricator and in most cases it w pay for itself in a short time. We . a good grade of oil. We have stand- r gas engines and never have trouble; v also use the same oil on air com- r rs.

J. O. **Benefiel.**

erson, Ind.

use an average of one gallon of less cylinder oil each twenty-four s' run. It costs 42 cents per gallon. Ou equipment is as follows: One en- 18 and 36 by 30, 150 revolutions per te, 150 pounds steam; one engine, 15 n 0 by 30, 150 revolutions per minute, ds steam; two engines, 7x8, 400 r ti ns per minute, 80 pounds steam; w d pumps, 7 and 4½ by 10; two ll pumps, 6 and 6 by 6; two oil p . 4½ and 1⅝ by 4; one 500-kilowatt Cu turbine; two jet condensers, 11 and 18, 75 to 100 feet piston speed; one t ndenser, 14 and 20 by 24, 75 to 100 f t iston speed; two Westinghouse engines.

run one main engine, one exciter 7x . one condenser, one feed pump, twell pump and one stoker engine time, day and night. For from six hours each day we run two units, the 18 and 36 by 30 engine and with their auxiliaries. During we generally run the motor- r exciter unit, but sometimes use steam exciters. Our station out- rages 225,000 kilowatts per month. r il r pressure is 150 pounds sat- rat steam from Stirling boilers.

**Howard Gluys.**

Ri ond, Ind.

W have a 24 and 42 by 48-inch tandem- mp nd Corliss engine running at 65 evol ions per minute with 110 pounds tean pressure.

W use on an average one quart of yliner oil in the high-pressure cylinder very eighteen or twenty hours; in the ow-p ssure cylinder a quart lasts from went to twenty-two hours. So far as am ble to judge the cylinders are well bricated, as the valves work smoothly and one man can easily handle all eight valves.

The cost of the oil I do not know, but am sure that it is under 45 cents per gallon. It is a compounded oil of rather heavy body.

This plant runs 24 hours per day, six days per week. It is used in connection with a water-power plant and the steam pressure used varies from 50 pounds at some seasons of the year to 110 pounds at others. I find that it is necessary to use more oil with the low than with the higher pressure.

**W. A. Field.**

Anoka, Minn.

Our engine is a 14x14-inch, running at 280 revolutions per minute. We use three drops of "Model" cylinder oil per minute.

**Charles B. Miner.**

Conneaut, O.

## Expert Advice

In the September 28 issue there are a few more words with reference to expert advice. Mr. Chandler's words are very interesting, and I think the readers would be very glad to hear of the practical work in his plant and the improvements that were suggested by the experts that would cost the company all its profits, and how this was proved. Also what the improvements were which were carried out under his suggestions, and *which are to result* in a saving of $3485 per year. It would seem as though Mr. Chandler was counting his chickens rather early.

With reference to Mr. Samuels' letter, if the operating engineer of today in New York is qualified to such an extent as outlined by Mr. Samuels, he has no business being an operating engineer, for such qualifications, if complete, would enable him to be one of the most called-upon consulting engineers of the country, and soon enable him to command an income many times in excess of what he could obtain as an operating engineer, at the same time enabling him to be free to do work when and where he saw fit, and not be confined to the operation of one plant. It is not always the good fireman who develops into a good engineer, and it is not necessarily the good operating engineer who is a good designer or a good man to make changes in a plant. A man may be very expert in the operation of engines and boilers, and yet lack the necessary theoretical training and practical experience which will enable him to lay out and pipe up a plant properly, although he might be able to operate it very successfully after it was done.

With reference to Mr. Samuels' experiences with consulting engineers and their willingness to accept all the credit of improvements, I should like to ask if these improvements which were made under the direction of the consulting engineer and possibly through the cooperation and suggestions of the operating engineer, had not been in part offered to the plant owner by this engineer and they had refused to accept his advice. If this were so, it would show that the consulting engineer was entitled to some credit, although not the full credit, for the changes; and also that the operating engineer should be willing to allow a part of this credit to go to the consulting engineer, for was he not the gainer from the work being done, and if he had already suggested these things, was not his standing with the manufacturer enhanced?

**Henry D. Jackson.**

Boston, Mass.

## What Caused the Air Pressure?

The exact cause of the trouble described by Louis B. Carl, in the September 21 issue, cannot be definitely traced, since he does not show the general construction of the pump, beyond the fact that it was caused by air being trapped in the pump when priming. If only the pipe leading to the suction had been used for priming, the trouble would not have occurred. Generally, the pump casing is provided with a petcock to allow the air to escape when priming. As it was, the water flowing into the discharge pipe undoubtedly cut off the escape for air and consequently the air in the pump casing was compressed by the incoming water.

**John B. Sperry.**

Aurora, Ill.

## How Should Boilers Be Run?

Milton Heglin's course of procedure as related in his letter in the issue for September 21, page 498, seems to me to have been the proper one under the circumstances. If it was not possible to separate the two boilers, although one was not used to its capacity, a fire under each was more logical than to fire one only, when we consider the fact that the other boiler with its brickwork would have to be raised to practically the same temperature as the working boiler anyway.

With a connection through the mud drum as well as through the steam drum, there would be developed a state of affairs sure to result in more or less injury to the boilers if one were worked while the other was not. In the first place the dead boiler would act as a kind of condenser with cold water at the bottom and hot steam in the upper part, and this would serve slowly to circulate the water into the working boiler, until they became of practically the same temperature. In this process I have no doubt the fuel consumption would exceed that of the s[illegible] firing of [illegible] boiler while the [illegible] from [illegible]rted expansion w[illegible] make itself evident later.

L. F. Wilson.

Chicago, Ill.

## Will a Centrifugal Pump Do the Work

Noting L. Corwin's quest for information in regard to centrifugal pumps, on page 400 of the September 21 issue, the writer's experience in a quite similar case may be of use. For more than a year I ran two two-stage centrifugal pumps of a capacity of about half a million gallons each per twenty-four hours under a suction lift of from 20 to 25 inches of vacuum against a head of 140 feet. I had no trouble at all about the high suction. That I was lifting the water out of a dozen wells, while Mr. Corwin gets his supply as stated, would not seem to make any difference, providing he will go to some little extra expense and rig up an arrangement such as I was using. Where the 10 inch suction line entered the pump house, we had a check valve, followed by a short run into a suction chamber 36 inches in diameter and about 6 feet high. From near the bottom of this chamber the suction pipes led to the pumps. From the top of the vacuum chamber a 1½-inch connection led to a small vacuum pump. The air that leaked into the suction or was liberated from the water accumulated in this chamber and by pumping out this air once in a while we kept the water level in this chamber always a foot or two above the intake openings to the pumps, thereby assuring a solid body of water for the pumps to work on. A gage glass on the chamber indicated when it was time to start the vacuum pump, which in this case was run at intervals of from half an hour to an hour, depending on the condition in the suction side. Another small pipe from the air pump ran to the top of the centrifugal-pump casings, providing a convenient way of priming the pumps.

As Mr. Corwin is pumping under considerable head, also, it is a small matter quickly to reprime a pump rigged up in this way, should it lose its suction, while running, from a leaking stuffing box (which is the only way it could happen unless the water is allowed to run low in the vacuum chamber). By simply connecting a 2-inch pipe from the pressure side of the system to this vacuum chamber, the chamber can quickly be put under pressure and the pump reprimed while running at full speed, the large check holding the water back from the suction side.

It is not necessary first to fill the vacuum chamber, as this fills immediately as the pump stops delivering water.

R. Cederblom.

Gary, Ind.

I beg to express the opinion that the centrifugal pump would be just the ticket for the work described. I am not interested in the sale of centrifugal pumps, but I believe that there is nothing which will compare with them in efficiency on just such work as Mr. Corwin describes. The United States Government has had surprisingly good success with the centrifugal in suction-dredge work, and if the readers of Power can name any work to which pumps may be subjected which exceeds this in rigorousness, I bow to their superior experience. I have seen boulders of a diameter only slightly less than that of the suction pipe come up to the pump when the strainer was left off. As a matter of fact the suction of the centrifugal pump may be expected to equal that of any class of pump, the only difference being that the centrifugal will lose its suction easier.

Almost any class of pump will raise water to the limit as prescribed by atmospheric conditions; the advantages and disadvantages which go to make one pump better than another are computed along other lines. As to the two-stage idea, it would seem that the advice of the pump people as based upon the particular conditions of this installation had better be followed. Two and even three-stage centrifugals are used either against heavy heads or on difficult suctions. If the work is to be in very dirty water, however, the simpler the pump the better.

I suggest that in case Mr. Corwin decides to install the centrifugal pump, he keep the reciprocating pump connected up for emergency use; not that it is the better or more trustworthy device, but conditions as he describes them would seem to call for this precaution.

L. F. Wilson.

Chicago, Ill.

I am not a centrifugal-pump salesman, but I can assure Mr. Corwin that the centrifugal will produce as great a vacuum as the reciprocating pump; in fact, I have frequently run them when the vacuum gage showed as high as 28¾ inches.

As to the advisability of replacing the pump mentioned with a centrifugal pump, and as the possibility of air leakage is merely an assumption, it would be better to install the pump, and if it failed to maintain its priming, then means of instantly repriming could be arranged with little difficulty. I know of instances where automatic primers have been installed, but for this case probably the simplest would be a bypass from the tank to the suction line.

Single-stage pumps will care for as high suction lift as will multistage pumps.

John B. Sperry.

Aurora, Ill.

I should say to Mr. Corwin: "Under these conditions, don't do it." I have had considerable experience with the centrifu
gal pump and while I realize all thei
good points, I can assure Mr. Corwi
that in his case it would be far better t
retain the old pump and still continu
to repair its worn parts.

If it would be possible to place t
centrifugal pump at the water's edge
would be a different proposition, and
should advise its installation by all mean
but where you have a long suction pi
and high lift and want something depen
able, keep the old pump.

The centrifugal-pump salesmen do n
exaggerate when they say that it is po
sible for the centrifugal pump to ta
water from as great a depth as the reci
rocating pump, only it is the excepti
rather than the rule. Conditions must
perfect for a centrifugal pump to oper
successfully on a 24- to 26-foot lift, and
would be well to remember that wh
water is getting low in the supply tan
and the centrifugal pump fails to thr
water the engineer is there to take t
brunt of it while the salesman is mi
away.

L. C. Tucker

Newburyport, Mass.

## Criticism of Indicator Diagram

The indicator diagrams of a triple-
pansion engine submitted by J. O. B.
tour, September 14 number, page
show very bad division of the load
tween the three cylinders. In the hi
pressure diagram the cutoff is too l
especially on the left-hand end, and
lease is also late, while compression
gins too early. In the intermediate
gram cutoff is late, which if made ea
would raise the back pressure on the h
pressure cylinder, thus reducing the m
effective pressure of the high-pres
cylinder; and having a late cutoff on
low-pressure cylinder, to reduce the l
pressure on the intermediate cyli
would reduce the second receiver p
sure, thus reducing the amount of w
done in the low-pressure cylinder an
creasing the work in the intermediate
inder.

The left-hand diagram from the
termediate cylinder shows much later
off than the right-hand end, and
shows the valve to be leaking quite b
In the low-pressure cylinder it is
to determine the point of cutoff, b
should be quite late to keep the se
receiver pressure down, reducing the
pressure on the intermediate cylinder
increasing the mean effective pressu of
the same cylinder. Release on the
pressure diagram is not early en h,
especially on the left-hand end, and ad
is a little late on both ends. There s ns
to be more compression on the left- nd
diagram of all three cylinders than o he
right-hand end.

The first receiver pressure should be about 60 pounds and the second about 5 unds. All the diagrams show evidence leakage.

J. C. Hawkins.

lyria, O.

## Interesting Pump Experience

Mr. Wadsworth's "Interesting Pump perience" was very likely due to his pump having more liberal clearance e water end than the old one.

With the plunger at one end, the air ained between the end of the plunger the bottom of the valve is sufficient l the entire water space in the cyl-r under a vacuum of 20 inches. This g the case, the effort of the pump is ely spent in expanding and compress-the same air over and over.

ilar trouble is experienced in at-ting to make air compressors deliver gher pressure than they are designed i. As the pressure gradually goes up, volume delivered decreases until a sure is reached where the air in the rance spaces expands to atmospheric sure and no air flows in on the suc stroke.

H. R. Hadfield.

wark, O.

## Tansfer of Heat under Opposite Conditions

have noticed considerable discussion n ent issues, as to whether a hot body n vacuum bottle would take more or e time in cooling on a cold day than ld body in warming up on a hot day. the figures assumed by Melvin E. l in a late article be taken (viz., that dy at 212 degrees Fahrenheit cools o degrees for one case, and that a body at degrees Fahrenheit heats up to 92 es for the other case), the answer s quite simple and hardly in ac-ce with Mr. Weil's.

e temperature of the hot body must f 180 degrees while that of the cold must rise 60 degrees. Everyone will dit that it takes a liquid as long to off from 60 degrees above the air rature as it takes it to heat up from grees below the air temperature. the hot liquid starts at 180 degrees the surrounding air. It must there-r reach a point 60 degrees above its ndings on the way down, and no ne can deny that this change would me time. But, when this point is raced it will take as much additional to cool the remaining 60 degrees as it uld take the cold liquid to heat up 60 grees. It is thus very evident that the ot liquid will stay hot longer than the old one will remain cool, although the posite statement is often heard.

H. G. Hill, Jr.

Pladelphia, Penn.

## Some Erroneous Ideas

In the September 14 number, on page 450, appears an article headed, "Some Erroneous Ideas." It starts out by saying that unbalanced pressure on the back of an engine valve depends not on the size of the valve but on the area of the ports covered by the valve. The writer then goes on to say that, "if a valve could be conceived under which there were no ports no degree of pressure would press it to its seat."

Strange how we've been plodding along all these years with the mistaken idea that steam under pressure will exert this pressure on all surfaces exposed to it. Engine builders have used balance plates, piston valves and whatnot, thinking that they were overcoming something, and now we are told there is nothing to overcome.

Let us consider a valve, as this writer suggests, that is doing nothing in the port-closing line, but is ground to a perfect bearing on its seat. We will say that the area of contact of this valve with its seat is 100 square inches, and there is steam pressure of 100 pounds per square inch; making a total pressure of 10,000 pounds on the valve. If instead of exposing it to steam pressure we were to put a weight of 10,000 pounds on it, does the writer of the article referred to contend that it could be moved on its seat as easily as before it was weighted? I have the erroneous idea that it could not.

If there is any difference between the two cases cited, in so far as the pressing of the valve to its seat is concerned, I should like to have it pointed out. Again, anyone who has had experience scraping or grinding two surfaces to a bearing knows that it requires considerable force to separate them when the contact is perfect. This is due to atmospheric pressure on the surfaces opposite those in contact.

Or, is this another erroneous idea?

J. B. Clapper.

Cleveland, O.

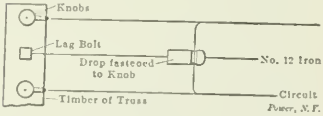
## A Useful Method of Wiring

In the issue of August 10, F. H. Stacey shows "A Useful Method of Wiring," being a method of supporting the wires and drops on iron-wire supports between long spans.

I have a method for doing this class of work that I have used for the past fifteen years in buildings of mill construction where I can jump from one truss to the other. In most of these buildings the trusses are spaced about 20 feet apart and a circuit of ten lamps will run from 3 to 5 spans. If the trusses are of wood, I fasten one end of a No. 12 iron wire at one end of the run either by wrapping around the timber or by the aid of a 4-inch lag bolt, the other end is carried down the length of the run and before making it fast, the proper number of No. 5 knobs corresponding to the number of lamps required are slipped over the wire. I secure this end by screwing a 4-inch lag screw in the under side of the lower timber; just before I get it entirely screwed up I pull up the No. 12 wire with connectors and take about three turns around the bolt and by holding the wire and at the same time screwing up the lag bolt a few more turns I can give the iron wire as much tension as is necessary. The circuit is run along about 3 inches on either side of this wire and supported at each truss by knobs, and at the same time a knob or a staple is used to support the iron wire.

Wherever a lamp is required, the knob is set, the cord fastened in the groove and the ends made fast to the lines as shown in the accompanying sketch.

When the building trusses are of iron I dead-end one end in the usual manner and with a small set of blocks pull up and make the other end fast around the angles without the need of any bolts. I have used screw bolts but do not consider them of any advantage, as I can put up just as good a job without them and



A USEFUL WIRING METHOD

with less time and expense, and it has been my experience that after a job of this kind is once put up, it is not gone over and pulled up as it rarely needs it. It is a very cheap method of installation and in my experience has been very reliable for spans of 15 to 20 feet. Of course, where it is necessary to run a span of two or three times this length some means should be taken to support the line wires properly, and Mr. Stacey's scheme of blocks is very good for long runs.

G. S. Sprague.

Geneva, Neb.

---

Three employees of the Penn Iron and Coal Company, Canal Dover, O., were crushed to death in the cylinder of a 160-ton blowing engine. The inside of the cylinder was four feet in diameter and the men were working with their feet against the piston end.

The piston was being held back by a brake against the 30-ton flywheel. Suddenly the brake slipped and the wheel, impelled by a many-ton counter-balancing weight on one side, turned over. The piston crushed the three men into a space three inches deep and four feet in diameter, between the piston and cylinder head.

POWER AND THE ENGINEER

DEVOTED TO THE GENERATION AND
TRANSMISSION OF POWER

Issued Weekly by the
Hill Publishing Company
JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.
505 Pearl Street, New York.
355 Dearborn Street, Chicago.
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of POWER solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "POWPUB," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During 1908 we printed and circulated* 1,836,000 *copies of* POWER.

*Our circulation for September,* 1909, *was (weekly and monthly)* 141,000.

*October* 5.............. 42,000
*October* 12.............. 33,000
*October* 19.............. 30,000

*This paper reaches* 42,000 *separate readers each month and* 30,000 *each week.*

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*

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## Engine Speed Regulation and Tungsten Lamps

The fact that the relatively new tungsten incandescent lamp is considerably more sensitive to voltage variation than the old carbon-filament lamp is well known to electrical engineers, but either the fact itself or its relation to reciprocating engine performance seems to have escaped the attention of some designers of such engines, not to mention consulting engineers, architects and others concerned more or less directly with the installation of engine-driven electric-lighting plants.

A corporation decided to build a large office building in a certain inland city, and employed metropolitan architects to make the plans and supervise the entire construction. The plans and specifications covered the electric-light plant, which was, in a measure, modified to meet the desires of the man who was to be chief engineer of the building. He was familiar with a certain make of engine, and the change was only such as would let in this particular engine. The features called for as to the engines were a speed of 200 revolutions per minute; speed variation not to exceed two per cent.; flywheels of a certain weight, and operation to the satisfaction of the chief engineer of the building and the architects. Just what the specifications as to the electric generators were we do not know, but the machines were multipolar generators of 100 kilowatts capacity, designed to run at 200 revolutions per minute.

The contract was let by the owners to a large contracting concern, and they sublet the contracts for engines and generators to separate companies. This was at a time when tungsten lamps were just beginning to be used, and nothing was said in the specifications about them. The engine builders having seen but a few of the lights supplied from generators driven by their engines had no reason to think there was anything peculiar about them. When the plant was erected and the lamps then commonly used were put in no complaint was made, but as soon as tungsten lamps were put in they flickered to such an extent as to be a source of complaint, and the plant has not been accepted by the engineer and architects.

The electric-light people claimed that the fault was in the engine governors, but when the indicators followed a constant line for three minutes, that claim was rejected. Then it was claimed it was due to insufficient flywheels, but these proved to be 25 per cent. heavier than the specifications called for; besides, a similar engine with a flywheel very much lighter, but with a different generator, gave steady light at 200 revolutions.

But now a new card was played by the electric company's agent. One engine was disconnected, and a motor set up to drive
its flywheels and generators; this gav
steady light. Consequently, the buy
representatives claim it is up to the eng
builders to give a steady rate of turn
at the engine shafts.

The electric people have filled their c
tract (so they claim); the engine buil
have filled their contract (so they clai
but the chief engineer and architects w
accept the plant. Hence, neither get t
pay.

The mysterious feature of the cas
that nobody seems to have discov
that the source of the trouble is
speed regulation but changes, within
revolution, in the velocity of the flyw
rim, which no governor can correc
control, and which no steam-engine
cator can indicate.

The moral, however, is that if
want to supply high-efficiency incande
lamps from a generator driven by a r
rocating engine, the "angular varia
in the speed of that engine mus
smaller than would be allowable
low-efficiency lamps.

## Detroit's Boiler Inspection and gineers' Examination Law

The common council of Detr
wrestling with an ordinance prov
for the inspection of boilers and th
amination and licensing of engineers
understand that the form which was
what critically discussed in our iss
September 7 has failed of adoptio
we have before us another draft
duced by Alderman A. J. Walsh,
instead of endeavoring to cover eng
ing details, provides for a Boa
Boiler Rules, similar to that exist
Massachusetts, which shall provide
for the conduct of the boiler-insp
department, subject to the appro
the common council.

This appears to us to be a wis
cedure. The establishment of a
rules, compliance with which wil
guard the public and still not be o
upon the owner, operator or manuf
of boilers, is a task for specialis
such rules may much better take th
of a departmental code than be
into the fundamental law. The
of the Massachusetts departme
shown that a workable set of r
arrived at only after frequent r
and it would seem to be wiser t
the boiler-inspection department
such rules, revisable by a bo
specialists, than to lumber the bod
ordinance with technical detail wh
only be modified by the cuml
process by which an ordinance is a nd
The proposed Board of Boiler Ru on-
sists of one mechanical engine
boiler manufacturer, one operati sta-
tionary engineer and one steam u , and
they are to hear all complaints rising

under the ordinance, as regards examining and licensing engineers, as well as inspecting boilers.

Instead of imposing upon this board the task of compiling a set of rules, the ordinance adopts the Massachusetts rules in their entirety. We are glad to see this. A lot of brains and money have been spent by Massachusetts in working out this code. It has had the advantage of several years of operation, and has been molded to meet the rugosities of practice. A boiler which is safe in Massachusetts will be safe in Detroit, and anything that is required to make a boiler safe in Massachusetts will be just as essential in Detroit. Should local conditions develop the necessity for new rules or modifications of the old, they can readily be effected, but it is difficult to think of necessary differences between the practice of two cities or States, and the indorsement and adoption of the Massachusetts work by Detroit is a step in the direction of uniformity which we are glad to see taken.

## Marine Producer Gas Power

The publication of our brief comment on this subject in the issue of October 5 has brought out the statement from one of our readers to the effect that a Boston concern has several boats equipped with gas producers and engines, and that therefore the three boats mentioned in our editorial do not embody the only attempts made in this country to build a practical gas-power boat. We hope the information is true; in this case we shall be actually glad to find ourselves in error, if the Boston efforts have been successful.

Mr. Hasbrouck, to whose boat "Gloria" we referred, has also sent us some information. On July 2, this year, he tells us, the boat made a run to Poughkeepsie and back in 13½ hours, carrying twelve passengers. The total coal consumption was 88 pounds. This, like the report of the run made by Mr. Aldrich's yacht to Albany, is interesting and encouraging, but it is not complete information. Mr. Hasbrouck kindly offered to put his boat at our disposal and allow us to carry out any tests we wish to make; it is scarcely necessary to say that we have neither the time nor the facilities for making such tests, much as we should like to embrace the opportunity.

Within the past few days rumors have been drifting around to the effect that somebody with the courage of his convictions is going to build a producer-gas freight boat for ocean service. We hope there is a basis of truth for the rumor. While we do not feel sanguine about 50,000 horsepower producer-gas battleships and ocean "greyhounds" being put in commission next year, there is no engineering reason why gas-driven boats of a few thousand horsepower should not be successful if built in the light of experience already available.

By the way, when the producer-gas boat "arrives," as it surely will some day, will it be called a "gasser" in small sizes and a "gasship" when of large proportions? These terms are anything but euphonious.

## The Educational Value of Advertisements

What percentage of the readers of Power are also students of its advertising pages?

This question, which is often asked in one form or another by the advertiser and others interested in publicity, can best be answered by the readers of the paper, and in this regard the following is an expression from one of them:

"I should no more think of laying aside any of my mechanical journals, as being read through, without going over the advertising pages than I should think of leaving a Christmas dinner before the arrival of the pudding. In either case there would be a sense of having missed something. As a matter of fact there is scarcely a page of any issue of the current mechanical papers that will not give a thinking reader some information. It may be something wholly new to him and to the world, and it may be an old idea presented in a new light. In any event the reader adds to his store of useful knowledge. But if he neglects the book notices, the notices of new catalogs and the advertising, he misses the dessert to his intellectual meal.

"Modern advertisements are full of information to the engineer. They are largely pictorial in their makeup, but instead of the old wood cut or cheap engraving, there are fine halftone illustrations and line cuts that represent accurately and correctly the appearance and construction of the devices or articles advertised. For this reason they convey correct and valuable ideas to the reader.

"The reading matter accompanying the illustration often contains information that can be used, and still more often contains statements that will set an intelligent engineer to thinking. For example, pick up any recent number of Power and observe the advertisement of almost any well known oil filter. Without exception there will be found some statement concerning the saving in oil bills, or in the quantity of oil used. Lubricating oil is so generally used in every engine room that no engineer can read the statement without a desire at least to investigate its truth, and since many of the filter manufacturers permit a trial of their devices to demonstrate their efficiency, an engineer can readilly determine whether he has discovered a new way of practising engine room economy.

"But this is not the extent of the benefit to be derived from a careful reading of advertisements. There was a time when manufacturers were very reticent in regard to the management of their business, and the construction and operation of their devices and appliances. That day is long past, and now the very opposite is true. Many of the large concerns maintain publicity departments, the duty of which is to spread among engineers a knowledge of the construction and application, as well as the performances in respect to economy and efficiency, of the various products. This information is usually got out in the shape of circulars, pamphlets or catalogs, and here is where the live engineer may fall heir to a vast amount of valuable data for a mere song. Most of these catalogs are mentioned in the advertisements, and the reader is invited to send for them at no expense except the cost of a postal card, or, at the most, a few cents in stamps. There is thus opened up a field of information covering every appliance, supply or machine used in a power plant. Sectional views are presented which make the construction and the method of operation perfectly clear, and for this very reason often save considerable time in locating defects in an apparatus practically inclosed, such as a heater, pump or for that matter an engine. The information given is thus useful in more ways than one, and for the greater part is accurate and reliable. For who should know the good and bad points in the construction of a device better than manufacturers who have spent years in producing a satisfactory type? Or, who should understand better what constitutes a good oil, belt or grease than the manufacturers of these products? Not only that, but many catalogs are in reality valuable treatises on various phases of power-plant engineering. So, in the perusal of this and succeeding numbers of your favorite journal, do not neglect the advertisements."

It is evident that this particular reader has made special study of the advertising pages, and thoroughly appreciates their value as an educational medium. There is practically no other way to keep in touch with the latest practice, and engineers who skip entirely this department of the paper, or give it only casual attention, are neglecting one of their best opportunities to become the leading and best-informed men in the profession.

## The Next A. S. M. E. President

George Westinghouse will be the next president of the American Society of Mechanical Engineers.

# Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

## The Bayer Soot Blower

The Bayer soot blower is a system for cleaning the tubes of water-tube boilers. In Fig. 1 is shown the elevation of the rear water leg of a water-tube boiler with the system in place. The lower header carries the nozzle for blowing the tubes between the upper and lower baffles. The upper header is used to agitate the dead spaces known to exist at the point where the jets come through the water legs. Fig. 2 shows a side elevation of the system as applied to a water-tube boiler.

When operating the system, it is only necessary to open the controlling valves *A* and *B*, Fig. 2, about three minutes, letting them operate in conjunction. While they are going, open *C* and *D* for about twenty seconds, several times during the operation, in order to stir up the accumulations which have been blown into the space between the headers.

The system is easily installed and does not require the cutting of holes in the boiler setting, or altering it in any way. All that is necessary is to make a steam connection on the header or some other convenient source of steam supply and attach the blower by means of an ordinary union. The jet extends into the hollow stays flush with the inside of the water leg, and is thereby protected from t heat.

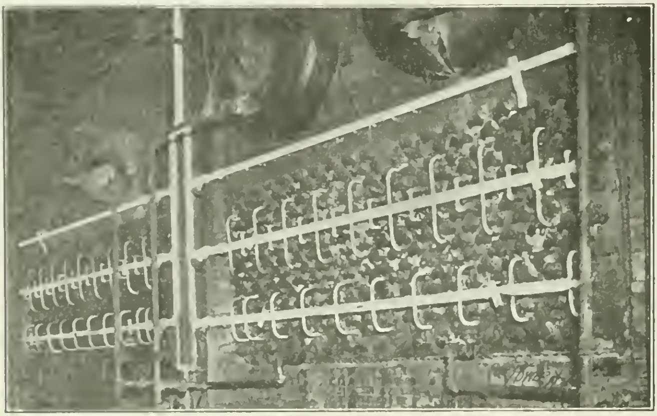


FIG. 1 REAR VIEW OF SYSTEM ATTACHED TO A WATER-TUBE BOILER

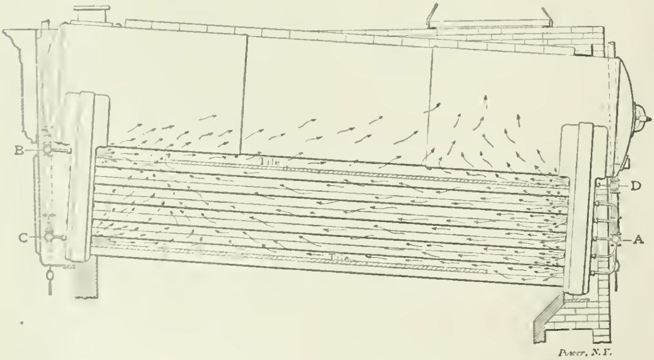


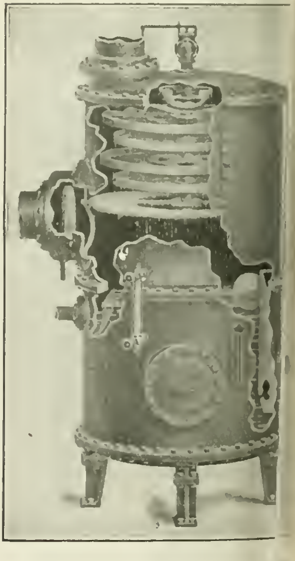
FIG. 2. SIDE ELEVATION OF SYSTEM APPLIED TO WATER-TUBE BOILER

This system is manufactured by t Bayer Soot Blower System, 207 Pi street, St. Louis, Mo.

## Bonar Feedwater Heater and Purifier

A semi-sectional view of the Bonar fe water heater and purifier is shown in accompanying illustration.

The water supply is introduced at top through a balanced valve to a ing device. The water then falls circular pans, passing downward in zag manner from pan to pan. The pan, located immediately above tl haust inlet, is so arranged that the is conveyed up through the center heater below the center line of the thereby causing a thorough mingl the steam and water, and preventi possibility of the steam from passi of the exhaust outlet without con direct contact with the water. Tl



BONAR FEEDWATER HEATER AND PU

re revolvable and may be readily cleaned y opening the door on the shell of the eater.

On the exhaust-steam connection is laced on an oil separator which entrains e oil contained in the exhaust steam fore entering the heater.

A surface overflow is located at the ow ff connection, on the water level; he water level being maintained by a at regulating the balanced valve on the pply line.

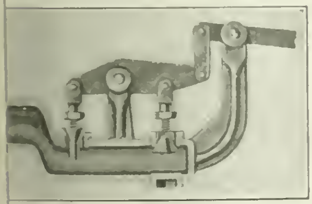
On the water outlet is a hood extended ove the water level and below the water let, open at the top and bottom. This vents any of the surface impurities m entering the pump, at the same time king a seal so as to prevent the water e heater from being siphoned.

The heater is of the simplest form and throughout of strong cast-iron con- n

It is manufactured by James Bonar & Frick building, Pittsburg, Penn.

## nprovement in the Davis Steam Trap

A improvement has been made in the s steam trap, manufactured by the M Davis Regulator Company, 144 lwaukee avenue, Chicago, Ill., by equipment with removable seat bushings and ving the valves made of Tobin bronze lace of steam metal, which was formerly used.



WING REMOVABLE SEAT BUSHINGS IN THE DAVIS STEAM TRAP

## Danubil Sheet Packing

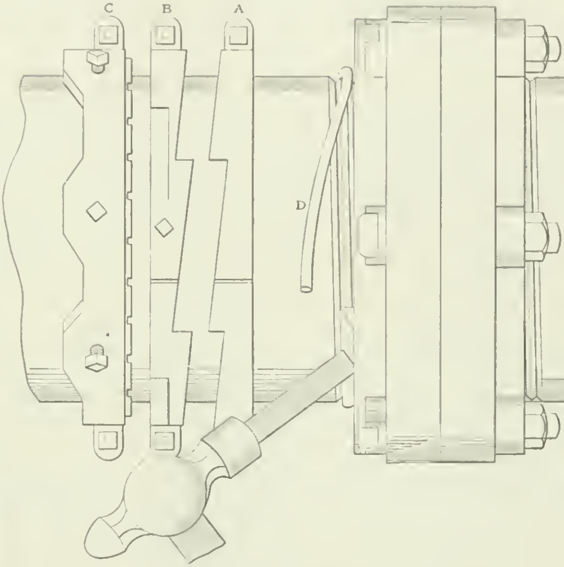
bil sheet packing is made of Para r Canadian asbestos and secret components which enable it to resist great pressure and heat, and its resistance to erheated steam is practically unlimited, it is claimed.

t does not need any following up after ting in, and the engineer need not bother about the gasket again until he is ready to break the joint, it is claimed. Another advantage is its great pliability. It is manufactured by the Danubil Company, 253 Broadway, New York City.

## "King Bee" Clamp

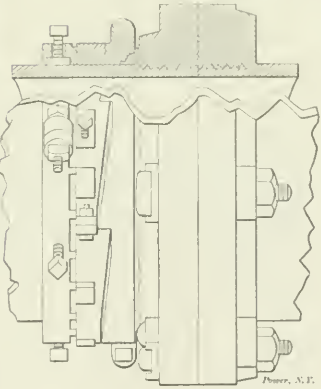
A pipe clamp known as "King Bee," manufactured by the King Bee Clamp Company, Washington and Mound streets, Dayton, O., is illustrated and described herewith.

The clamp consists of three parts, as shown in Fig. 1, the first being a sectional ring *A*, having long teeth on one side of the ring and a beveled inner edge on the other. Another ring of practically the same design, shown at *B*, is placed on the pipe and clamped together so that its teeth face the teeth on ring *A*. The piece of metal packing *D*, shown next to the flange, is placed in position and the ring *A* fitted snugly to it. The clamp ring *C* is then placed in position on the pipe and secured and the ring *B* driven around on the pipe so that as it revolves the ring *A* is forced up against the packing, due to the difference in thickness of the rings between their smallest portion and widest parts.



Power, N.Y.

FIG. 1 SHOWING PARTS OF "KING BEE" CLAMP



Power, N.Y.

FIG. 2. "KING BEE" CLAMP LOCKED IN POSITION

Fig. 2 shows the clamp in position and illustrates how the device is applied to a leaky joint.

## A. O. S. E. Ladies' Night

Old Colony Council No. 14, A. O. of S. E., observed ladies' night Saturday evening, September 25, by a banquet and reception at Odd Fellows hall, Rockland, Mass. Among the guests were Supreme Chief Engineer Frederick Markoe, of Abington, Penn.; Supreme Trustee W. R. Smith, of Coplay, Penn.; Past Supreme Chief Engineer E. H. Naylor, of North Abington, Mass.; and Senator Melvin S. Nash, of Hanover, Mass.

Supper was served at 8, covers being laid for fifty persons. After the spread, Chief Engineer Charles A. Scott, of Old Colony Council, who acted as toastmaster, welcomed the guests. Supreme Chief Markoe and Supreme Trustee Smith spoke interestingly of the work of the order. Senator Nash gave an address on "The Massachusetts Legislature." Soprano solos were rendered by Miss Alice Garvey, of Waltham, Mass., and piano selections by Miss Mary Mahoney, of South Weymouth, Mass.

October 5 one man was badly scalded and considerable damage was done to a section of the plant of the Auburn (N. Y.) Heat, Light and Power Company by the bursting of a water heater.

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The next meeting of the National Gas and Gasoline Engine Trades Association will be held at the La Salle hotel, Chicago, Ill., November 30 and December 1 and 2. Several papers treating of the gas and gasolene-engine industry are being prepared.

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The United States Civil Service Commission announces an examination on November 24, to secure eligibles from which to make certification to fill a vacancy in the position of miller and engineer, qualified to operate a sawmill, at the Uintah and Ouray Indian agency, Utah, at $900 per annum.

## Obituary

George A. Rollins, president of the Rollins Engine Company, died September 30 at Nashua, N. H., aged 82 years. He was born in Dedham, Mass. He learned the machinist trade at Manchester, N. H., and removed to Nashua, where he founded the business which bears his name. The Rollins engine attained a high degree of development under his direction. He was a director of the White Mountain Freezer Company, of Nashua. He took an active part in the public life of the city.

## Business Items

The Alaska-Yukon-Pacific exposition has awarded grand prizes for insulated wires and cables to the General Electric Company and the John A. Roebling Sons Company.

The Hill Clutch Company, of Cleveland, Ohio, manufacturer of power transmission machinery, announces the appointment of G. W. Hoffman as sales engineer in charge of its Chicago office, at 610 Marquette building.

Thurlow E. Coon, 1809 Ford building, Detroit, Mich., has been appointed agent for the American Radiator Company for the sale of Bundy traps and separators in the State of Michigan. Also, the Philip Carey Company, 27-Havana-Apartado 658, Havana, Cuba, will handle Bundy traps and separators in that locality.

F. W. Dean, mill engineer and architect, Boston, is regularly inspecting two large pumping engines now being built at the Scranton works of the Allis-Chalmers Company. Each engine is to have a capacity of 100,000,000 gallons, each 24 hours, and is of the triple-expansion type, with three horizontal cylinders with a vertical shaft. The centrifugal pump is below the engine.

The Ford Motor Company, of Detroit, Mich., ordered sometime ago, from the Riverside Engine Company, of Oil City, Penn., a two-cylinder, 35x48 tandem gas engine, to run at 100 revolutions per minute, rated at 1400 horsepower. The company has now contracted for a second of these units and is talking of a third. Each of the engines is direct-connected to an alternator and crank-connected to a two-stage air compressor. Hughes producers, furnished by the Wellman-Seaver-Morgan Company, are being used with bituminous coal, the gas-cleaning plant being by Gustav Sanier.

The C. O. Bartlett & Snow Company, of Cleveland, O., reports recent orders as follows: Kelly Island Lime and Transport Company, Cleveland, Ohio, one elevator, capacity 1000 tons of crushed stone an hour, and one elevator, capacity 600 tons of crushed stone per hour. It is believed that these are the largest elevators of the kind ever constructed. Winding Gulf Colliery Company, Cincinnati, Ohio, one Greene self-dumping car haul and complete outfit, through F. C. Greene, mining engineer, capacity 2500 tons of coal in eight hours. William A. Clark, Butte, Mont., one ore dryer. American Smelters Securities Company, New York City, one ore dryer for mines at Santa Barbara, Mex.

The Bristol Company, Waterbury, Conn., has established a branch office at Pittsburg, in the Frick building annex, and one of the company's experts will be located there to coöperate with customers whose plants are in the immediate vicinity of Pittsburg. The company is making a specialty of studying the application of Bristol's recording instruments in different industries. For instance, it has specialized in recording instruments for blast furnaces. Besides the blast furnaces in the Pittsburg district there are many other processes in connection with which Bristol's recording instruments are used and the company is prepared not only to recommend and furnish the most suitable recording instruments, but also to have its own representative superintend the installation of them.

## Help Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

WANTED—Good draftsman familiar with Corliss engine work. Box 44, POWER.

WANTED—Good mechanical designers and detail draftsmen for machinery manufacturer located in Wisconsin. Box 98, POWER.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

AGENTS WANTED to sell Burgmann celebrated engine packings in territories not yet covered. See our advertisement on page 80.

WANTED—Draftsmen; large company requires at once, men familiar with general engineering work; prefer those familiar with mining plants and machinery. Address Box 49, POWER.

WANTED—Young man as steam engine salesman; only replies giving full details of past experience, training and remuneration will receive consideration; all replies confidential. Box 43, POWER.

## Situations Wanted

*Advertisements under this head are in serted for 25 cents per line. About six word make a line.*

M. E. GRADUATE, experienced, solicit drafting evenings; heating, steam piping, repairs, installations. A. H., Box 32, POWER.

A FIRST-CLASS machinist with ten years experience wishes a situation as an oiler o assistant engineer in New York or New Jersey. Box 47, POWER.

WANTED—Position by mechanical engineering graduate; four years' experience i power-plant design and construction; refe ences. Box 50, POWER.

ENGINEER who has handled such plant in New York as the Hudson Terminal Bldg Park Row Bldg., Ansonia and Manhattan h tels, licensed for 27 years, desires positio Box 45, POWER.

POSITION WANTED as superintendent o master mechanic of power or manufacturin plant; am at present connected with larg manufacturing plant, but desire a change am highly capable and can produce result Box 46, POWER.

MECHANICAL ENGINEER, with thoroug practical experience and complete technic training (Cornell), in power plant buildi and operation, and allied branches, wishes obtain position as manager, superintenden etc., in power plant, pumping plant or man facturing firm, or as consulting engineer f any project. Address Box 51, POWER.

MECHANICAL ENGINEER, experienced the design and construction of blowing e gines, Corliss engines, reversing engine pumps, air compressors, power transmissi machinery, etc., wants position; could ta charge of engineering office, design engine make tests or act as salesman. Box 4 POWER.

## Miscellaneous

*Advertisements under this head are serted for 25 cents per line. About six wor make a line.*

PATENTS secured. C. L. Parker, Solicit of Patents, 4 McGill Bldg., Washington, D.

NEED the part-time services of draftsm and designers? Years of experience on ste and power pumps, gasolene engines, hois etc., at your command at reasonable pri S. S. Engr. Co., Elgin, Ill.

ANY FIRM or engineer in charge of steam plant that is troubled with scale in boilers can get absolutely free, the best in cator and reducing wheel made, with vel lined mahogany case. For particulars, dress Great Lakes Chemical Works, Mani woc, Wis.

AUTOMOBILE auxiliaries pay large p fits; we have something every owner sho have; liberal commission; any serious-min energetic man who would look after our terests can add considerable to his income. draulic Oil Storage Company, 602 Penobs Bldg., Detroit, Michigan.

## For Sale

*Advertisements under this head are serted for 25 cents per line. About six w make a line.*

FOR SALE—20x48 Wheelock engine two 72"x18' high pressure tubular boilers good condition cheap. Address "Engine Box 2, Station A, Cincinnati, Ohio.

FOR SALE—500-horsepower tandem c pound Fleming single valve, automatic; two small engines, cheap for cash. S Manufacturing Co., 1801 Third National B Bldg., St. Louis, Mo.

FOR SALE—250-horsepower Lane & l ley Corliss engine, 18x42 cylinder; engine small for our work and will be replaced with one of greater power. Wm. A. Coo Milling Co., Coldwater, Mich.

FOR SALE—One 75-horsepower eng slide valve, Nordberg cutoff, in perfect or three rope drives complete, A. & F. Br make; one open heater, 75 horsepower; oil separator. All above replaced by la power plant. Est. S. H. Condict, 26 l rence St., Newark, N. J.

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# Friction Drums and Brakes

## Various Types of These Important Devices as Used in Hoisting-engine Practice; Showing How They Are Constructed and Applied

### BY WARREN O. ROGERS

In hoisting-engine practice two of the important parts which must operate with certainty at all times are the friction drum and brake. When very heavy material is being hoisted, the engineer and all others concerned with the work want to be sure that the brake on the hoisting engine is going to hold when it is applied. In order that he may know that the brake and friction drum are in working order, it is advisable for the operating engineer to become familiar with the construction of various types.

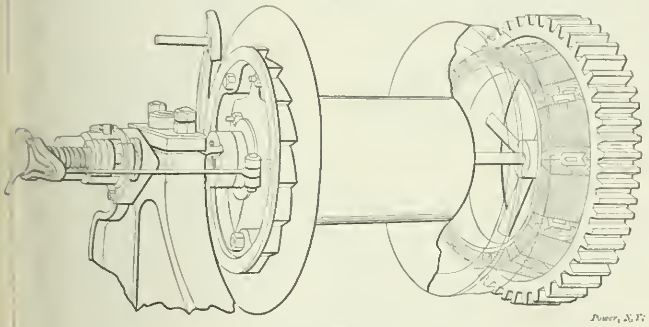

FIG. 1. FLORY FRICTION DRUM

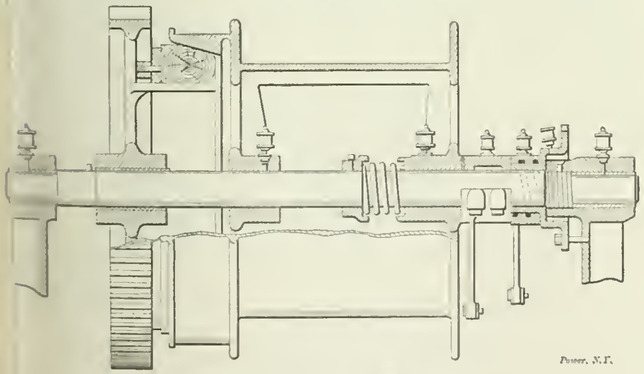

FIG. 2. EXETER FRICTION DRUM

In Fig. 1 is shown a friction drum which consists of blocks of seasoned hardwood fitted and secured to a projecting rim on the gear wheel. On the drum end is cast a rim having a beveled surface on the inner side to correspond to the bevel of the wood pieces with which it engages when thrown into contact.

The drum is fitted to turn freely on the shaft, and also have a slight lateral movement on the drum shaft, sufficient to make contact on the friction drum with enough force to hold the strain of any load the engine can hoist. The drum is moved by means of a lever, attached to a screw, which makes contact when thrown into gear with a steel pin, two steel plates and one of bronze, the latter being placed inside the friction nut. These plates are in oil receptacles which should be kept filled with lubricating oil.

The movement to release the friction is effected by connecting the end of the friction screw to the drum by means of a rod and yokes which, by a reverse movement of the friction lever, will positively disengage the friction under all circumstances. As an auxiliary, a recoil spring is placed on the shaft between the gear wheel and the drum, the pressure of which against the drum produces a gradual release. This friction drum is used on the hoisting engines made by the S. Flory Manufacturing Company.

A cone type of friction drum is shown in Fig. 2. It is lagged with either wood or mineral-tan leather. The spur wheel which carries one member of the friction is keyed against a shoulder upon the drum shaft. At the opposite end of the shaft is a collar threaded and secured to the shaft by a set screw, the end thrust when applying the friction being taken by the collar. A flange sleeve having an external thread of coarse pitch is placed between the collar and the drum hub, the flange and the sleeve having a number of holes spaced on a concentric circle. Through one of these hubs a screw passes and screws into the side frame to prevent the sleeve from rotating. The wear on the friction is adjusted by turning the sleeve in the proper direction a sufficient amount, and the sleeve is then secured by means of the bolt placed in a hole in the frame that coincides with the hole in the flange.

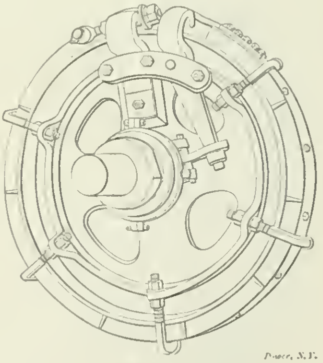

FIG. 3. BAND FRICTION CLUTCH

On the sleeve is a hub with a lever for rotation. When rotated in one direction the friction is applied; rotated in the other direction the friction is released by the release spring. A loose-fitting stationary hub is placed between the operating sleeve and drum hub, and is provided with an extending arm to prevent rotation. This stationary hub is made in halves so as to be removable for relagging the friction if necessary. This friction drum is made by the Exeter Machine Works.

Another type of friction, or clutch, is shown in Fig. 3. The clutch runs loosely on the drum and is fitted with a band friction clutch consisting of a disk keyed to the shaft which is fitted with two arms carrying a steel band, lined with removable basswood blocks and having a suitable means of adjusting the friction band by means of bolt and nut, as shown. One arm is bolted to the disk, and the other fulcrumed from it, and receives its motion from a combination toggle connection and rockshaft, which is operated by a hand lever. In this type of friction the clutch is locked in either the on or off position and end thrust of the shaft is eliminated.

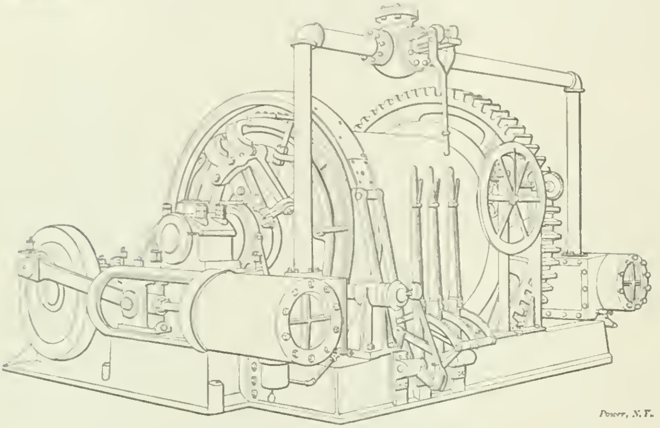

FIG. 4. APPLICATION OF BAND FRICTION TO DRUM

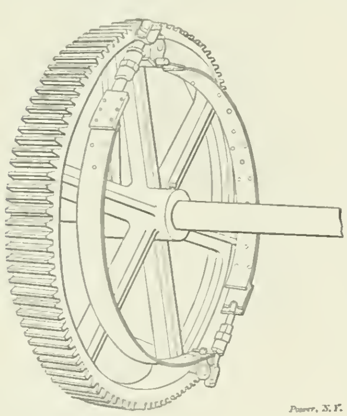

FIG. 5. DENVER FRICTION CLUTCH

Fig. 4 shows the application of the friction which is fitted to the hoist put out by the Wellman-Seaver-Morgan Company. The illustration also shows the band brake which is operated by an independent hand lever. The band is attached at one end to the foundation, and at the other to the hand lever, the connection being such that a continuously increasing force is applied to the brake, while the operator pulls with uniform strength on the lever.

Another type of friction clutch is shown in Figs. 5 and 6, which show both sides as it appears when applied to a gear wheel. It consists of two steel bands, lined with a special material to take up the wear instead of having it come on the steel bands. These bands encircle the clutch drum, which is made a trifle smaller in diameter. The ends of the clutch band are connected to a pair of bell cranks mounted on the rockshaft, which passes through bosses cast on the rim of the main-drum gear, as shown. On the opposite ends of each rockshaft, carrying the bell crank, is forged a lever arm that reaches to opposite sides of the gear hub and shaft, as shown in Fig. 6. Thes arms are connected by means of rings t the clutch sleeves that slide on the drur shaft. On the outer end of the sleeve a groove which engages the clutch forl and is in turn operated by the clutch leve at the operator's stand. As the clutc sleeve is moved toward the gear, the lir forces the ends of the long lever ou ward, which actuates the bell crank as to draw all four ends of the cl band together. This clutch is self-lock whether open or closed.

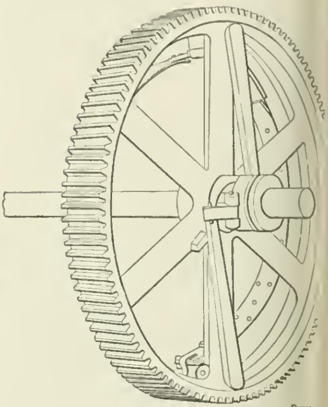

FIG. 6. ANOTHER VIEW OF THE DENVER CLU

In Fig. 7 is shown a type of post br consisting of two beams placed vertic each partially encircling the brake on opposite sides. The beams carr large wooden wearing block, the side to the brake rim conforming to a ci Both brakes are controlled by hand le

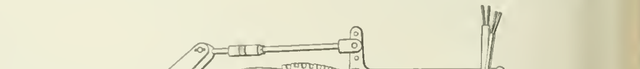

FIG. 7. ONE TYPE OF POST BRAKE

The types of brake shown in Figs and 7 are made by the Denver Eng er- ing Company.

A cork-insert friction is illustra Fig. 8 and is made by the Lidge ood Manufacturing Company. The gear ied of the drum is fitted with a friction nge, as shown, in which are fitted co inerts which are allowed to project about 32 inch above the wooden flange rim, nd although contrary to what one would ppose, as the wood of the friction wears vay the cork retains its original amount projection, the wear seemingly being proportional. As cork will not burn as readily as wood, and does not slip as easily, the cork is very durable. Another feature is that oil does not affect its holding power and trouble from slipping is practically eliminated, even though oil should get on the friction drum.

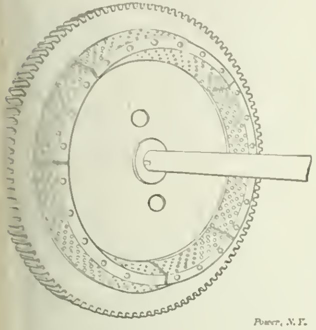
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FIG. 8. CORK INSERT FRICTION

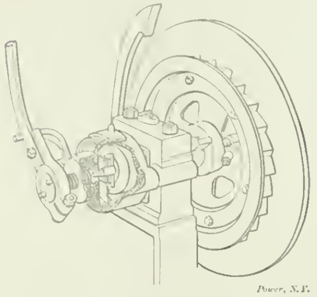
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FIG. 9. LIDGERWOOD FRICTION PIN

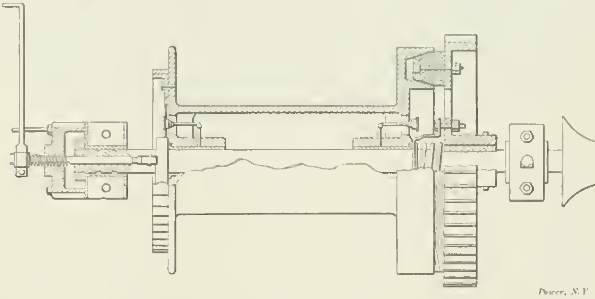
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FIG. 10. CLIDE V-TYPE FRICTION CLUTCH

In Fig. 9 is shown the design of the friction pin used for this type of friction drum. It consists of a coase-pitch screw to which is attached the lever for operating it. The screw when turning comes in contact with a friction pin which is placed in an oil box, and being submerged in oil eliminates what would be serious friction losses, as well as any possibility of the pin and screw becoming welded, due to dirt and friction. As the oil box is inclosed, foreign matter is prevented from getting into the oil, and the pin and screw are kept clean, at the same time sufficient lubrication is always provided.

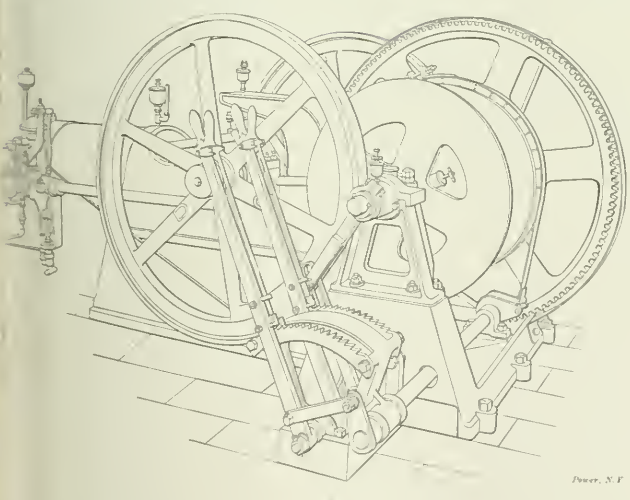
Power, N.Y.

FIG. 11. DRUM AND BRAKE OF OTTO GAS ENGINE HOIST

A friction of the double V-type is shown in Fig. 10, and is made by the Clide Iron Works. It is composed of long segments of hardwood bolted to the spur wheel and turned to fit the faced friction surfaces in the drum flange with which they engage when in gear. These friction blocks are arranged with the grain rad'al and present a large area of friction surface across the grain. Owing to the angle of the friction and friction block a very slight movement of the drum along the shaft is sufficient to engage it, which makes it a positive and powerful friction.

The friction engagement is accomplished by means of a forged steel lever, friction screw and nut, placed at the end the drum shaft between the drum and motion to the drum by means of a tool steel pin crosskey and collar. This friction arrangement is so efficient that a very slight pressure on the lever is sufficient to hold the drum in gear against any load the engine may handle.

The release of the friction is automatic when the pressure is removed, due to the heavy steel spiral spring, which encircles the drum shaft between the drum and gear wheel, and the end pressure against the thrust members exerted by this spring is relieved when the drum is thrown off. The spring is confined by a steel check bolted to the gear wheel to allow for adjustment when needed. This spring-check device removes all resistance to free unwinding of the drum, and at the same time prevents the spring from exerting a pressure on the thrust member.

In Fig. 11 is shown an outline drawing of an Otto gasolene mining hoist. The thrust collar which takes up the thrust when the friction clutch is thrown in is screwed to the drum shaft. The friction surfaces are inclosed in a box filled with oil or grease which protects them from dust and dirt.

The brake is of the differential type, and the load tends to tighten it after it has been applied. The brake bands are lined with blocks of hardwood and are made in two sections, joined by a bolt with nuts to adjust for wear.

The load is hoisted by throwing the drum in gear and lowered by applying the band brake. As shown, the operating levers are mounted in a rack and so arranged that the operator faces the shaft. The clutch lever is connected to a speed-changing device, the speed of the engine being automatically reduced when the hoist is not in actual operation or when the load is being lowered.

# An Unexplained Accident

By W. H. Wakeman

The power plant of a certain small but very busy mill consists of the following equipment which is operated under varied conditions. Steam is generated at 80 pounds pressure in a tubular boiler, the shell of which is 50 inches in diameter, containing 52 tubes 3 inches external diameter, and 13 feet long. As this accounts for approximately 600 square feet of heating surface, the boiler would be rated at 50 horsepower, allowing 12 square feet for each horsepower. The water level is indicated by three gage cocks and an ordinary water gage. These form the trimmings of a plain cast-iron water column without either high- or low-water alarms. With this column located high enough to carry the water level 3 inches above the tubes, and barely appear in the glass, it is impracticable to carry more than two gages of water, as any more is liable to cause excessive priming, and three gages is sure to make a dangerous quantity pass over into the engine. As a safeguard against such action, a horizontal separator with a large reservoir provided to take care of a sudden rush of water, in installed in the main steam pipe. The boiler is supplied with water by a direct-acting steam pump which is too small for the duty required, hence it is run at a high speed which is regulated by hand.

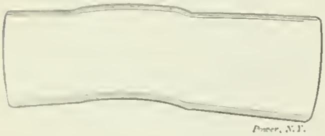
Power, N.Y.

FIG. 1. OUTLINE OF KEY AFTER ACCIDENT

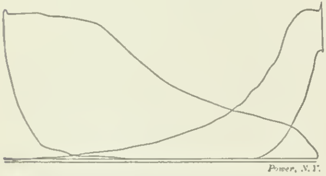
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FIG. 2. CARD TAKEN WHEN ENGINE WAS RACING

Steam is supplied to a 12x24-inch engine, the speed of which is regulated under normal conditions at 125 revolutions per minute by a shaft governor that moves the cutoff eccentric across the shaft to reduce the travel of the valve, which is of the piston type. The exhaust valve, also of the piston type, is operated by a separate eccentric. Each end of the cylinder of this engine is fitted with a good water relief valve, originally set to open at 140 pounds pressure, but reset by the engineer at 90 pounds and kept in good order. The load is frequently so heavy for short periods that with full pressure on the boiler the point of cutoff is extended to one-half stroke.

One day the engineer was obliged to leave his plant for a few minutes in charge of a helper about the mill, who had frequently watched the engine and boiler under similar conditions. When the engineer had been absent for a very short time, the engine began to pound badly, causing the helper to rush to the engine room door, but he was afraid to enter because water was spurting into the room through joints at both cylinder heads, and at other points. Hearing an unusual noise in his otherwise quiet engine room, the engineer hurried back and with the instinct of a true engineer sought to save his engine from damage without regard to his own safety. Notwithstanding the loud noises, which warned him of probable wreck, and the steam and hot water which filled the room, he rushed directly in line with the cylinder to the throttle valve and closed it.

Immediately after closing the throttle valve he went into the boiler room to note the water level and found it at the second gage, where he carries it for a greater portion of the running time without trouble or apparent danger. Examination of the separator showed that it was not full of water. Having drained all the water out of the steam chest, cylinder and exhaust pipe, and as there appeared to be no reason for further delay, the engineer proceeded to start up again, but a loud knock warned him of trouble with the key which fastened the piston rod in the crosshead. He proceeded to shut down and remove the key which was forced out with much difficulty. Fig. 1 is a tracing of this key, showing its exact form and giving an idea of the great strain put upon it when water entered the clearance which is only 1/16 inch in this case. A new key was fitted and driven in tightly, proving a complete remedy for the lost motion at this point. As no other part was damaged, the plant has run full time since the new key was put in.

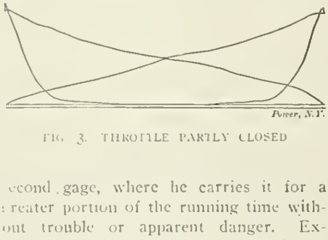
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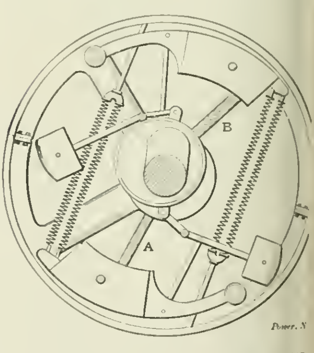
FIG. 3. THROTTLE PARTLY CLOSED

For some time before and after the accident this engine would not regulate perfectly for short periods, then would run in a satisfactory manner for hours. During one of these periods of racing and slowing down, the indicator was applied, and Fig. 2 illustrates specimen diagrams taken under these conditions. The above mentioned accident probably happened during one of these unsatisfactory periods, although there is no positive proof of it.

When diagrams like these are presented, the casual observer of such matters usually remarks that the cutoff mechanism is not correctly adjusted, but this is not necessarily true, and in the writer's estimation constitutes no proof whatever either for or against the above assertion, unless all conditions are known and measures have been taken to produce positive results.

In this case the engineer considered i unsafe to run the engine with the thrott valve wide open, as there was danger o excessive speed causing a wreck, henc he throttled the pressure and while run ning under these conditions the diagram shown in Fig. 3 were taken. They do no indicate an economical condition of af fairs, but their evidence is in direct op position to Fig. 2 so far as adjustmen of the cutoff mechanism is concerned.



Power, N

FIG. 4. GOVERNOR GIVING LONGEST POSSIB CUTOFF

Another point to be considered in tl connection is the claim commonly ma to the effect that when an engine is ru ning under conditions shown by Fig. the boiler is much more liable to pri than it would be if an equal volume steam were taken for both ends of the c inder. The philosophy of this argument that when the cutoff valve on one end held open longer than the other, it crea a sudden demand for steam that cau water to come with it. It is possible this theory to be realized in practice the cutoff took place at about one-l stroke on one end, and one-eighth on other, or at least it would be more lia to cause excessive priming than if same load were equally distributed why is it that nobody seems to beli that water would come over in la quantities if the same engine carrie load that called for cutting off at one-l stroke on both ends of the cylinder? S ly if such action on one end cau trouble, the same condition on both e should result in more trouble, but it oes not, hence there is good reason for elieving that it does not cause priming.

An explanation of the conditions which roduced the diagrams shown in Fig. 2 hould be both interesting and instructive. ig. 4 illustrates the governor of this ngine in the position that it takes to ive the longest possible point of cutoff. Vith this type of engine the point of cutff is changed by shifting an eccentric cross the shaft, or in other words, by rying the throw of the eccentric. Therere, when the engine is at rest the ecntric takes a position directly opposite Fig. 4.

The point to be noted is that while the vernor wheel and the eccentric relve together, their relative positions ange every time that the load varies. follows that there is more or less vement of the parts although the swiftrevolving governor wheel does not perit it to be observed. This movement uses friction, and unless the rubbing rfaces are lubricated, there will be ugh friction to prevent free operation the governor. This is exactly what used trouble in this case, for although engineer is careful, he did not oil the bing surfaces above mentioned until g vernor failed to operate properly. reason for this omission is found the fact that these parts are not dily seen unless the machine is taken rt. In this connection it will not be t f place to say that while special oil s and other devices for holding and ing oil may serve a useful purpose many cases, it is a good idea to use a mon squirt can for oiling a shaft vernor, as it is then possible to know the bearings are oiled, while some the complicated devices that are used xcluding dust, etc., exclude oil also, re unprofitable and unsatisfactory service.

s already stated, Fig. 4 is in position t ive the longest point of cutoff, and in r o keep it there strips of wood fastened in place at *A* and *B*. If is now admitted to the cylinder and n full speed is attained by the flyl, sufficient load is put on to admit pening the throttle valve wide withgreatly exceeding the normal speed, ms may be taken with an indicator. I se show that the point of cutoff is t same for both ends the evidence is clusive, but if not, adjustments that make them even ought to be made ut delay.

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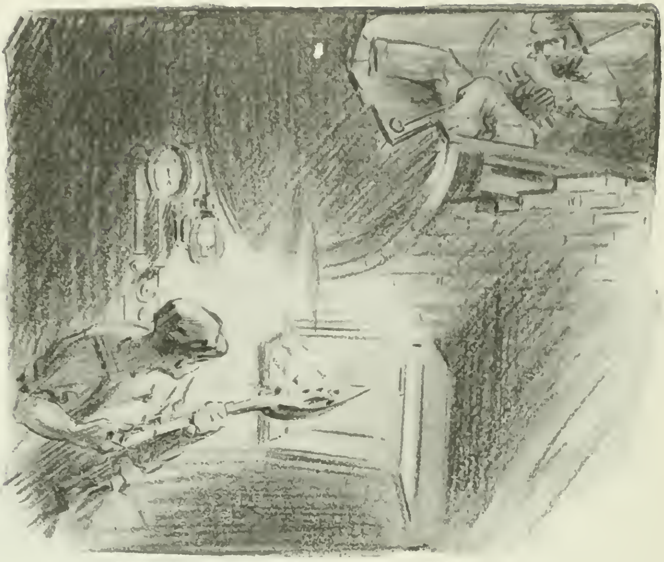
r ascertaining the setting time of cement a "needle" has been designed. This ice weighs 2½ pounds and the point a flat end exactly 1/16 inch square. T cement is considered to be set when needle fails to make an impression on ying its point gently to the surfa.



"LYIN' UPON MY BACK AND BRACIN' MY FEET, I PULLED IT BACK AND THEN LET IT SPRING AGEN THE BOILER HEAD"

## The Tale of an Ex-Boiler Inspector

By F. R. Low

He was a thin, nervous-looking individual, and I tried to figure out, as he sat opposite me at the writing table in the little country hotel, whether it was his bright eyes and young-looking features, or his snow-white hair which was telling the truth in their contradictory story of his age. Once when I raised my eyes from my writing I caught him looking full at me.

"Boiler inspector?" he asked.

I nodded "yes."

"Many a report like that I've made out myself."

"Been in the business, eh?"

"Yep."

"Got something better now?"

"Well—sumthin' different, anyhow. Say, is old Griffin still on the job?"

Griffin had been our chief inspector for years and was still "on the job." I told him so.

"Put in there that Charlie Evans is here and says 'Hello,' will yer?"

I added his message to the letter which I was writing and sealed it up with my report. Seeing me free he offered me a cigar—he was smoking a pipe himself—and went on talking of the days when he was in the business. He had covered some of my own territory and knew a lot of my boilers and the men who ran them. Finally my cigar ran out and, with the thought of buying some more, I nodded toward the little barroom and said:

"Will you have something?"

"Nope," he said, with almost a scared look. "I don't tech it. And say, if you don't mind a bit of advice from one who's bin there, you better let it alone yourself. It don't go with boiler inspectin'."

"Oh, I don't drink any to speak of," I said, going to the desk instead of to the bar for my cigars, "and I never touch it on duty."

"No, neither did I, neither one," he returned, putting the cigar which I offered him into his pocket and refilling his pipe; "but I got bit just the same."

He puffed away a few minutes reflectively, then turned to me suddenly:

"Say, will you take a tip from me that may save your life sometime?"

"Sure," I assented.

"Always take the manhole plate into the boiler with you."

"What for?"

"Then some chump won't put it on and shut you in."

"You don't think anybody could get a manhole plate on without my stopping him, do you?"

He pointed significantly to his blanched hair and said:

"See that? They did it to me and that's what done it. Yes, Sir. Made an old man of me in an hour; but the longest hour and the damnedest hour that a man ever spent."

"Had a grudge against you?"

"Nope. You see, I was a young feller like yerself. Never drinked much and 'never on duty,' as you say. P'raps that's the reason that what I drinked that night went agin me so. I was lonesome around the hotel and I sat in with some of the boys to a little game. The game kep' up till pretty late, and by the time I'd drinked up all the booze we played for and smoked all the cigars, I felt a bit groggy. Not so bad when I went to bed, though. I remember that my feet felt as though they was raisin' up after I'd laid down, but in the mornin'—ugh!—I couldn't raise my head without gettin' dizzy, and goin' sick to my stumick, an' everythin' turnin' black on me.

"Well, I fit it off the best I could, and after a little I got down to the mill and into the boiler, but, Lord! I was sick. I had to come out two or three times and heave up. I stuck to it, but when I was workin' on the front head braces my hammer slipped out of my hand and went rattlin' down between the shell and the tubes and I was discouraged-like and said 'T'ell with it,' and laid my head down on my arm to sort'er fight off a dizzy spell and get myself together.

"I don't know how long it would have been after that but I woke up with a stifled feelin', strugglin' for my breath. The candle had gone out and there was the gurglin' and lappin' sound of runnin' water among the tubes below. I scrambled for the dome. My God! The manhole was closed tight. I was bottled up and they was fillin' the boiler.

"Well, pardner, I ain't bin treated the best in the world, but I've got nuthin' agin any man that would make me want ter see him go through what I went through then. I screeched and yelled like a madman. I kicked and pounded agin the shell but my soft shoes and fists didn't make no noise to speak of. My hammer was gone and I hadn't brought my tool bag in. I laid down on the tubes and felt down at the side. The water—hot water—was more than half way up of the tubes and risin' fast. The only hole between me and outdoors was the one through the pet cock of the water gage, and out of this what little air I had left was oozing as the water drove it out. I put my mouth to the steam connection of the gage and yelled like mad. Bangs and scraping agin the fire sheet told me that they was puttin' in a fire. I should be boiled like a live lobster. Not merciful and quick like them, but slow and lingerin'.

I laid down and cried like a kid. I thought of the things I had read—men boiled in soap vats, fellers slippin' into big lard tanks and all that. I wondered what they would think had become of me. Would they guess that I was in there and open me up, or would they think I had run away and go on makin' steam of me until some other inspector came and found what was left of me? Gee! what a report he would have to make out. What a story there would be in the papers. I thought of my folks and wished I had been better to them. I wondered how I could meet It when the end come. Wasn't there some way I could end it all before it got too bad? How would it come? I would get up there on the braces out of the scalding water—but the steam—ah! I should be suffocated before that.

"I felt agin for the water. It was up to the second row of tubes. It would soon show in the gage glass and then they would light her up. I began to lose my senses. I scampered around like a caged monkey gone crazy. I yelled and cussed and prayed and cried.

"All of a sudden there was a rattlin' noise among the tubes, as a chisel that I had been usin' on the brace pins clattered through. What a fool not to have thought of it. With that I might have tapped the shell hard enough for them to hear. And now even that was gone.

"But it put an idee into my head. I had been workin' on a pin brace that was loose when my hammer dropped and had driven out the pin. If I remembered right it was in the front head. Which was the front head? I was in a swirl and had to figure it out. Safety valve rear. I felt along the top to the first nozzle that I came to. It was the steam outlet. I followed along to the head and groped in the dark for my loose brace. By this time I was fightin' for my breath. My heart was pumpin' like a steam drill and I was stranglin' for air. I tried a dozen before I came to it; some of them two or three times, maybe; but I struck it at last. Lyin' upon my back and bracing my feet I pulled it back and then let it spring agin the boiler head. If it made as much noise outside as it did in I was saved. If it didn't—well, the water was pretty near to the top of the tubes as I laid on my back on them and I knowed that they would be lighten the fire.

"Say, old man, can you imagine if I felt good when I heard the bang of a wrench on that manhole and somebody commence to back off those nuts? There was never anythin' felt better to anybody than that first breath of fresh air when the manhole plate come in and, you bet yer, I wasn't long a-follering of it out.

"Well, it upset me quite a bit. They kep' me in a hospital for a speel afterwards and they tell me now that I mustn't think about it, but seein' them report blanks and knowin' you was liable to get ketched the same way, I wanted to forewarn yer 'T always sets my nerves on age to think about it."

I answered with a shudder that my ow nerves were pretty well strung up, too.

"Well, if you're still minded to hav that drink you mentioned, it might d us both good," he suggested, getting u and leaning toward the barroom. don't ordinarily tech it, and don't adv it, specially 'on duty,' as you say; but seems to be the only thing to steady y nerves when you get to thinkin' about

And when we reached the little l the keeper handed Charlie down a bo of red liquor and asked me what I wo have.

"THERE WAS NEVER ANYTHING FELT BETTER THAN THAT FIRST BREATH OF FRESH AIR"

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Both the new American "Dreadnough of 26,000 tons displacement, for wh contracts were recently awarded, are be equipped with Parsons turbines. New York Shipbuilding Company, wh is to construct the "Arkansas," was n fied some time ago that turbines would installed. Decision as to the motive po for the "Wyoming," to be constru by the Cramps, was postponed tem rarily, but the decision has been n to use the Parsons turbine.

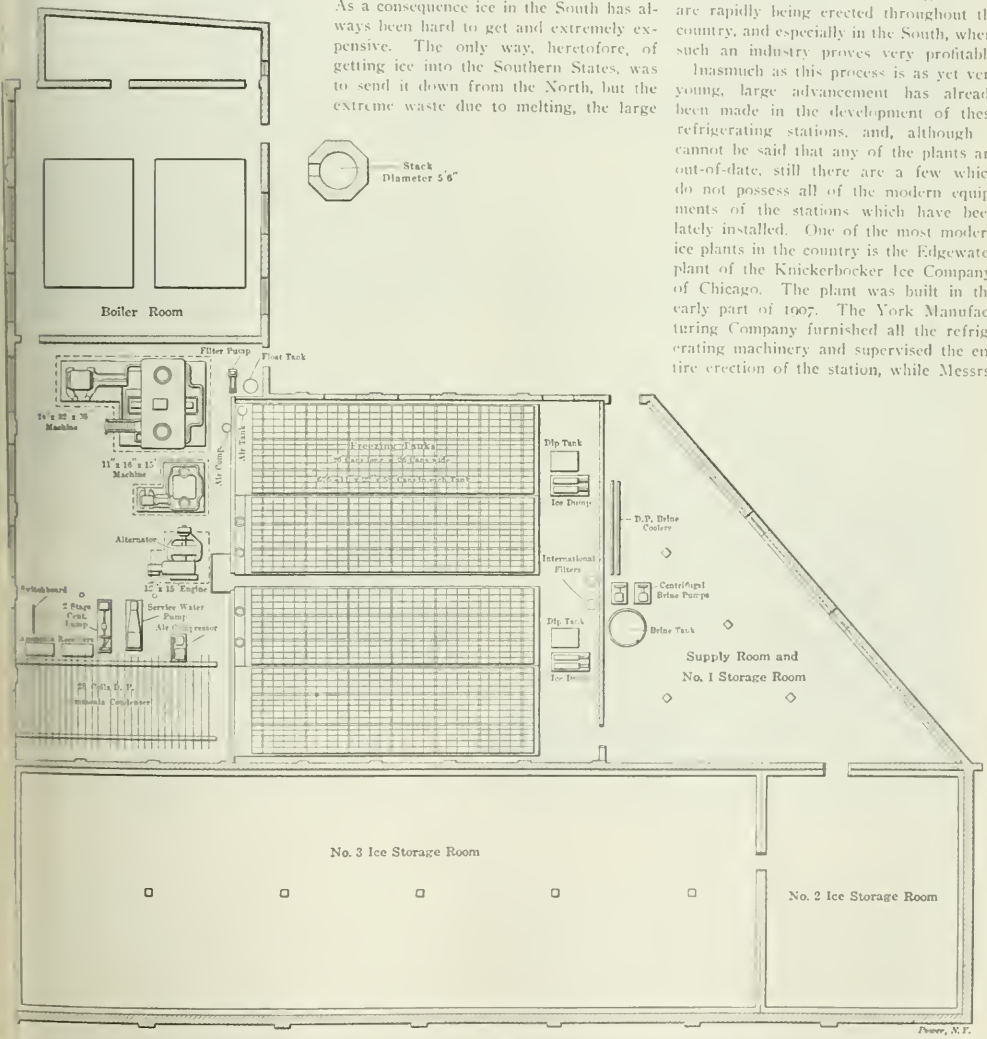
# A Modern Ice Plant in Chicago

## An Interesting Description of the Model Edgewater Plant of the Knickerbocker Company, with Cost Data and Other Plant Records

BY CARL HEIM

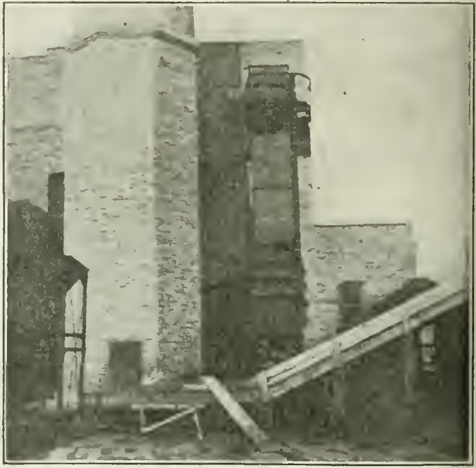
Of all the industries which have come the front so rapidly in the last twenty ars, not one has made such rapid strides that of making ice by machinery. Be- re plants were installed to freeze water rtificially, ice had to be obtained from lakes and rivers in the winter, and then stored in ice houses for summer use. This, however, could be done only in colder zones, for in this country, below the Mason and Dixon line, the weather never gets cold enough for any length of time to freeze rivers and allow ice to be pulled. As a consequence ice in the South has always been hard to get and extremely expensive. The only way, heretofore, of getting ice into the Southern States, was to send it down from the North, but the extreme waste due to melting, the large cost of shipping on account of the distance and great weight, and the difficulty of keeping it, made this not only a very expensive scheme, but also a very impracticable one. Since the invention of refrigerating machinery, this problem has readily been solved. Ice-making stations are rapidly being erected throughout the country, and especially in the South, where such an industry proves very profitable.

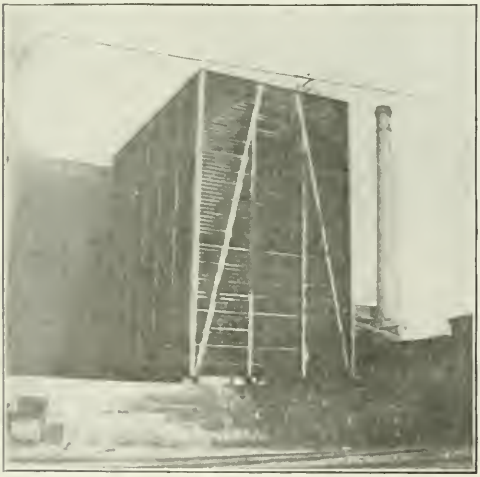
Inasmuch as this process is as yet very young, large advancement has already been made in the development of these refrigerating stations, and, although it cannot be said that any of the plants are out-of-date, still there are a few which do not possess all of the modern equipments of the stations which have been lately installed. One of the most modern ice plants in the country is the Edgewater plant of the Knickerbocker Ice Company, of Chicago. The plant was built in the early part of 1907. The York Manufacturing Company furnished all the refrigerating machinery and supervised the entire erection of the station, while Messrs.



LOCATION PLAN OF EDGEWATER PLANT OF KNICKERBOCKER ICE COMPANY, CHICAGO

Postel and Linn, Chicago consulting engineers, designed the plant. The building, which is two stories high and more than half a block long, is located on Evanston avenue between Foster and Berwyn avenues, and faces west. The first provision in selecting a site for this plant was to get it located near to a railroad in order that coal might easily be obtained and the ice shipped away. As a consequence the station was located on the Chicago, Milwaukee & St. Paul railroad, from which three tracks run into the yard. The entire plant is built of brick, with cement floors, both in the boiler and engine rooms. The most noticeable feature of the plant is its simplicity.





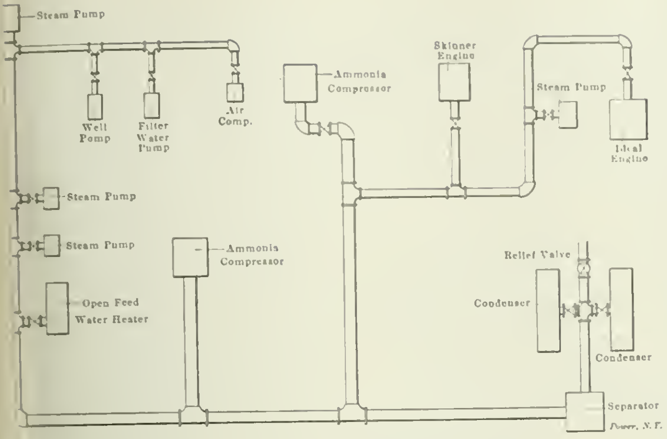
THE FREEZING ROOM
THE COOLING TOWER

THE COAL ELEVATOR
THE ASH TOWER

### MANUFACTURE OF THE ICE

All of the ice made at this plant is manufactured from the exhaust steam of the engines and pumps. The main object of the Knickerbocker Ice Company in its process is to get the ice as pure as it is possible to get it. On account of this the water is filtered and refiltered and softened, in order to get as good results as possible under the conditions existing in the plant. The sweet water which is used in making the ice is tested daily by the chief engineer for hardness, causticity and alkalinity, and if his results prove unsatisfactory or abnormal, the charges of lime and soda in the Kennicott water softener are changed.

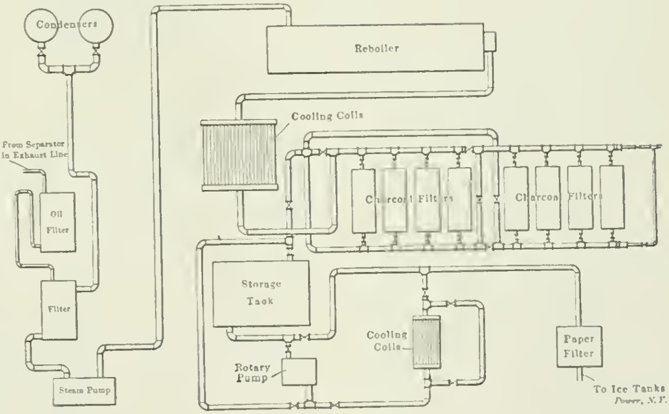
The exhaust steam from the engines and pumps is piped to a main underneath the main floor, from which it is brought to the mezzanine floor through a specially designed York oil separator, installed for the purpose of removing all the grease and oil from the exhaust steam, obtained from the cylinders of the engines. From the separator the exhaust is piped to two Worthington surface condensers, each of which has 500 square feet of condensing surface. The average temperatures at which the cooling water enters and leaves these condensers are 78 and 120 degrees Fahrenheit, respectively. The steam after being condensed is drained to a float or oil skimmer, from which a 5¼ 4¾ by 5-inch Snow pump forces the water to the reboiler. The reboiler 30x16x9 feet, is on the floor above mezzanine, and contains the reboiler. is a large metal-lined tank 24 feet and 4 feet wide fitted with steam coils supplied with a patent regulator and ming device, which may be adjusted



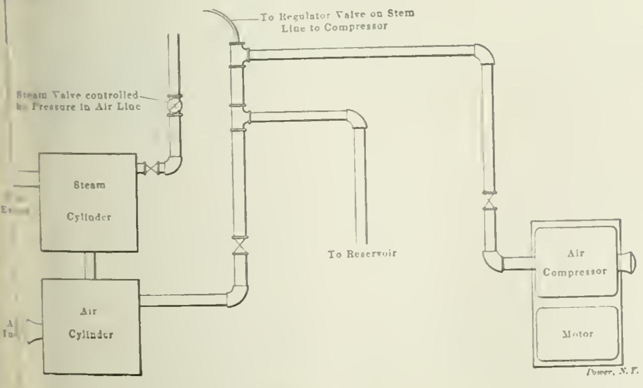
EXHAUST-STEAM PIPING

t second floor. The sweet water after g reboiled and separated from some r of the oil flows by gravity to the g pipes or flat coolers. The sweet r is cooled here by flowing through le tube pipes, the water being cooled well water flowing in the other direc- t. The cooling water is obtained from ll underneath the plant, about 400 deep, although the pumping is done from a depth of 225 feet. A W. B. F double-acting deep-well pump having a ke of 24 inches with a 2½-inch pipe a ment, top and bottom, and a ca- p of 2.48 gallons per revolution, and g at 20 revolutions per minute, is

e sweet water flows through five -pipe cooling coils, 12 pipes high 7 feet long, of 2- and 1¼-inch gal- l piping. After the water has been it flows through charcoal filters of andard York type, of which there are eight in this station. In order to insure very good filtration the water is passed through a set of four of them and then is refiltered in the remaining four. From the eight filters the water is discharged into a 19 and 8½ by 6-foot storage tank on the mezzanine floor, which is provided with a direct-expansion ammonia coil, the tank being made of ¼-inch iron. From the storage tank the sweet water is drawn through a centrifugal water pump, made by the Platt Iron Works, and direct-connected to a 1-horsepower, 220-volt, three-phase induction motor. This pump agitates the water in the storage tank and forces it through coils of the double-pipe style, employing the direct expansion of the ammonia gas for cooling the water still more. After passing through these pipes the water is forced through No. 5 International paper filters, two of which are installed in this plant. The water is then delivered to the automatic can filters and into the cans, where it remains until frozen. The amount of water entering the cans is controlled by patent regulators. After the cans have been filled with water they are lowered into the brine, which surrounds the ammonia expansion pipes, and allowed to freeze. The average length of time it takes to freeze a can of water is approximately forty-eight hours. Freezing cans used in this station are 11½ and 22½ by 58 inches, each making 400 pounds of ice; the capacity of the plant being 1350 cans. After freezing the cans are removed by means of pneumatic hoists, the compressed air being furnished by a 11 and 11 by 12 Westinghouse air compressor of the locomotive type. The cans are then transferred by means of a traveling crane to the east end of the freezing room, where they are lowered into dip tubs of warm water to loosen the ice from the sides of the cans. The ice is then removed



FILTERED WATER-PIPING DIAGRAM

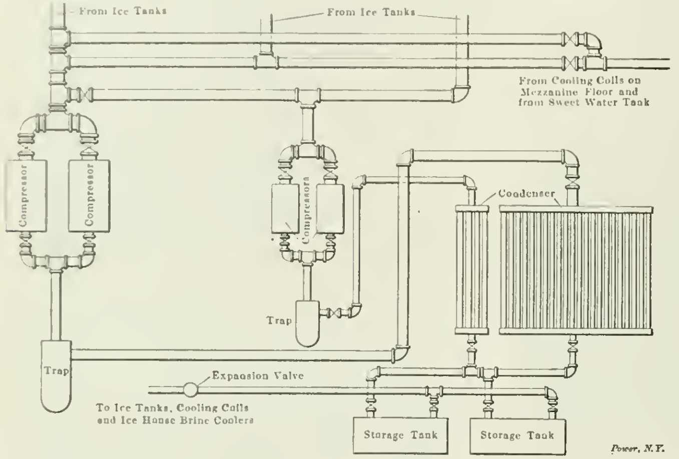

To Regulator Valve on Stem Line to Compressor
Steam Valve controlled by Pressure in Air Line
Steam Cylinder
Air Cylinder
To Reservoir
Air Compressor
Motor
Power, N. Y.

COMPRESSED-AIR PIPING

by placing the cans in the dumps, which tumble them and allow the ice to slide through chutes into the storage rooms.

### THE FREEZING ROOM

The freezing tanks are two in number, made of 0.25-inch steel, each being 62¼ and 30.75 by 5¼ feet, and containing 40,000 feet of 1¼-inch ammonia piping, placed in vertical sections between rows of cans; the tank is fitted to accommodate 676 ice cans. Each tank is divided in the center by a partition running the full length of the tank, with an opening at the top at one end and one at the bottom of the other for the circulation of the brine.



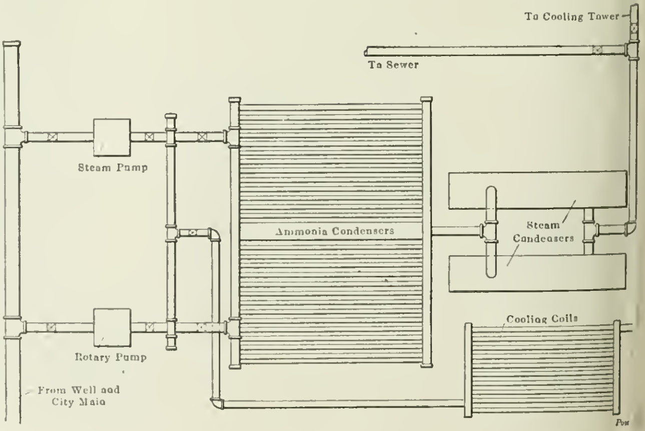
AMMONIA-PIPING DIAGRAM

Two vertical brine circulators are used on each tank, the circulators being operated by three-phase 240-volt 3-horsepower Westinghouse induction motors. The circulators are of the standard York type, being specially designed centrifugal pumps. Two Curtis pneumatic hoists are employed in the freezing room, the air coming from the aforesaid locomotive-type air compressor, with a connection to a motor-driven auxiliary. These hoists are capable of lifting two 400-pound cans and conveying them to any portion of the room.

### THE AMMONIA CIRCUIT

The process by which the water is frozen is extremely simple, being based on the principle that the compression of a gas by mechanical means causes its temperature to rise and, *vice versa*, the expansion of gas lowers its temperature. By cooling down "compressed gas" and then by its expansion, absorbing heat from the surrounding medium, a change of heat units is obtained which can result in a very low temperature. In this plant the ammonia-compression system is used, employing anhydrous ammonia as the cooling medium. Anhydrous ammonia, that ammonia which contains no water, is placed in two cylindrical, horizontal receivers 28 inches in diameter and 6½ feet long, and kept there under a pressure ranging from 150 to 185 pounds. From the receivers the ammonia is allowed to flow through a back-pressure or pressure-regulating valve into a series of ammonia coils surrounded by brine. The pressure on the ammonia is reduced in these coils and the ammonia in expanding takes the necessary heat for the physical change from the surrounding medium. Inasmuch as ammonia boils at 28 degrees below zero, a very cold temperature is realized.

The gas, as it leaves the expansion coils, is drawn into two gas-compression pumps of the vertical single-acting type, with 24 inches bore and 36 inches stroke, fitted with cooling jackets and properly lagged. The pumps are fitted with special ammonia stop valves. The gas, after passing into the compressors at a pressure of 15 pounds, is compressed to about 150 pounds, and is then forced through an oil trap into the ammonia condenser or cooling coils, which consist of 28 stands of the double-pipe type, 1¼-inch and 2-inch 12 pipes high by 19 feet long, with re wash headers. Their capacity is 350 ton refrigeration of water at 60 degrees Fah renheit. The inner pipe of these coil contains the mixture of well water an city water. The outer pipe contains th ammonia gas, which has become greatl heated by being compressed and must nov be cooled. In the York system of re frigeration the directions of the flow the cooling water and the ammoni through the pipes are opposite. When t gas has become sufficiently cooled by t water it is condensed into a liquid a drained to the receivers, from which t ammonia goes through the same process. order that the ammonia gas may be pe fectly free from oil, which is used for lu ricating the compressor cylinder, it is nece sary to employ oil traps, as stated, especia designed for the purpose of removing entrained oil. For this purpose two traps, one on each discharge line from t compressor, are used in this station. O of the attractive features in all of ammonia and steam piping is the thorou system of pipe insulation. All the li are insulated with Keasbey & Mattison per cent. magnesia pipe covering.



COOLING-WATER PIPING

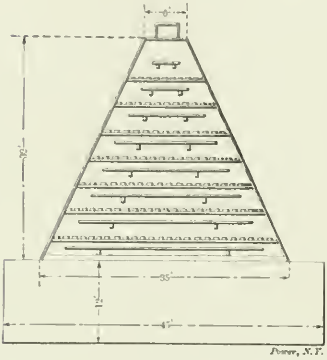
### SERVICE OR COOLING WATER

The cooling water used in this pl obtained, both from the 400-foot we fore mentioned and from a 4-inch supply pipe. Two service pumps ar ployed alternately for circulating water through the cooling coils and densers and over the cooling tower. one of these pumps is sufficiently to do the work, but one is held in r for cases of emergency. The recip ng pump is made by the American Steam ump Company, and is of the Marsh type, o and 14 by 20 inches, with 10-inch sucon and 8-inch discharge connections. A inch riser carries the cooling water to e flat coolers, where the temperature of e sweet water is lowered. The other ump is of the two-stage centrifugal type, ade by the American Steam Pump Comny, with 7 inch suction and 6-inch disarge connections. The pump is directnnected to a three-phase 60-cycle 240lt 40-horsepower Fairbanks-Morse inction motor, which is provided with a parate starting box. The cooling water, ich is maintained at a pressure of 40 unds, after passing through the amnia condensers, sweet-water coolers d the steam condensers, where its temrature is raised from about 80 to 130 grees, is forced to the roof of the buildg through a 10-inch riser and into a gh 240 and 4 by 0.833 feet, which has a pe of one foot in eighty, and is allowed pass over the cooling tower. Part of the ling water is allowed to go into the tubs after leaving the flat coolers and e of it is directly pumped through a ch line to the jackets around the gas mpressors. The trough, on the gravel f, through which the heated water runs, metal-lined and extends the full length the storage rooms, 240 feet, the water ing kept in constant agitation by means baffles.

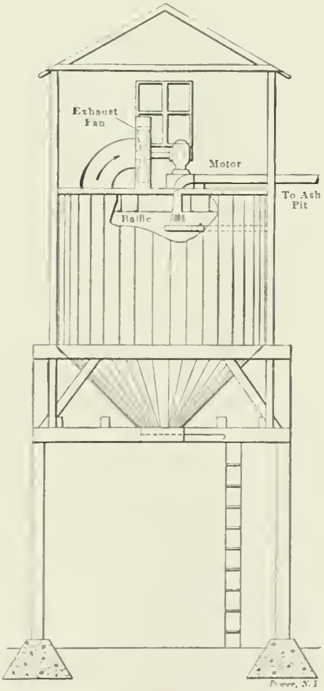
he cooling tower consists of a number shelves made of 1-inch boards, placed inch apart, the boards on alternate lves running at right angles to each er Water falling on the top shelf through the cracks and over the s to the shelves below, falling into t reservoir at the bottom, being cooled a made ready for use again. The water the tower at about 80 degrees Fahr eit The cooling tower is 32 feet high a from a width of 6 feet at the t 32.5 feet at the bottom, making a of between 60 and 70 degrees. The r rvoir underneath the tower is 45 feet w and 12 feet high.

### Coal-handling Apparatus

no's screenings is the coal used in station. An average of 28.5 tons is c med per day. The coal is shipped t plant via the Chicago, Milwaukee & t P l, and is switched into the yards t northern end of the station. Laborer vel the coal through a 2-foot chute, w arries it to a 30-foot coal elevator C O. Bartlett & Snow Company m A 220-volt three-phase 60-cycle 5ep wer Fairbanks-Morse induction m r operates the elevator, which passes a large sprocket, the teeth of which emge with the links of a chain on the hat of the coal buckets. The induction mor is back-geared, the gear ratio being 8 The large gear is on the same shaft as small pulley to which a larger pulley, pating the elevator, is belted. The buckets on the elevator dump the coal into the chain drag, which carries the coal to the bunkers. A small ½-inch pipe delivers water through six 0.0625 inch holes onto the coal as it enters the bunkers, giving it the proper percentage of moisture. The coal can be made to fall in any of the four bunkers by opening the chain above that respective one. The coal bunkers are 10 and 10 by 12 feet and allowing 45 cubic feet of coal to the ton, each bunker has a capacity of 26.6 tons, making a total capacity of 106.4 tons. The chain conveyer is driven by a three-phase 5-horsepower back-geared Fairbanks-Morse induction motor. Each boiler when running at full load consumes about 5 tons of coal per eight hours.



COOLING-TOWER ARRANGEMENT



ASH-HANDLING DEVICE

### Handling of Ashes

A vacuum or "suction" system devised by Ilson Brothers & Co., Chicago, takes care of the ashes. The ashes drop into pits directly underneath the boilers, each pit being provided with a 6-inch pipe through which the ash is conveyed to an elevated ashbin, by means of a No. 7 Sturtevant exhaust fan operating at 2575 revolutions per minute, and which can create a suction of 10 ounces at the intake and has a capacity to deliver 2180 cubic feet of air per minute, consuming 10 horsepower. Upon entering the bin, the ashes are sprayed with water, to settle the dust, and are allowed to fall to the bottom of the bin. The air passing around the baffle plate is drawn to the exhaust fan and out to the atmosphere, the fan being direct-connected to a three-phase 40-horsepower back-geared Fairbanks-Morse induction motor. The bin is 8 feet in diameter by 8 feet deep, with a 45-degree slope at the bottom. By operating a slide at the bottom of the bin the ashes fall into a wagon, to be carried away. When a boiler is running at full load, 1300 pounds of ashes are given off every eight hours. One of the accompanying views shows the construction of the ash-handling system. This tower is located about 20 feet from the northern extremity of the station.

### The Electrical Equipment

The main generating unit is a Crocker-Wheeler 75-kilowatt three-phase 240-volt alternator running at 277 revolutions per minute and furnishing current at 60 cycles. The machine has a star-wound armature and a revolving field magnet with 26 poles. It is direct-connected to a 12x15-inch Skinner engine. The exciter is on the same shaft and delivers current at 125 volts. This exciter is a compound-wound machine and rheostats are provided on the switchboard for adjusting the voltage in both the shunt and series field windings. The exciter has a capacity of 3.8 kilowatts, and its full-load current is 30.4 amperes.

The alternator furnishes power for the entire plant, comprising twelve three-phase induction motors, and current for the incandescent and arc lights. The motors range from 1 to 40 horsepower and operate at 220 volts. The lights of the station are all connected between the main wires and the neutral ("star" distribution). An auxiliary engine and generator are installed, which consist of an 11x14 "Ideal" engine, of the piston-valve type, made by A. L. Ide & Sons Company, running at 275 revolutions per minute and belted to a 6-pole 240-volt 60-cycle three-phase 60-kilowatt Bullock generator The exciter for this alternator is shunt-wound and is direct-connected, delivering current at 120 volts. Full load current for this ex-ver is 20 amperes. Both the alternator and the exciter have a normal speed of 1200 revolutions per minute.

Synchronizing apparatus has been installed but on account of the difficulty in keeping up the voltage of the smaller machine, they are never run in parallel. The larger unit is used about twenty-two hours per day on the average, the other being used only to furnish current, in case the larger machine is shut down for repairs or oiling. Governors are placed upon the flywheels of the engines, keeping the current generated at 60 cycles at all times. The leads from the main generator to the switchboard are run underneath the main floor, all the cables being doubly insulated. The conduit contains four leads from the generator, three from the terminals of the phases and one from the neutral, and five field wires, three from the 8-pole Crocker-Wheeler direct-current exciter, and two returning to the collecting rings of the alternator. The Skinner system of lubrication usual with Skinner engines is used on this unit, controlled by a rod connected to a pawl and the eccentric rod. The pawl actuates a ratchet, which in turn causes a cam to rotate, operating a valve which allows oil to flow at regular intervals.

The wiring throughout the plant is in iron conduits, and as alternating current is used throughout the system there is practically no danger of electric sparks setting fire to the ammonia gas.

### The Switchboard

The board consists of two panels, 40x60 inches, equipped with Wagner Electric Company's instruments. Two 400-ampere alternating-current ammeters, one 300-volt voltmeter, two 125-kilowatt wattmeters reading correctly at 60 cycles, and one Westinghouse single-phase synchroscope are placed on the two panels. Two rheostats for the regulation of voltage are placed upon each panel. A switch for determining the voltage between phases on either machine, or any phase to neutral, may be found on the board.

The busbars on the rear of the switchboard are ¼x1¾-inch copper bars. Two potential and six series instrument transformers are on the back of the board. Field-discharge resistances have been included in the equipment, but on account of incorrect installation they have been of no use in reducing the large arcs at the field switches. Junction boxes are placed in the engine room, boiler room and freezing room, where fuses may be replaced.

### Cost of Producing Power

The cost of producing the electrical energy at the switchboard was calculated from indicator diagrams taken from the engine during a test. Only the cost of evaporating the water was used in figuring the cost per kilowatt-hour. All calculations were made on the assumption that the same amount of work was done in both ends of the cylinder. This is slightly in error, but not enough to throw the results off to any appreciable extent.

The values in the following data were found on each of three diagrams, and the average used in the calculations. Absolute pressure in the cylinder at cutoff equaled 98.36; at release, 44.03; at compression, 39.03. These values indicate pounds per square inch. The piston displacement in per cent. of stroke, including clearance of 10 per cent., equaled at cutoff 36.75 per cent.; at release, 86.20 per cent.; at compression, 20.6. The volumes displaced in cubic feet are as follows: Cutoff, 0.3608; release, 0.845; compressio 0.202. These values represent the volume of steam in the cylinder at the variou points in the stroke. The weight of stea per cubic foot at the various pressures the cylinder, which were obtained fro a steam table, were as follows: Cutof 0.2575 pound; release, 0.1393; compre sion, 0.12. The products of these weigh and the corresponding volumes will gi the weight of steam in the cylinder at t various parts of the stroke. These wo out to be: at cutoff, 0.0935 pound; r lease, 0.1140; compression, 0.0265.

The amount of steam used per stroke found from the foregoing data, at cuto and release by subtracting the weight the cylinder and at compression fr the weight at cutoff and release: at cuto 0.0661 pound; at release, 0.0920 pound.

The water rate is determined by mul plying the weight of steam used per st by the number of revolutions per mi multiplied by 60 and dividing by the dicated horsepower: the water rat cutoff equals 10 pounds; at release, 1 average water rate, 11.975 pounds.

This value takes into consideration one end of the cylinder, and since we sume equal amounts of work to done in each end of the cyli the total amount of steam used per dicated horsepower is equal to pounds. The steam used per kilow hour was found in the same manne using kilowatt-hour instead of indic horsepower-hour in the previous w rate formula. The water rate per watt-hour equals 40.54 pounds.

The cost per kilowatt-hour was on the cost of evaporating the water tirely, and does not include the han

**ECONOMY AND COST DATA FOR SKINNER ENGINE AND CROCKER WHEELER 75-KILOVOLT-AMPERE ALTERNATOR.**

| Number of Run. | Average Absolute Pressures at | | | Average Piston Displacement in Per Cent. of Stroke at | | | Average Piston Displacement in Cubic Feet at | | | Weight of Steam per Cubic Foot at Pressure in Cylinder at | | | Weight of Steam in Cylinder at | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. | Cutoff. | Release. | Compression. | Cutoff | Release. | Compression. | Cutoff. | Release. | Compression. | Cutoff. | Release. | Compression. | Cutoff. | Release. | Compre sion. |
| 1 | 85 | 17.7 | 85.3 | 12.74 | 79.03 | 11.33 | 0.125 | 0.776 | 0.1112 | 0.2289 | 0.07896 | 0.2296 | 0.02863 | 0.0613 | 0.025 |
| 2 | 69.7 | 17.7 | 57 | 18.65 | 90.7 | 15.11 | 0.183 | 0.890 | 0.1483 | 0.1958 | 0.07896 | 0.1696 | 0.0358 | 0.0703 | 0.025 |
| 3 | 90.03 | 28.7 | 52.7 | 22.80 | 78.5 | 17.2 | 0.2239 | 0.77 | 0.1688 | 0.2396 | 0.1049 | 0.1586 | 0.05355 | 0.0807 | 0.026 |
| 4 | 93.7 | 39.7 | 41.03 | 37.83 | 89.7 | 20.43 | 0.3714 | 0.88 | 0.2008 | 0.2476 | 0.1297 | 0.1320 | 0.092 | 0.1140 | 0.026 |
| 5 | 98.36 | 44.03 | 39.03 | 36.75 | 86.2 | 20.59 | 0.3608 | 0.845 | 0.2020 | 0.2575 | 0.1393 | 0.1282 | 0.093 | 0.1179 | 0.025 |
| 6 | 92.7 | 45.03 | 43.7 | 43.6 | 92.7 | 15.41 | 0.4280 | 0.91 | 0.1512 | 0.2454 | 0.1116 | 0.1386 | 0.1050 | 0.1290 | 0.021 |
| 7 | 77.7 | 29.03 | 41.36 | 26.88 | 83.7 | 20.02 | 0.2640 | 0.821 | 0.1967 | 0.2132 | 0.1056 | 0.1334 | 0.0563 | 0.0866 | 0.026 |
| 8 | 86.03 | 30.36 | 30.36 | 31.18 | 89.8 | 33.03 | 0.3090 | 0.881 | 0.3242 | 0.2312 | 0.1087 | 0.1087 | 0.0715 | 0.0957 | 0.035 |
| 9 | 70.7 | 24.36 | 39.03 | 24.25 | 79.5 | 27.93 | 0.2378 | 0.78 | 0.2740 | 0.1980 | 0.09494 | 0.1282 | 0.047 | 0.0741 | 0.035 |

| Weight of Steam in Cylinder after Deducting Weight of Steam at Compression. | | Indicated Horsepower of Engine. | Kilowatts Output. | Speed in R.P.M. | Steam Used per I.H.P.-Hr. Assuming Same Amount of Work Done in H. E. and C. E. | | | | Steam Used per Kw.-Hr. Assuming Same Amount of Work Done in H. E. and C. E. | | | | Cost Kw.- Cent |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cutoff. | Release. | I.H.P. | Kw. | S. | Cutoff. | Release. | Average. | Total. | Cutoff. | Release. | Average. | Total. | K |
| 0.00307 | 0.03575 | 10.04 | . | 277 | 5.1 | 5.9 | 32.04 | 64.08 | ..... | .... | ... | ..... | .. |
| 0.01065 | 0.04515 | 32.84 | 12.35 | 277 | 5.38 | 23.6 | 14.49 | 28.98 | 14.32 | 60.9 | 37.61 | 75.22 | 8.5 |
| 0.02682 | 0.05397 | 51.20 | 25.05 | 277 | 8.7 | 18.15 | 13.425 | 26.85 | 17.85 | 35.8 | 26.87 | 53.74 | 6.1 |
| 0.06585 | 0.08748 | 103.6 | 58.775 | 277 | 10.55 | 14.05 | 12.3 | 24.6 | 18.55 | 24.7 | 21.62 | 43.24 | 4.9 |
| 0.06610 | 0.0920 | 109.51 | 64.850 | 277 | 10.0 | 13.95 | 11.975 | 23.95 | 16.95 | 23.6 | 20.27 | 40.54 | 4.6 |
| 0.0840 | 0.1080 | 120.64 | 68.425 | 279.2 | 11.6 | 14.9 | 13.25 | 26.5 | 20.4 | 26.2 | 23.4 | 46.8 | 5 |
| 0.03005 | 0.06035 | 56.50 | 27.525 | 279.2 | 8.85 | 17.85 | 13.35 | 26.7 | 18.6 | 36.8 | 27.7 | 55.4 | 6 |
| 0.0363 | 0.06050 | 70.79 | 38.750 | 279.2 | 8.60 | 14.3 | 11.45 | 22.9 | 15.65 | 26.1 | 20.87 | 41.74 | 4.7 |
| 0.01185 | 0.03895 | 33.88 | 12.700 | 279.2 | 5.85 | 19.2 | 12.525 | 25.15 | 15.5 | 51.1 | 33.3 | 66.6 | 7 |

f coal and tending the boiler. This was ne because the steam must be had for king ice, and all energy that is taken vay from it between the boilers and ndensers is money saved. Therefore the st of generating energy does not affect e cost of operating the plant, and for t reason the economy of the driving gine is not of any great value. About e only thing gained or brought out by e cost and economy data is the varia- n for various loads on the machine.

The cost of evaporation per pound als $0.1128 per 1000 pounds. The duct of the cost per pound of evapora n and pounds of steam used per kilo t hour gives the cost per kilowatt-hour:

$$0.1128 \times 40.54 = 4.61$$

ts per kilowatt-hour. The average load the machine is about 50 kilowatts, and s is about the point at which the maxi- n economy is obtained, so that the ma ne is running at its best practically all time, since the load is continuous for ty-four hours per day, the time being led into three watches of eight hours . The total average output of the t is 125 tons of ice per day, with an rage coal consumption of 28.5 tons. s falls a trifle short of the standard in modern refrigerating plants, of ns of ice to 1 ton of coal. The aver- cost of running the plant, neglecting sses after the ice leaves the store- s, and not taking into account de- tion and repairs, is $86.74 per twenty- hours. The cost of producing a ton e is therefore approximately $86.74 d by 125, or 69 cents. The follow- gures show a list of the expenditures into account in calculating the cost ducing the ice: Salaries per day, $[illegible], average cost of coal, $38.50; av- cost of oil, $1.50; average cost of r at 7 cents per 1000 gallons, $5.94; $86.74.

e data presented in this article were available through the efforts of Chief eer Benjamin M. Kirker.

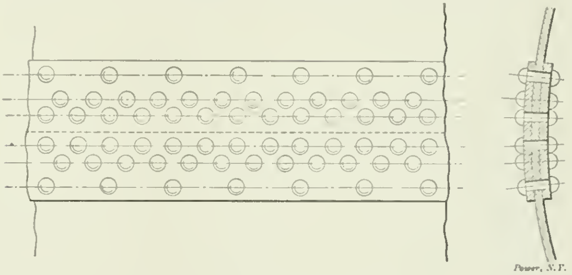
# he Best Form of Longitudinal Joint for Boilers*

By F. W. Dean

been generally accepted in this for a number of years that the rm of butted longitudinal riveted r boilers is that in which the in- ap is wider than the outside, and or more rows of rivets which pass the shell and the inside strap be- each edge of the outside strap. The of the first row of outer rivets is that of the rows that pass through straps, and if there are other outer they may or may not have a still greater pitch.

In England, where until comparatively recently boiler construction has been superior to ours, this form of joint appears to receive no recognition. It was first devised, as far as I know, by Dr E. D. Leavitt, past president of the society, and Edward Kendall, both of Cambridge, Mass., and was first used by Mr Leavitt in some locomotive type boilers designed by him for the Calumet & Hecla Mining Company. I have a blueprint of this boiler dated 1879. It is, of course, hazardous to state that this joint was never used before and it is quite possible that it was used in England, discarded and forgotten as poor construction, as I believe it is. It was first used on an American locomotive by the Baldwin Locomotive Works in a consolidation locomotive built by them for the Calumet & Hecla Mining Company, the drawing of this joint having been made by me when I was in Mr. Leavitt's employ.

While every boilermaker has for years been familiar with butt joints, this form made slow progress toward adoption in this country. One form of joint, used to avoid the butt joint and get something as good, was a lap joint with an inside strap bent at the edge of the lap and riveted on each side of it. This was used on locomotives exclusively and was of little or no value, as it was simply a somewhat elastic bent tie connecting the two parts of the shell plate. Finally, and fortunately, this joint gave way to the butt joint first described.


Power, N.Y.

RECOMMENDED FORM OF LONGITUDINAL JOINT

I believe there has been no case of an explosion of a butt joint boiler; at least one due to rupture of the joint. Recently, however, a boiler at Woonsocket, R. I., narrowly escaped explosion, a longitudinal rupture of the plate on one side of the joint, and within its limits, being discovered while the boiler was subjected to steam pressure. The steam pressure was rapidly reduced and no explosion occurred. An account of this is given in POWER, January 26, 1909, and the joint itself is in possession of the boiler inspection department of the Massachusetts district police at the State House in Boston.

It has been growing upon me for some years that a one sided boiler joint, such as that first described, is poor construction, and may sooner or later cause a crack in the plate. The Woonsocket phenomenon has tended to confirm this opinion. It is evident that unless the outside rivets fill the holes they do very little good, and when they do fill them they form an overhung connection and to some extent possess in themselves the now recognized defect of the lap joint. Moreover the extended inside plate forms a bent connection between the different rivets at different distances from the center line of the joint.

In many cases designers have placed the outside rivets at a considerable distance from the edge of the outside strap and this is constantly overdone. It is obvious, on careful thought, that the outside rivets should be as near the edge of the outside strap as practicable, thereby diminishing the bent-tie effect. In order to diminish this effect still further, and also to render the overhung rivets more effective, the inside strap should be thicker than usual, and this feature can hardly be overdone. The inside strap should be at least as thick as the shell plate, and great care should be taken to have the holes match and the rivets fill the holes.

When a joint of this kind is tested to destruction in a testing machine, it will be found to fail somewhat in detail, the inside strap bending slightly and the outside rivets being the last to rupture after yielding a little. In a boiler the joint would be weaker than a flat specimen on account of the bent tie feature. This could be prevented if it were practicable to calk the inside strap, as it would thereby be compelled to maintain the circular form. The theoretical efficiency of this joint is greater than of any other kind, but in practice I believe the efficiency is not realized and the defects that I have described render the joint, in my opinion, undesirable.

In order to avoid the defects of the one-sided butt joint, I have adopted and intend to use hereafter, a joint with both straps of the same width, as illustrated in the accompanying sketch. This has the merit of having all rivets in double shear and the strains all taken care of in the best manner. The efficiency of this joint can hardly be above 84 or 85 per cent., while that of the one-sided joint can be theoretically 91 or 92 per cent., but the certainty that the efficiency of the former is realized in practice is ample compensation for the use of slightly thicker plates. The pitch of the outer row of rivets is rather great, compelling the use of a thick outside strap in order to stand calking and remain steam-tight. I use an equally thick inside strap in order to diminish the bent-tie effect. This effect is small, however, as the rivets are all near the center of the joint. It can be eliminated by calking the inside strap, which is practicable with this joint, and is done in the best marine practice. This assumes that the calking is effective and remains so.

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*To be presented at a meeting of the American Society of Mechanical Engineers.

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## Revision of Massachusetts Boiler Rules

The first public hearing of the Board of Boiler Rules under section 2 of chapter 393 of the acts of 1909 was held in Boston, August 2 last, and resulted in numerous changes in the rules as formerly issued governing the construction and operation of steam boilers in the State of Massachusetts. Practically all of the changes were in the nature of a revision of the rules downward, or clearing up of ambiguity in interpretation, so that their application might better suit practical boiler construction and operation. The new rules will be published shortly in practically the same form as the previous issues, with the exception of the removal of all recommendations from the body of the rules, they being placed in an appendix. There is to be an index to enable ready location of rules governing the different features of construction and operation. A feature that will greatly add to the ease of locating any particular subject is having printed at the top of each page the part and section to which the matter on that page belongs.

The principal changes to be noted in the previous rules are as follows: The most radical change is in paragraph 2 of section 3 of part 3, which has been changed so that it is imperative that a member of the inspection department of the State, or an insurance inspector holding a certificate of competency to inspect boilers for the commonwealth, stamp and certify that the material and construction of the boiler are in accordance with the Massachusetts laws. This inspection must be made at the shop where the boiler is manufactured and a data report, describing in detail the construction, is to be forwarded to the chief inspector of the State before the boiler is shipped. The first paragraph of part 1, section 1, which refers to boilers used in the State before May 2, 1908, has been changed so that the lowest actual tensile strength of the plate and not the stamped tensile strength may be used in determining the maximum allowable pressure. This change allows the owner of a boiler installed in the State previous to the enactment of the rules to obtain an increase in pressure over that allowed by the previous rules, provided a test of the material in the boiler shows a higher tensile strength than that stamped on the sheets; the rule operates both ways, however, and should the test show a tensile strength lower than that stamped on the sheets it would result in a reduction of pressure.

Specific instructions have been added regarding the equipment of safety valves, in plants where more than one boiler is operated, connected to a single header but the boilers allowed different pressures. The tables for safety-valve areas required for all types of valve have been modified very slightly. The examples for calculating the efficiency of the various styles of boiler joint have been extended to include the possible modes of failure by crushing of the plates in front of the rivets. While this change materially adds to the labor involved in the calculation of joints, it would appear that this change was necessary, unless the limit for crushing strength of steel as specified by the rules was omitted. The rule relating to laying out boilers, so that the tensile-strength stamp and brand of material may be seen after manufacture, has been modified so that a portion of such brands on the tube sheets of vertical boilers now fills the requirements of the law. A brand is now required on the furnace sheets, which is an addition to the previous rules.

The table giving the minimum thickness of butt straps for various thicknesses of shell has been modified so that no thicknesses are given in thirty-seconds of an inch, this being accomplished by reducing those dimensions formerly given in thirty-seconds to the next lower sixteenth. The table referring to required thicknesses of heads and tube sheets with reference to the diameter of the shell is now made to refer to tube sheets alone.

The minimum diameter of furnaces for vertical boilers which may have special staying has been increased from thirty-six inches to thirty-eight inches; sizes over thirty-eight inches diameter are considered as flat surface and to be stayed accordingly. The table giving the maximum pitch of stays for varying thickness of plate on flat surface have been changed, where dimensions were formerly given in sixteenths of an inch, by increasing such dimensions to the next eighth above; this same change has also been made in the tables for maximum pitches of staybolts in furnaces of thirty-eight inches diameter or less. Modifications have been allowed for spacing of stays adjacent to handholes or other openings necessary in staybolted surfaces, so that such stays may be spread considerably to accommodate these openings.

The formulas for obtaining the maximum pitch of staybolts, when not given in the tables, have been transposed to give the value of each variable facto direct, so the formulas may be used by anyone not familiar with the rules o transposition. The table giving the area to be braced on the segment of head above the tubes has been changed t start at a hight of eight inches instead o ten, as formerly, and progresses by half inch instead of one inch increments. table giving the allowable loads on vari ous-size staybolts which are cut wit ten threads to the inch has been added t the rules.

The paragraph relating to the minimu distance allowed between the center rivet holes and the edge of plate riveted joints has been changed to ref only to longitudinal joints, and the stat ment that this provides against the crus ing of the plate in front of the rivets h been omitted. The rules regarding th making of rivet holes have been chang so that the holes may be punched on eighth inch less than finished size plates of five-sixteenths or less and th drilled or reamed to full size; the form rules required that no rivet holes us for seams could be punched larger th one-quarter inch less than finished si regardless of the thickness of the plate

The methods required for making tu holes have been changed so that they m now be punched one-half inch less th finished size and completed by drilling reaming. Bronze composition has b added to the materials of which flan may be made for main steam or safe valve outlets. The standard sizes forme required for handholes and manh have been abolished and a minimum of eleven inches by fifteen inches elliptical, and fifteen inches diameter circular, manholes established.

The maximum size of tubular boi except the vertical type, that may be h without a manhole has been increa from thirty-six inches to forty in diameter.

A new figure, No. 18, is given, show how rivets may be spaced on a man reinforcement; this shows that a styl riveting commonly known as one an half rows fills the requirements for rows of rivets as called for in the r A requirement that the strength o rivets in shear in such reinforcem must be at least equal to the te strength of the shell plate removed allel to the axis of the boiler has added to the requirements for such inforcements.

Section 6 of part 3, relative to bo that may be installed although not str up to Massachusetts requirements. may be passed under joint inspection been considerably enlarged upon an ranged to fit most legitimate case this nature that might arise; a parag has also been added permitting the mission of portable boilers which been removed from the State since passage of the rules.

# Small Isolated Producer-Gas Power Plant

## Description of a Very Efficient Installation in the Middle West, with Several Notable Features; the Equipment Described in Detail

BY OSBORN T. MONNETT

In many industries requiring a small mount of power, it is beginning to be alized that on account of the low fuel arges and attendance required, the pro- icer-gas power plant is especially suited their needs. This has been the case ith the recently erected automobile harging station of the Kopmeier Motor ar Company, of Milwaukee, Wis., the anagement being progressive enough to re upon this method of power produc- n from the first, with the result that e power cost per kilowatt-hour will be proximately 0.6 cent, with no extra rge for attendance.

The building is 150x120 feet in ground n, with brick walls, concrete roof and or, absolutely fireproof in every respect l divided into two bays, one 70x150 t for gasolene machines, and one 50x feet for electrics. The power plant ins the main building and is of the me substantial construction, divided in- roducer and engine rooms, each large ugh for duplicate units.

As shown in Fig. 1, the coal supply will kept in one corner of the producer m. The power equipment consists at ent of an 85-horsepower, three-cyl- der vertical Nash gas engine connected ugh a flexible rope coupling to an lis-Chalmers six-pole, 125-volt, direct- rrent generator, and supplied with producer gas from an 85 horsepower Industrial Gas Power Company's suction producer. Anthracite pea coal is used, costing $6.60 per ton, delivered. The plant is operated entirely at night, charging automobile storage batteries for the next day's run, and one man supervises both departments: the generating and the charging.

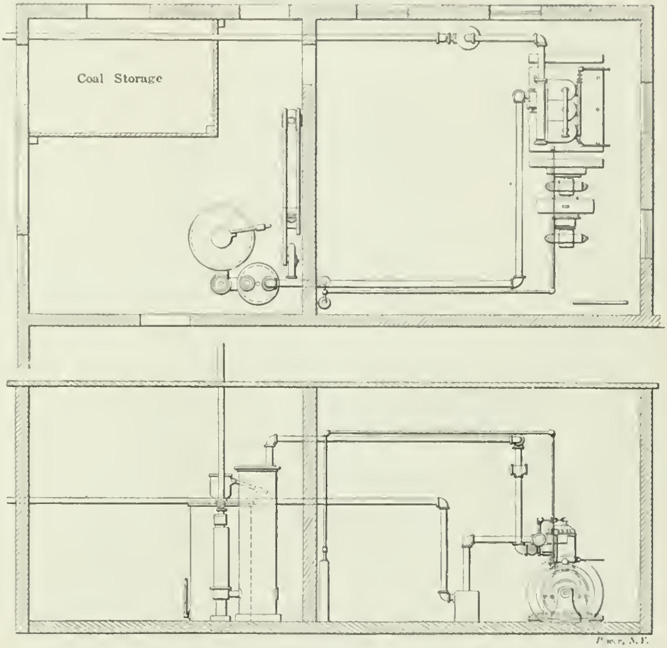


FIG. 1. PLAN AND ELEVATION OF GAS PLANT

Power, N.Y.

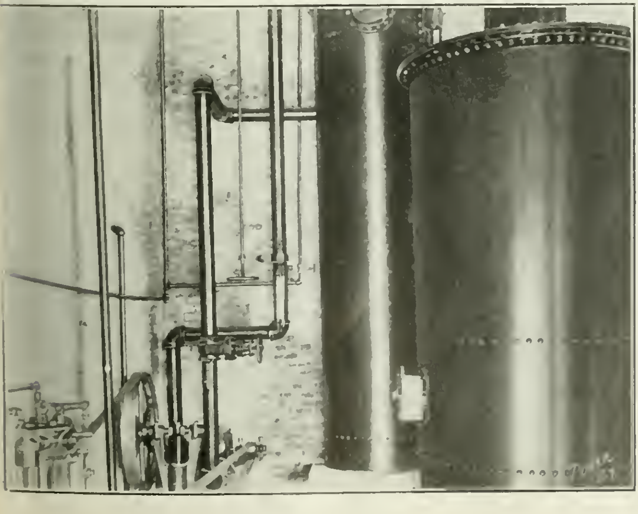
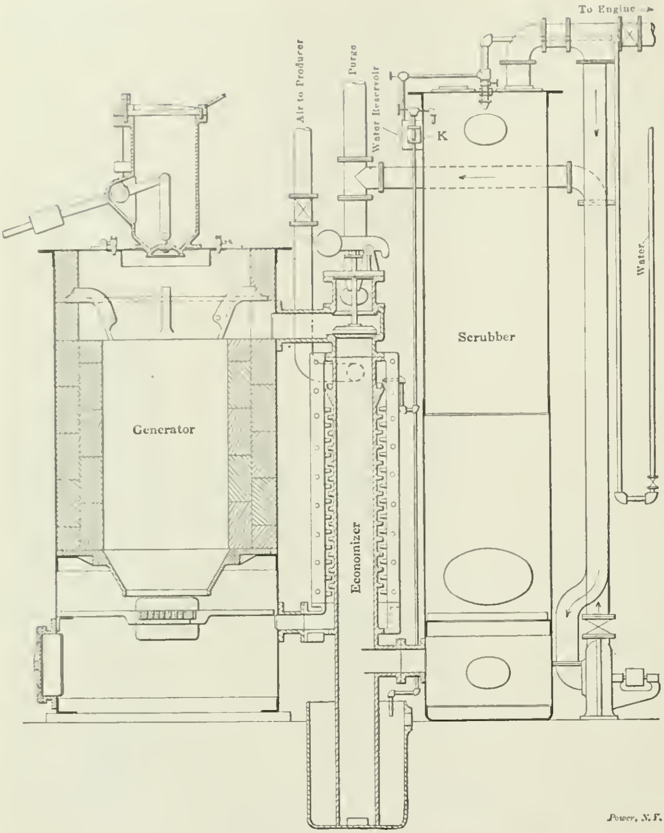


FIG. 2. PRODUCER ROOM

### The Producer

This apparatus, which with some of the auxiliaries is shown in Fig. 2, is 10 feet high by 5 feet in diameter, with 9.6 square feet of grate surface. The shell is made of $\frac{1}{4}$-inch tank steel, riveted and calked, and has placed near the bottom a large machine faced door for the easy removal of ashes. Above this door is the grate, opposite which there are additional doors for cleaning purposes. Above the grate is a cast iron bosh and support ring for centralizing the draft of the fire. The same ring that carries the bosh plates also supports a 9-inch lining composed of arch brick set on end and laid with



Power, N.Y.

FIG. 3. GAS-GENERATING OUTFIT IN SECTION

cement. No fire clay was used in putting up this lining. In the top of the producer is a magazine to form a gas area for off-take purposes and support the green fuel for the fire. Fig. 3 shows the producer plant in section. The connection between the generator and scrubber is used for heating the air supply and vaporizing the water used in the producer, thus utilizing the sensible heat of the gas and requiring less water in the scrubber for cooling purposes. As shown in the drawing, the water vapor and air pass over cast-iron corrugations in the economizer and have opportunity to absorb much of the excess heat of the gases.

The water regulator is designed to proportion the quantity of water delivered in accordance with the load on the engine. From the top of the scrubber a pipe leads to the top of a glass cup, in the bottom of which is located a nozzle having connection with a small water reservoir *K*, Fig. 3. The water in the reservoir is kept at a constant level by means of an overflow, and at a hight slightly below the orifice of the nozzle in the glass cup. When the engine takes a suction stroke a partial vacuum is formed in the scrubber, inducing a flow of water from the nozzle. A pipe from the bottom of the cup conducts the water to the economizer, where it is flashed into steam. This constructio of the regulator enables the operator t see at any time the quantity of water being fed.

A two-horsepower gasolene engine i used to blow up the fire when starting an to operate the air compressor. Two hundred pounds pressure of air is used fo starting, and the air is also used to fil tires. Connections of the blowing mechanism to the producer are somewhat unusual, as instead of forcing air into th generator directly below the fire, the blower, or rather exhauster, is attached t the gas main just after leaving the scrubber and discharges into the waste pip just over the purge valve. When the fa is started, gas is drawn through the generator and scrubber, and when the fi is sufficiently active the valve to the wast pipe is closed and the one leading t the engine opened, thus filling the mai supply pipe with gas under some litt pressure and insuring that the engine w get a charge of gas immediately f starting.

### FEATURES OF THE ENGINE

The engine is of the vertical, self-co tained type, with 12x16-inch cylinders, a cranks and main bearings running in bath of oil. The main bearings are lin with phosphor bronze, and adjustment the bearings is made from above, t construction following standard mari practice. In addition to the splash lub cation, force-feed oilers are provided f the main journals and all other importa bearings. The valve mechanism, govern

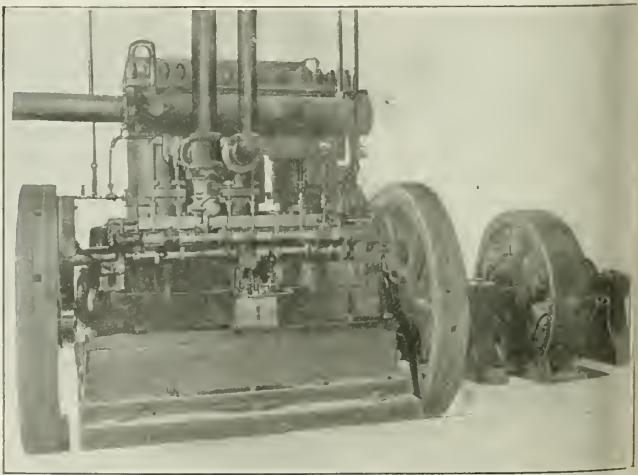


FIG. 4. GENERATING UNIT

and auxiliary devices are all located on one side of the engine, as shown in Figs. , and 5. A spur gear drives the cam shaft direct from the main shaft of the engine.

Regulation is secured by control of the mixture and throttling, and ignition effected by special make-and-break devices. A 40-volt magneto and 20-cell storage battery constitute the source of igniting current. On the engine are an ammeter panel and a double-pole, double-throw switch to control the ignition circuits. Ordinarily the storage battery is used to supply the engine, the magneto being connected as a generator to charge the battery. On the end of the cam shaft is the timing mechanism. This consists of a steel commutator having three depressions corresponding to the three cylinders, and brushes carrying the contact points, which are submerged in oil. Contact is made when a brush enters one of the depressions. By suitable electrical arrangement the movable electrode pall is caused to vibrate while the brush on the commutator is passing over any given segment. One of the advantages of this is that instead of producing one spark, a series of sparks is produced while the electrodes remain in contact. The brush holder is movable around the commutator, allowing the spark to be advanced or retarded.

A feature of special note and something [illegible]tly adopted is the piston pin take-up illustrated in Fig. 6. This consists of a sleeve tapered on its outer surface and slotted longitudinally to allow for adjustment. The sleeve fits into a tapered hole in the end of the rod and is threaded at the smaller end. A special nut with teeth on the outer circumference and turned by the ratchet arrangement indicated, moves the sleeve in either direction. It is possible to tighten or adjust the bearing as desired without dismantling [illegible] part of the mechanism. When the engine is running the wrench is bolted [illegible] to the connecting rod and always [illegible] in place.

Muffling had to be exceptionally complete, as this installation is in a residence street, with a hospital just across the [illegible], so that noise of the exhaust would not have been tolerated, more especially [illegible] plant operates only at night. The exhaust connections are all 6-inch pipe. From the engine the gases pass down to an ordinary cast-iron muffler in the engine room, then out into two connecting underground chambers, with an outlet to the [illegible], terminating in an elbow turned away from the street. With this arrangement noise of the exhaust is effectively eliminated. The starting engine is [illegible] provided with an underground muffler, embedded in the concrete floor of the producer room.

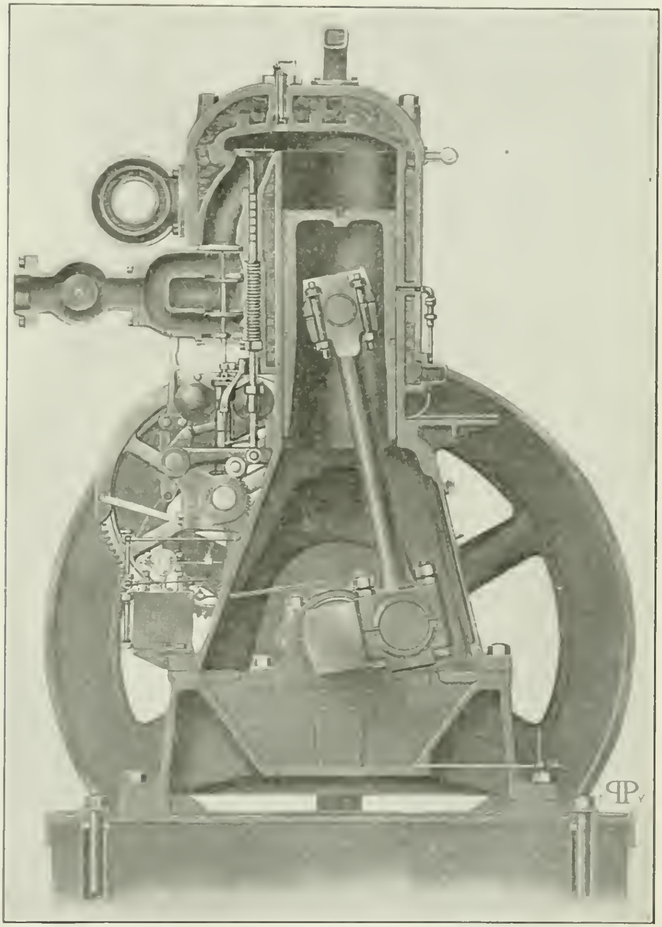
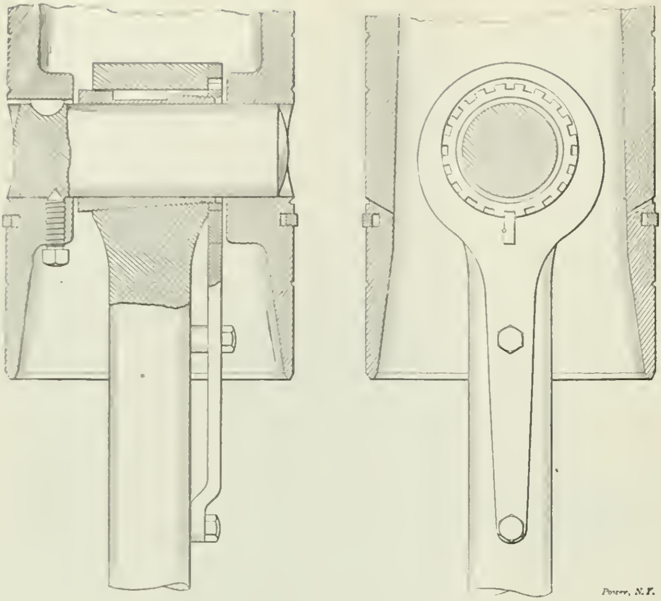


FIG. 5. SECTION THROUGH NASH GAS ENGINE

### ELECTRICAL EQUIPMENT

Facilities are provided for controlling all main circuits from the engine room. On the engine-room switchboard are carried an ammeter, voltmeter, recording wattmeter and underload and overload circuit breakers. City current comes to the board and a double-pole, double-throw switch enables the lighting to be thrown from one source of current to the other. City current can also be used to operate a motor-generator set which is held in reserve to charge batteries. This consists of a 15-horsepower, 200-volt, single-phase Wagner motor operating a 125 volt, direct-current generator. It is now located in the main room of the garage, but will eventually be moved to the engine room. The wiring is all carried in exposed iron-armored conduits and leads to outlets conveniently spaced along one side of the charging room. To control the actual work of charging, there is installed on the charging floor a Cutler-Hammer switchboard of special design, consisting of four Monson slate panels, Fig. 7, with a hinged voltmeter and ammeter panel at the left, and carrying cast grid resistances horizontally disposed, arranged with sliding contacts and universal rocking brushes for cutting resistance in and out.

Two machines are generally charged in series from each outlet, the pair being controlled by one set of resistances on the board. As the board is equipped with 12 of these sets it has a capacity of 24 machines at one time. With two machines in series the operator sets the rheostat at the proper charging current, the ammeter and voltmeter being plugged in to any circuit by means of push buttons. In case it becomes necessary to charge one machine at a time at an outlet, the



Power, N.Y.

FIG. 6. GUDGEON-PIN BOX ADJUSTMENT

connecting plug corresponding to the absent machine is placed in a short-circuiting socket on the wall, and it is then only necessary to cut in more resistance with the rheostat.

No battery is charged until it has had a proper amount of discharge, and in case it is desirable for the welfare of the battery to completely discharge it before being recharged, it is done by short-circuiting the battery through one of the switchboard rheostats, by means of the double-throw horizontal switch provided on each panel. For high charging rates, truck service, etc., any two or more panels can be paralleled by means of a detachable bar connecting two rheostats as one unit. Being in parallel a correspondingly larger current flows. In this way any combination up to the capacity of the board may be obtained to meet special conditions.

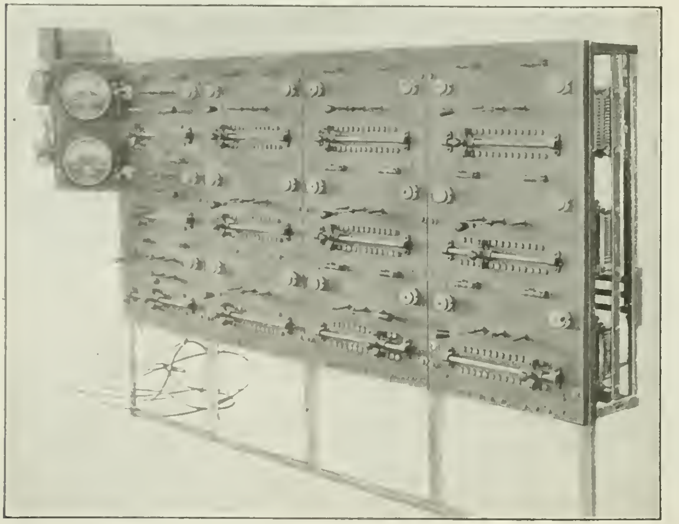


FIG. 7. CHANGING BOARD

# A. S. M. E. New York Novembe Meeting

At the New York November meetin of the American Society of Mechanica Engineers, to be held on the 9th in th Engineering Societies building, 29 Wes Thirty-ninth street, at 8:15 p.m., ther will be two papers presented, one b Prof. Gaetano Lanza and Lawrence Smith of the Massachusetts Institute Technology, on "Reinforced Concret Beams," and the other by Prof. Walt Rautenstrauch of Columbia Universit on "Stresses in Curved Machine Men bers."

The paper on "Reinforced Concre Beams" is the same as that given at t Boston meeting of the society on Octob 20. It compares the results of tes upon full-sized beams made at the Mass chusetts Institute of Technology and t University of Illinois with three differe theories of beams of this type.

The paper on "Stresses in Curved M chine Members" outlines the method procedure for the design of princi sections of hooks, punch and shear fran and other machine curved parts. Expe mental results are submitted in supp of the theory presented.

The papers are of a character to dr out discussion upon the stresses in elements entering into structures and chines and should result in the preser tion of data on the general subject stresses which will be of great importa to the designing engineer.

# Early Steamboats and Othe Things

By F. L. Johnson

One of the boys had just laid a prog of the Hudson-Fulton celebration on desk, and as I glanced over it my thou went back to a winter which I spen Fairley, Vt., forty-odd years ago. It there that I saw the model of a r engine that Samuel Morey used to p the little sternwheel ferryboat that across the Connecticut river between ly and Orford, in 1793. I was so de a day dream that I did not notice I was not alone until a cheery voice a nasal twang of the New Hamp yankee said: "Come, take your han of the company's pocket and get ont job."

I looked up. It was Sawyer, wh had not seen for months. I made a r functory apology for not noticing hi n- trance and asked if he came to se he celebration.

"Yes," he replied, "I have been i the city for two or three days. I hav in- spected the 'Half Moon,' the 'Cler nt' ad the flying machines. I had some il- l trations of Fulton's engine a long time o, and as it was not so much different m those which are driving the East ston ferryboats, I became interested in t history of the application of steam wer to navigation. I know I have not got the whole story, nor do I think ossible for anyone to get all of it, but ave got enough to satisfy me that re are many who have contributed to t solution of the problem of steam igation who have been forgot, and t injustice has been done to some have not been forgot."

Do you know anything about Morey's t that used to run on the Connecticut r?" I asked.

"Yes," he replied, "I know what little c be got from one of the New Hamp- s e historical societies, that is all. In 1 3, with the help of his brother, Morey e a small engine which was put into a t at the front end of which was a lewheel which drew the boat along. odel of this boat he sent to New Y k, where it was seen by Robert Fulton Chancellor Livingston, and at the s gestion of Fulton the wheel was taken f the bow of the boat and put at t tern. A patent was granted to M y in 1705. About this time he was v by Fulton at his home in Vermont, w he became thoroughly acquainted w Morey's invention. Morey made s improvements in the engine and t nd with an improved model of it me to New York to see Fulton, f whom, it is said, he had conceived a s g friendship; but Fulton, having l ned to Livingston, treated him to t ery essence of New York coolness a glect. It was on this visit that he d that Fulton was making a steam- f r himself, and he returned to his broken-hearted and despondent at w e believed to be the treachery of whom he had trusted. His boat was from the river to a small lake n where it was sunk.

re is much more to be learned r the records of the Historical Society ermont, but I was unable to visit sum where may be seen the model f riginal engine which Morey de t propel his steamboat, while Ful- was painting portraits in South lea. I have made up my mind that i ns are in the air, as it were, and th n who never see, or know, or even h f ne another, are often working t same time along the same lines, th separated by thousands of miles. Le ng out of the question De Garay, wl in 1543 tried to drive a steamboat steam in the harbor at Barcelona, S n, the other inventors of the steam- were practically contemporaneous.

onathan Hulls was perhaps a little too much ahead of the others to be really a ntemporary, for in 1736 he designed a at to be propelled by a single-acting engine and a sort of ratchet movement connected to long poles for shallow water which pushed the boat ahead, and to pumps which acted by reaction in deeper water. But about fifty years later there were fully a dozen men at work on steamboat propulsion in different parts of the world, and all with the exception of Fulton ignorant of what others were doing.

"It is, I think, rather a difficult matter to decide the exact order in which the developments of the marine steam engine took place. Fitch's boat, which was first operated in 1783, was improved to such an extent that six years later he succeeded in making a speed of eight miles an hour. Rumsey's American steamboat, propelled by poles in shallow water and by the reaction of pumps in deep water, in a manner almost identical with that of Hulls, in the eleven years from 1784 to 1703 was so improved that with the boat which was built in England, he was enabled to make four miles an hour on the Thames against wind and current. Oliver Evans, a Philadelphia millwright, began experiments in 1784, and twenty years later built his 'Oructor Amphibiolis,' a combined land and water vehicle which ran under its own steam from the shop where it was built to the beach, into the water, and was successfully navigated on the bay.

"Ormsbee, in Rhode Island, was in 1702 operating on Narragansett bay a steamboat with banks of paddles instead of wheels, and Roosevelt here in New York, in 1707, operated a small steamboat about which I have been unable to learn anything, except the date and the fact that it was operated more or less successfully. Symington in Scotland, between 1786 and 1802, built and operated on the Clyde a sternwheel steamboat which, against a strong breeze, drew two 70-ton barges loaded to the limit at the rate of 3½ miles per hour; but the owners of the canal on which the boat was expected to work refused permission for its operation because of the damage which was expected would be caused to the banks by the wash of the waves. Symington's means being exhausted, the boat was drawn up on the bank and allowed to rot, and it was here that Fulton saw it and got the idea of a stern wheel which he advised Morey to use.

"Fulton was fortunate in having a rich and powerful patron in the person of Chancellor Livingston, who furnished the means for buying the engine and machinery from Boulton & Watt, at Manchester, England, and for the building of a second hull for the 'Clermont' when the first one failed. Had any of the men of whom I have spoken had sufficient capital, I doubt not that they too would have been equally successful. Naturally, my prejudices incline toward giving Morey the most of the credit, for all of his work was done in what was practically a backwoods settlement where he had never seen even one of the crude engines of his day, and in the beginning he only knew that steam was used in some way to drive machinery. All of his manual and mechanical skill had been acquired by work almost alone on the farm and the river, and I cannot help thinking that the honors and emoluments which were showered upon Fulton should have been given to Morey.

"I did not intend to say anything about steam engines when I came in, but some way the subject fascinates me and has done so since the first time I saw an engine, which was at Waukesha, Wis. It was made by Turton & Sercomb, of Milwaukee, was 6x18 inches, with cylinder, guides and main bearing bolted to an oak frame. There were, it seems to me now, two governors, one an old-style, slow-moving arrangement which operated a butterfly valve in the supply pipe, while a more modern high-speed one operated a little gridiron-cutoff valve just above the steam chest. This, I believe, was connected also to an eccentric on the main shaft and was similar in its operation to the Nordberg device which came out some years ago.

"Of this I am not so sure, but I remember well the old, plain, cylinder boiler, the cast-iron steam pipe and the venerable engineer, who said that 'on casting days she turns up full eighteen horsepower.'

"I have often wished that I could write the history of the use of steam from the time that the Pompeiians made water grates and water-tube boilers to the present."

I was about to say that I should be glad to assist him in preparing such a history, when one of the boys came in, saying, "Wilbur Wright is flying around the Statue of Liberty and one of the airships is sinking in the river up in the Bronx," and Sawyer, whistling, left me to wonder why a man who had such a faculty for picking up information and such a pleasing, breezy way of imparting it to others, never wrote for publication.

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In a recent bulletin issued by the United States Geological Survey which includes a report by E. S. Bastin on the peat deposits of Maine, the following data on the value of peat as a fuel are supplied from comparative tests made in Germany and Sweden:

Peat has been used as a fuel in both down-draft and pressure types of gas producers for some time and the calorific value of the gas thus generated is found to compare favorably with that derived from bituminous coal. The figures for several tests showed in B.t.u. per cubic foot for peat: Sweden, 132; Nymphenburg, 114; Stockton, 145; Wilmington, 152. For coal: Indiana, 147; Illinois, 143; Ohio, 157. For lignite: North Dakota, 161

# Points to Consider in Choosing a Moto

## Views of Two Experienced Engineers on Advisable Features of Construction, Speeds, Windings and Ratings of Direct-current Motors

## BY H. M. PHILLIPS AND E. F. BUTLER

### Mr. Phillips' Advice

In buying a motor it is to be assumed that the purchaser wishes to obtain one that will do all the work which he may require of it in a thoroughly satisfactory manner and that he desires to obtain such a motor at the lowest possible cost. A "cheap" motor may be obtained where the cheapness consists of a sacrifice of material and workmanship and may turn out to be "dear at any price;" on the other hand, a motor may be unnecessarily expensive because it is so designed that it can stand conditions that will never arise in the work for which it is purchased. Even though it be decided to purchase a motor of a certain make it will frequently be possible to eliminate this unnecessary expense by careful consideration of the exact requirements that one wishes the motor to meet; it is also possible that a certain manufacturer will be able to quote the lowest price on a motor to meet one set of conditions but will not be able to do so in another case. It is always well to listen to the advice of the seller but not always safe to follow it; it will frequently be found that his engineering ability is quite limited. Consideration of the following points should be of help in selecting the most desirable motor.

### VOLTAGE

The motor must, of course, be wound for the voltage on which it is to operate; in most cases there is no choice, as this is already determined by the source of current supply. The 115-volt motor operates on the ordinary incandescent-light circuit; the principal objection to its use is the comparatively large amount of current required to operate it. This is likely to cause lights on the same circuit to burn dim or to flicker when the motor is started, stopped or run on a variable load; it may also add appreciably to the cost of installation on account of the heavy wire required.

The 230-volt motor requires but one-half the current that is taken by a 115-volt motor of the same power, and unless the motor is a very small one it will require but one-half the weight of copper wire to connect it to the line: if the line is a long one it may require but one-fourth the copper necessary for a 115-volt motor.

The 500-volt motor bears about the same relation to the 230-volt that the latter does to the 115-volt motor; that is, it will require from one-half to one-fourth of the amount of copper to connect it to the source of supply. When the line is a long one, a mile for instance, this saving makes its use almost compulsory. The motor is more apt to give trouble in operating than those of lower voltage, although this tendency can be largely counteracted by careful construction. Shocks that are likely to be quite severe, though rarely dangerous, may result from careless handling of this motor.

While there should be no great difference in the cost of these motors, the 500-volt motor is slightly higher in price than the 230-volt machine and the latter usually costs a little more than a 115-volt motor of the same kind.

### WINDING AND SPEED VARIATION

The shunt-wound motor is by far the most commonly used and runs at nearly constant speed at all normal loads. The increase in speed from full load to no load in commercial motors will generally be between 4 and 12 per cent., the larger motors having the smaller amount of variation. It is a good plan to have the manufacturer state the amount of variation that he will guarantee on the motor he proposes to furnish; some may be found to be better than others.

Constant-speed motors are not well adapted to the driving of punches, presses and the majority of machines that are equipped with flywheels. The purpose of a flywheel is not so much to keep the machine running at a constant speed as to store energy during one period of operation and to deliver it quickly at the moment that it is needed. The shunt-wound motor, on account of its tendency to run at constant speed, will do its best to rob the flywheel of its proper function and to keep the machine running at constant speed and supply all the power required at the moment of heaviest work without the assistance of the flywheel. This is almost certain to overload the motor seriously, if only for a fraction of a second; there will be a flash at the brushes and a very heavy momentary current will be drawn from the line; the first causes rapid deterioration of the commutator, the latter is almost certain to cause any lights that are on the same circuit to flicker and if the machine is a large one the effect may be felt on other motors and even on the generator.

Increasing the size of the motor is an unnecessary expense and not an adequate remedy. The compound-wound motor is designed to overcome such difficulties. runs considerably faster at no load th at full load, the difference in speed l ing not far from 20 per cent. in mo standard motors, and exerts 10 per ce to 25 per cent. more torque at full lo than at no load. When driving a pun or shear, the drop in speed enables t flywheel to give up its stored energy the moment of heavy load, and the ex torque renders an excessive current u necessary and therefore obviates flash at the brushes.

The series-wound motor is subject very great speed variation with cha of load. If suddenly relieved of its l the acceleration will be very rapid and many cases will be limited only by bursting of the armature or other accid to the motor. For this reason a seri wound motor is hardly suitable for l drive of any description, the belt be liable to be thrown off at some time is largely used for cranes and hoist purposes where an operator is in const attendance. Its property of running sl ly under heavy loads and rapidly, if operator desires, on light ones is rat advantageous and for starting a gi load it causes somewhat less fluctua of current than other motors. A hea compounded motor would do equally but would be more expensive. The ser wound motor may also be direct-conne to a fan or other machine where the is practically constant; this may so times effect a slight saving in cost apparently has no other advantage. less the exact power required to the apparatus is known the speed ca be predetermined.

The differentially wound motor is tended to run at exactly the same s at all loads or, if desired, to increas speed with the load. Years ago, w shunt-wound motors did not approxi as closely to constant speed as they now and when perhaps too great im tance was attached to a slight vari in speed, they were frequently used; t they are very rarely installed. possess many undesirable features: produce violent fluctuations of curre the line, have a strong tendency to s rk as the load increases, are liable to ce on overload, in which case they may d denly stop and immediately start at g speed in the reverse direction. It sh ld seldom be necessary to put in a d r- entially wound motor; if very close ed regulation is specified, a definite lim ıg given, you may compel the manu acturer to furnish a motor to meet your equirements, but if he can meet them ,ith a shunt-wound motor it will be far referable.

Other characteristics being the same iere is not a very great difference in the st of the different windings. The series-ound motor usually costs a little less ian a shunt-wound machine, but in some istances it may cost slightly more; the ompound-wound motor will cost more ian either the shunt- or series-wound achine. Any special features in regard speed control that will compel the man iacturer to depart from his standard ractice will increase the cost of the ıtor and probably delay the delivery.

### Horsepower

No general rule can be given for de rmining the power that will be required f a motor to drive a given machine. fairly close approximation, however, ıst be made, by the best means avail-le, in order to get a motor that is large ugh without the expense of one that unnecessarily heavy. Two factors limit e output of a motor: the heating of the res in the motor and sparking at the mmutator. If the motor is to carry its ll load for several hours, the heating is most sure to govern; if it is to run but few minutes, the sparking.

To drive a ventilating fan that is to n all day, a "continuous-duty" motor the proper horsepower must be put in. ry few machine tools can be operated even an hour at their maximum load thout stopping, and a motor takes from ree to six hours, depending upon its e, to reach its maximum temperature; will cool quite rapidly when shut down d in some cases even more rapidly en running on a light load. A motor t be used on an ordinary machine tool u l be capable only of carrying full load t two hours without overheating; if the ı tor can do this it should be able to ve the tool all day on such loads as i will receive in actual service.

lotors for cranes and similar service, v re the maximum load can be of but s rt duration, may be given a thirty-min-t or even a fifteen-minute rating; by r king the rating for as short a time as p sible the manufacturer is enabled to i sh a motor that will do the work p fectly and yet be light and compara-t ly inexpensive.

he ability to carry a heavy overload f a short period is a very useful fea-t e, especially for machine work, and s uld not be overlooked in comparing d erent motors. To specify a high value m cause the manufacturer to furnish a special motor at a high price but a com-p ison of the overload guaranteed by d erent manufacturers on their standard m ors may be of assistance in making a section.

### Speed

The lower the speed of a constant speed motor, the higher will be the cost. Most manufacturers have at least three standard speeds for a given horsepower and almost any speed may be obtained by special design. A high-speed motor has a slightly shorter life of bearings and commutator; a low-speed motor is expensive and has slightly poorer efficiency and speed regulation; a medium speed motor is rather preferable, everything considered.

When it is necessary to vary the speed of the motor considerably by means of a controller while the motor is running, the cost of the motor will be greater than that of a constant-speed machine, not counting the extra cost of the controller. When the variation is large, say, 4 to 1, the minimum speed must necessarily be low; this will call for a large frame, which will bring the price up to that of a constant-speed motor of the same low speed.

A slight increase of speed may be readily and cheaply obtained on any shunt-wound motor by means of a rheostat in the field circuit, no change whatever being made in the motor; when the speed is increased in this manner the power of the motor is reduced, owing to the tendency to spark at the brushes. As the speed is increased the tendency to spark is increased and becomes serious at the full rated load of the motor. By diminishing the load the speed may be increased further, and on no load or very light loads the speed will be restricted by mechanical considerations only.

Compound-wound motors are seldom used for variable speed, not so much on account of the additional expense as because of the fact that a degree of compounding that is hardly noticeable when running at low speed will produce a very large speed variation when running at high speed. If a compound-wound motor must be used, the allowable speed variation when running at the maximum speed should be specified and the low speed will have to take care of itself, which it will probably be well able to do.

### Reversing

If a reversible motor is required, the cost is likely to be increased. Almost any well built motor may be made to carry its load in the reverse direction by changing the connections and shifting the brushes slightly around the commutator. The change in connections may be made by simply throwing a switch or by a movement of the controller but it is not practical to shift the brushes when the motor has to be frequently reversed. A motor that can carry full load in either direction without shifting the brushes is necessarily more expensive than one to run in one direction only.

A motor equipped with auxiliary poles to obtain speed variation, however, will usually run at full load in either direction without shifting the brushes. Auxiliary poles are sometimes used to render the motor reversible only, but there is no necessity for the buyer to specify their use; the manufacturer had better be allowed to exercise his judgment on this point

### Types of Frame

Most builders make motors in three types of frame: "Open," "Semi-Inclosed" and "Inclosed." The open motor should be used whenever practicable; it is the cheapest and in some respects the best. If the more delicate parts of the motor are in danger of mechanical injury, which is quite likely to be the case when they are located on or near tools, covers of perforated metal or heavy wire netting should be fitted over the openings in the motor frame, making it "semi-inclosed." These covers add slightly to the cost of the motor and reduce its capacity by reducing the ventilation.

When a motor is exposed to a great deal of dust, especially if the dust is of an inflammable nature, and when water or oil is likely to be spattered upon the motor, it must be "inclosed" by tight covers placed over the holes in the frame. It can now depend only upon radiation from the outside of the frame to get rid of the heat, there being no circulation of air, and the capacity of a given frame is largely reduced, usually about one-third; the cost for a given horsepower is therefore largely increased.

Aside from the cost, the open type of motor is usually desirable; because any dirt collecting about the interior can be readily detected, and if sparking occurs it is almost sure to be quickly observed and steps may be taken to remedy the trouble before serious damage is done; if it becomes overheated the odor is quickly noticeable.

### Efficiency

The relative importance of efficiency depends upon the amount of service required and upon the cost of power. As an extreme case, assume that a 10-horsepower-motor is to be run at its full rated load, ten hours per day, and that power is paid for by meter at 10 cents per kilowatt hour. Under these conditions a motor running at 85 per cent. efficiency will run up a bill of $8.78 per day; the use of a motor of 90 per cent. efficiency will effect a saving of 49 cents per day or $147 per year of 300 working days; in a case of this kind a difference of even one per cent. would be of considerable importance. Going to the other extreme, a motor may be in actual service for one hour or less each day in a plant which generates its own power; in this case a difference of even 10 per cent. would be of relatively little importance.

### Commutator and Brushes

The commutator is frequently a source

[illegible] attempts have frequently been made to use some cheaper material than mica for the insulation between the bars and between the clamping rings and the bars; to the best of my knowledge none of these has given satisfactory results. The commutator itself is subject to wear and must occasionally be turned off to keep it true; there should be a liberal depth of copper to allow for this.

Brush holders should be of substantial construction, not only to secure rigidity under ordinary conditions but also that they may not readily be destroyed when through an accident of some sort the current arcs across to them. The insulation should present a liberal surface, that there may be less likelihood of current leakage when a slight amount of dirt accumulates, and, as well as all other parts of the brush holder, it should be so arranged that it may be easily cleaned. As it may be necessary to reverse the direction of rotation of the motor the position of the brush holders should be reversible, although they are generally so arranged that they will operate nearly if not quite as well in one direction as the other.

### Heating

If the motor is to be used in an extremely warm location it may be necessary obtain one with a lower temperature rise than is usually allowable. In stating that the capacity of a continuous-duty motor was limited by the heating of the windings no limit was set as to the allowable heating. The American Institute of Electrical Engineers recommends as a standard that the heating be limited to 50 degrees Centigrade (90 degrees Fahrenheit) above the temperature of the surrounding air. The U. S. Navy Department specifies 40 degrees Centigrade temperature rise

The temperature rise can be measured by thermometers or electrically by the change in the resistance of the winding; the latter method is generally preferable for field magnet windings and in most cases will be found to give results several degrees higher than the thermometer; on the armature it is difficult to obtain accurate results electrically and the thermometer is therefore preferred. These results are supposed to be obtained when the air is at a temperature of about 25 degrees Centigrade (78 degrees Fahrenheit), and a slight correction immaterial for the present, is applied for a different temperature. The brushes and commutator are allowed 5 degrees Centigrade (or 9 degrees Fahrenheit) additional rise. Most reliable manufacturers build motors coming within these limits; motors of higher temperature rise are seldom to be desired and a somewhat lower temperature rise may give greater safety.

If the motor is to be run continuously or frequently where the air is at a temperature of 100 degrees Fahrenheit, or more, the temperature rise of its windings should be considerably less than if it were to operate in surroundings of 75 to 80 degrees. In this connection it should be remembered that a large motor placed in a small room or a small motor boxed in for protection will rise the temperature of the surrounding air very materially above that outside the room or box. Assuming that the normal motor will run safely in the air at a temperature of 95 degrees Fahrenheit, the allowable rise should be reduced at least one degree for each degree that the temperature of the air in which it is to run exceeds ninety-five. On the other hand, a motor that is to run in an exceptionally cool location or in a very strong draft of air may be depended upon to give somewhat more than its rated output.

### Ernest F. Butler's Views

When a man wishes to buy a motor he is liable to be swamped by pricelists and quotations from motor builders, each trying to prove that his particular make is the only one the buyer could ever be happy with. The prices are very much alike and nearly all makers will give a guarantee as to efficiency, temperature rise, material, and good workmanship. Which, then, should be chosen, and why?

It is the writer's experience that the best motor, ultimately, is the one which, after minimum liability to breakdowns, can be got going again soonest when trouble does come. The perject motor is not yet made, but one possessing the points mentioned comes nearer to it than any I have yet seen or heard of.

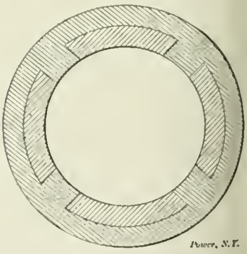
### Mechanical Features

The motor should look right and have no ill-balanced or awkward parts. It should have an ample baseplate, or if it has feet they should be well spread, otherwise the machine will tend to rock when running.

The main frame of a motor of about 10 horsepower or over should be in two parts, so the top can be removed. The top usually has a threaded hole to receive an eyebolt. If this hole goes right through, water, drillings, etc., may get in and damage the armature. In some machines the magnet poles are cast or cast welded in, and pole shoes are fastened to them by flush screws; in others each magnet pole and its tips are in one piece and the pole is secured either by means of a bolt right through the frame, with a nut on the outside, or else by capscrews through the frame into the pole. One of the two latter methods is preferable, as the magnet poles are less liable to work loose and damage the armature. A spring washer is an additional safeguard, particularly in the case of traction motors. It is best to use either two screws or bolts, or one and a dowel pin, in order to keep the pole pieces from twisting out of position. It is the practice of most makers to fit the bearings into endplates which are recessed into the frame and held there by mea of capscrews. A much better way is t have the bearings mounted in the botto half of the motor, so that the top can b removed when necessary and repai made with the armature in place. Th is impossible in the case of armatur slung between end plates. Furthermor a lot of time is lost in removing pulle or pinions, brush gear, etc.

In the matter of bearings there is n much choice. The sleeves are usual cast in one piece, and, externally tap slightly from a central collar which turned parallel and is a light fit in th housing, being usually held there by set screw. In length the sleeves shou be about three diameters; they shou have two oil rings, the broader the bett and be slightly recessed near the ends, keep the oil from creeping along the sha Brass is the metal usually employed a for most purposes is satisfactory; for t heaviest kind of work, however, there nothing like phosphor brouse.

Magnolia or white metal is also co mon, especially in large motors on acco of cheapness. Some bearing sleeves entirely of white metal, others consist bearing metal poured into a shell of br or iron. A very good form is that sho in the accompanying sketch in which p



Power, N.Y.

GOOD FORM OF BEARING SLEEVE

tions of the shell come level with white metal. Then, if a hot bearing sho cause the softer metal to run, the ar ture will not drop onto the pole faces.

Armature shaft should be sufficie rigid to avoid any springing. That p tion of it which fits in the bearings well be of larger diameter than that ta up by the pulley or pinion. Then i any time it should get cut or scored can be turned down slightly and the b ings refilled, saving the cost of a shaft, and a possible dismantling of armature.

It is a waste of money to pay for "t and polish," but at the same time a made motor will usually have a g though possibly not a showy, finish. will be some encouragement to the tendant to keep it in good condition will also show up any neglect on his All set screws, bolts, etc., should be st ard so as to be easily replaced. S akers do not follow this plan and trouble s caused thereby.

### Electrical Details

The armature should have as large a learance as possible. In some motors at portion of the armature taken up by e bands is slightly less in diameetr than e rest, so that the bands come level in tead of projecting. This is an advantage, s the increased clearance means longer fe for the bearings. The commutator ce should be broad and the segments ick enough radially to stand being trued p several times. If the segments are ade with lugs to take the armature leads ade with lugs to take the armature leads, e lug should be stamped in one piece ith the segment; a riveted lug means n extra joint which is a possible source f trouble. Preferably the leads of the ils should be held mechanically as well s by soldering.

It is important that the insulation beveen segments be pure mica only, and e end rings micanite and wide enough project well out from the sides of the mmutator. There should be no possility of movement between the mica rips and the commutator. Some comutators are clamped by means of two d plates bolted together. Sometimes e inner plate is tapped to receive a lt, sometimes it has studs in it to take ts on the front end. Once I was called to see a motor and found the commutor grounded to the frame. As soon the clamping bolts were slacked off it as found that the nuts were inside, and get at them most of the coil leads had be unsoldered.

Field-magnet coils may be either wound a spool or bobbin or, after being wound shape and size, on a former, taped and rnished and put directly on the magnet res. The latter method, if the coils are cuum-dried, and then impregnated while t with an insulating compound, is very tisfactory for all ordinary purposes. In ries motors, particularly, the field-magt coils should not be loose enough slide up and down the magnet res as the current will cause them to ve and in time chafe through the ulation.

The connections should be where they n be seen and reached. A number of kers bring the leads of the coils to tal plates with connectors. These are ually marked with an arrow to denote ection of winding or, respectively, "I" d "O" (inner and outer). If a machine s one pole directly at the bottom, that e will get most of the oil and dirt.

Brush gear and brushes are usually the akest part of a motor and more than e article could be written on that subt alone. With the exception of gauze ushes, which do not come within the nge of this article, there are two differt kinds of brush holders, namely, those the box type and pivoted holders.

In the first case the brush slides in a metal box and is fed downward by means of a spring pressing upon its top end. The chief faults of this type of holder are that the brushes are very liable either to stick or to chatter in the holder, and they have to be discarded in many cases before they are half used. Brushes for this type of holder should be fitted with flexible copper connections or "pigtails" so that the spring does not carry the current.

The pivoted holder is usually one in which the brush is held in some kind of clamp by means of a screw. The clamp is at one end of an arm and the other end is pivoted on the spindle and moves freely around it, while the spindle carries an adjustable tension spring. The disadvantages of this type of holder are that the brushes can often fall out, and they must often be made of a special shape with projections for clamping, which makes them more expensive. This type is often made too flimsy. These holders should be made so that they cannot drop onto the commutator if the brush falls out.

In general, each brush should be adjustable independently of the others; the sets should be adjustable to follow up wear of the commutator; the insulation must be ample; the brush leads should not cross one another where oil and dust can get on them, and a good, reliable connection to the holder must be provided.

Connections are another source of trouble. Sometimes the brush leads and field-magnet coil leads are brought out to a marble or slate slab and protected by a cast-iron cover. This makes a good job if there is sufficient room between terminals of opposite polarity. A better arrangement is that in which short porcelain tubes are fixed to the frame by means of melted lead. The terminals are formed of brass rod, drilled out to form a thimble for the motor wires at one end and threaded at the other to receive the line wires, and also to tighten down onto the insulator. A suitable cover incloses the whole. For watertight or crane work, bushings or glands in the sides of the motor, with the leads brought through and connected directly to the motor wires, are best. Avoid terminals coming through the bottom of the motor underneath the commutator.

The Trill Indicator Company of Corry, Penn., has recently issued a catalog descriptive of the "Triumph" steam-engine indicator and its accessory appliances. In addition to the descriptive matter, nearly one-half of the book is devoted to general hints for the use of the indicator, describing the usual faults found in a diagram, a method of combining diagrams from compound engines, indicating gas engines, etc.

## Curtis Turbine Used as a Regulator

By W. J. Davis, Jr.

An interesting example of the effectiveness of a Curtis steam turbine when used as a regulator on a large power system is found in the new Oakland power house of the Pacific Gas and Electric Company, of San Francisco. The installation consists of a 9000-kilowatt vertical-type Curtis turbo-generator manufactured by the General Electric Company, eight 750-horsepower McNaull water-tube boilers and a Worthington condenser outfit with cooling surface of 20,000 square feet.

The 60,000-volt transmission system of the Pacific Gas and Electric Company entering Oakland is delivering more than 100,000 kilowatts during maximum demand. Of this amount 20,000 kilowatts maximum are supplied to Oakland and immediate vicinity, the load factor being about 60 per cent.

While the new plant is of great value in carrying the local peak load during hours of maximum demand, it is almost continuously kept connected to the transmission system on account of the steadying effect on the voltage and consequent improvement in the lighting service. When acting as a regulator, the duty is especially severe, the turbine taking sudden momentary swings in load from 500 to 9000 kilowatts. In a word, the action of this turbine on an alternating-current system is equivalent to that of a large storage battery on a direct-current system.

## Westinghouse Bituminous Producer in a Sheet-Metal Factory

A Westinghouse bituminous gas producer for supplying fuel to gas engines, as well as furnishing gas for solder baths and enameling kilns, has been installed by the S. F. Bowser Manufacturing Company, maker of oil storage and distributing tanks and automatic weighing pumps, in its factory at Fort Wayne, Ind. This producer plant, of 350 horsepower capacity, supplies three 120-horsepower tandem horizontal engines, direct-connected to direct-current generators; these furnish power for the shops, which are motor-driven throughout. This equipment replaces three 150-horsepower Scotch marine boilers, equipped with underfeed stokers, which supplied steam to 50-horsepower and 125-horsepower simple engines. West Virginia coal, averaging 13,000 B.t.u. per pound, is used in the producer at present; it costs $2.55 per ton, delivered. A Green county (Indiana) coal of approximately the same heat value has been successfully experimented with, and will cost, delivered, $2.25 per ton.

# Some Useful Lessons of Limewate

## Special Wrinkles Not Always Found in Textbooks. A Few of the Things to Be Remembered in Connection with General Analysis

### BY CHARLES S. PALMER

We must pretty soon examine not merely the scale that may form in your boiler tube but also, if possible, examine the water itself, and later consider some of the practical points of oil and coal analysis; but, before we leave the general subject of analysis as illustrated by the last two or three lessons, it would be well to consider some of the special wrinkles which are not always sufficiently emphasized by the textbooks. I am not going to recommend any particular book on qualitative analysis, whether old or new; the books are all substantially the same in the kind of facts they consider and in the method of treatment; but there are some points which none of them treats with sufficient emphasis and clearness, and these are just the points which you will need in practical analysis where you will not have a clean filtered solution handed out for examination, but often a dirty mess or a mixture of messes which may be something that you have got to find out about.

One of the first things that you want to get in the habit of is to treat the substance to be examined with water, and then use litmus on this water solution. You want to do this before you attack the substance with acids or alkalies or any other solvent.

Another point to be noticed is to get the ash of the substance you are examining, no matter what it is. Burn it down in any clean, hard-metallic cup, or if possible, in a little porcelain crucible (which can be obtained from any of the supply houses mentioned in the first lesson). If you should happen to use a coarse assay crucible you will sometimes get results which are quite natural and yet which may seem surprising. I knew of a case, a few years ago, where a Western jeweler tried to assay a rock for silver and gold by fusing it in a Hessian crucible. The rock happened to be limestone, which as you remember is only so much calcium carbonate; and calcium carbonate when heated loses its carbonic-acid gas and becomes quicklime. Now lime is a strong base, not only in water solutions but also in the chemistry of fusion by fire. The Hessian crucible is made up largely of sand, which is only so much silica, $SiO_2$, the anhydride of silicic acid. Hence it is perfectly natural that the attempted fusion of limestone in such a crucible should result in the formation of a fusible calcium silicate which would cause the bottom of the crucible to flow out with its contents like so much molten slag. This operation was actually performed in a common blacksmith's forge; and the jeweler in question was much surprised to discover that the limestone flowed away with the bottom of the crucible like so much water.

Of course, this is only a special case illustrating the great use of limestone (as in fluxing and slagging out the silica from iron ore); but it sets one to thinking, and it will help you to explain why it is that sometimes you can clean out the grate bars of your furnace by a few oyster shells, or pieces of lime, which flux off the tough cinder into fusible silicates. All this again sets you to thinking and shows us how much one can learn from that old barrel of lime.

But we were speaking of the advisability of examining the ash of the substance in question in a crucible; you will find this suggestion of great value in nine cases out of ten; for, if one learns to use his wits, he can find out something from nearly every ash. One ash may be dark-colored and may burn white. That means probably that the substance contained some carbon which burned away. Another substance may leave a red ash; that means that it contains some iron, which at first existed in the ferrous form, and by burning the iron has oxidized to the red or ferric form. All green clays and green slates will illustrate this. Thus brick clay is a dark bluish-gray at first, because the iron is in the ferrous condition; yet it burns or oxidizes to the red-ferric condition.

Another point to be noted in analysis, and especially in turning insoluble things into solutions, is the assistance of not only acids but of the alkalies, and particularly a mixture of sodium and potassium carbonates in fusion; for the mixed carbonates of sodium and potassium fuse more readily than either will do alone. This suggestion, together with your handbook on analysis, will help you out of many difficulties.

Another point to be remembered in analysis is that several of the metals will act as bases in a lower state of oxidation and as acids in a higher state of oxidation. This is particularly true of chromium and manganese; the books will give you detailed information as to how to oxidize the basic forms of chromium and manganese to their acid forms, and how to reduce their acid forms back to the basic forms; but keep your eye fixed on the point that chromium and manganese hav these two forms. Also remember tha ferric and ferrous irons represent two distinct solutions of the same metal, iroı Again in the second group, subdivisio "B" (including arsenic, antimony and tin these metals have a set of sulphur derivatives where sulphur takes the place c oxygen, and where we may consider th metals as being "oxidized by sulphur. All this will be clear to you if you aı simply on the watch; the chemical guic book will tell you.

### Do Not Use Too Much Acid or Alka

Another point concerns what may loc to you at first like the uncertainty of ana ysis, due to using too much acid or tc much alkali. One wants to get in the hab of using as small a quantity of a solutic and as small a quantity of a reagent ; will perform a reaction. It is not nece sary to take half a tumbler of a sol tion if you are going to test for on one metal in a particular group, whe an inch or so of the liquid in a test tul will do, and where a few drops of a r agent will give you the precipitate th you want. Indeed, by using too much a reagent at first you may overlook sor precipitate which is first formed and afte ward is redissolved by itself.

Thus, ammonia precipitates from silv nitrate a brown oxide, readily soluble excess; potassium iodide precipitates frc a mercuric salt, like corrosive sublima a yellow iodide which is readily solul in excess of either potassium iodide mercuric chloride; and sodium hydroxi precipitates from solutions of lead aluminum hydroxides which are read soluble in excess of sodium hydroxi Always feel your way with a little of t reagent.

On the other hand, if you have p cipitated a metal and are in doubt as whether you have added enough of reagent, always filter off a little of solution being examined and add a f more drops of the reagent to the filtr to see whether any more of the me substance comes down. Suppose that are precipitating lead with hydrogen s phide (using the homemade apparatus scribed a few lessons back), and you in doubt as to whether you have preci tated all of the lead. You can easily se this point by filtering off some of the sc tion into which you have led hydrog sulphide gas, and then trying it again few moments with more hydrogen sulhide. Until you get used to analysis and now your reagents and solutions, this sting of the filtrates must always be ne.

On the other hand, do not work entirely rule of thumb, but always use your its and commonsense. I knew of a case few years ago where a student was ven a pinkish-red solution to analyze. f course he thought he knew that he had thing but cobalt nitrate; yet he could tain no test for nitric acid (using the own ring test with green vitriol and sul-uric acid as described in a previous son); neither could he find any cobalt urth group by ammonium sulphide in esence of ammonium chloride). The dent worried himself over this solun for three or four days, and meanwhile went nearly crazy; until his teacher ggested that it might be well for him evaporate his solution to dryness, when that he got was a faint dirty red idue from a trace of aniline ink used color a little water.

f course, this was a mean thing for t particular teacher to do; and of rse it was a trick; but it is no worse k than Mother Nature is trying on all us all the time. I knew of a case retly where a chemist in testing the wash ter of an engine oil to see whether it s acid or alkaline or neutral, found t the water was decidely alkaline. In this case he had used an old cork; in retesting the wash water he used a new cork, when he found the solution to be neutral. The old cork had fooled the chemist because it was full of alkali hidden in the pores of the cork, having previously been used in some solution containing sodium carbonate. Of course the particular moral of this lesson is to keep things clean; for 99 per cent. of good analysis depends on cleanliness.

t going back to the point of avoiding the excess of reagents, it is possible for you to make up a solution of your own, s of the first group, which would fool you entirely. Thus lead chloride which can be precipitated from lead nitrate by dilute hydrochloric acid is quite soluble in strong hydrochloric acid; and if you should add a little hydrochloric acid to a strong hydrochloric acid solution of lead chloride, of course you would get no precipitate. Again, if you should have a solution of lead nitrate strongly acid with nitric acid and hydrochloric acid, on leading in hydrogen sulphide you might get no black precipitate of lead sulphide at first, or at any rate only strangely reddish colored precipitates. All of these difficulties can be avoided by using only slight quantities of solution and reagents.

### Exceptions to Be Noted

hen again there are certain exceptions which come in naturally. Thus, going back to your friend lime (thus far we have considered the action of acids and alkalies on such compounds as limestone and gypsum), take a piece of common well-burnt bone and see what you get. Now this is calcium phosphate, $Ca_3(PO_4)_2$; this burnt bone or calcium phosphate is readily soluble in hydrochloric acid; and if you put this solution of calcium phosphate in hydrochloric acid (which really amounts to a solution of calcium chloride with some dissolved phosphoric acid present) through the group analysis, you will find, when you get to the third group, that on adding ammonia down will come a white gelatinous precipitate which looks exactly like aluminum hydroxide. This, however, is only the calcium phosphate dissolved by acids and reprecipitated by alkalies; and among other differences one marked difference you can easily see from the fact that aluminum hydroxide readily dissolves in an excess of sodium hydroxide (caustic soda), while calcium phosphate is insoluble in sodium hydroxide.

Even collecting some of this white precipitate of calcium phosphate, drying it, igniting it on charcoal before the blowpipe, moistening it with cobalt nitrate, and reheating it before the blowpipe, as the books tell, even this would not distinguish between calcium phosphate and aluminum hydroxide, because both will give a blue color in the method indicated. But this is a regular exception noted in the book and I need only remind you that calcium together with barium, strontium and, sometimes, magnesium may come down in the third group, with ammonia as a reagent, if you have any phosphoric acid, boric acid ("boracic acid"), or oxalic acid in the solution.

Another point to be noted in general analysis is that of making mixtures of the solutions of the metals for yourself to practice on. Of course to begin with you will try one metal at a time, like lime (calcium), or iron, or copper, or zinc, or lead. Then you will mix two or three solutions, separating each metal in its proper group, and proving up each metal for itself, and so on. Then you will try half a dozen metals mixed in the same solution, and—but here is where you will have your troubles; for some metals will dissolve in nitric acid and others will not, tin for instance. Some metals have soluble sulphates, and some metals are precipitated by soluble sulphates; as lead, calcium, strontium and barium. Some metals have soluble chlorides, as all but the first group; while the first group (silver, lead and mercurous mercury) are all precipitated by solutions of a chloride. Hence it is not possible to have *all* of the metals soluble in the same solution; though you can easily make a solution containing ten or a dozen metals. You will remember that the solution for the first group (silver, lead and mercurous mercury) is a nitric-acid solution; also, the solution for the second group, subdivision "B" (arsenic, antimony and tin) is a hydrochloric acid or, better still, an aqua-regia solution (that is, a mixture of hydrochloric and nitric acids).

Another point connected with analysis concerns a lot of new names which might easily confuse the beginner. Chemists are great faddists, and one fad which prevails at present is the excessive naming of old things with new names. Much of this has got into the modern textbooks; it concerns what are called "ions." This can be explained by a simple illustration. Thus take the following equation:

| $CaCl_2$ | $+ (NH_4)_2CO_3 =$ | $CaCO_3$ | $+ 2NH_4Cl$ |
|---|---|---|---|
| Calcium Chloride Soluble. | Ammonium Carbonate Soluble. | Calcium Carbonate Insoluble. | Ammonium Chloride Soluble. |

Here we have a solution of ammonium carbonate acting on a solution of calcium chloride. Now, according to the new theory of solutions, when calcium chloride is dissolved in water it does not remain as "associated" calcium chloride, $CaCl_2$, but is broken up into atomic calcium, Ca, and two parts of atomic chlorine, Cl and Cl. If we should pass a weak direct current through such a solution, the calcium, being a metal, would go from the anode to the cathode and the chlorine would go in the opposite direction from the cathode to the anode.

### Part Molecules or "Ions"

These part molecules which go from pole to pole in the electrolytic cell are called "ions," that is "goers or travelers." Hence the calcium atom which could go from the anode to the cathode with the electric current, in a common solution of calcium chloride is called the "calcium ion;" and similarly the chlorine atoms which could go in an electrolytic cell from cathode to anode are called the "chlorine ions." And the molecule of calcium chloride in solution is regarded as an atom of calcium carrying certain positive electric charges; and the chlorine atoms are looked at as being chlorine ions carrying certain negative electric charges. Now all this is very interesting, and the new theory of solutions is of immense value in explaining a thousand things which cannot very well be explained in any other way; but the point is, that giving us a new set of names has imposed an additional hardship on a beginner.

However, you can learn the whole thing in a word by remembering that these "ions" are only the names of the parts of the molecules which exchange places in the game of balancing your equations. Similarly, the ammonium carbonate $(NH_4)_2CO_3$ may be regarded in solution as being made up of two "ammonium ions" (or electrochemical travelers, each of $NH_4$, which act like metal ions), and one carbonic ion, $CO_3$, which acts like a nonmetallic ion or acid ion. In looking at the second side of the equation, we see that the calcium carbonate, $CaCO_3$, which has left the solution, being precipitated, is no longer in the state of dissolved ions, although it may be regarded as being composed of what would be ions under other conditions. But the two molecules of ammonium chloride in the second part of the last reaction, $NH_4Cl$, being still in solution may be regarded as made up, each of the ion $NH_4$, the ammonium traveler, and the chlorine ion, the chlorine traveler. Really, that is all there is to the naming of these ions; they are new names for the part molecules which react on each other when different substances are mixed in solution.

I do not expect that any one of you will take in all of the substance of this lesson at first reading; but it will pay you to read it every week or two as you go on with these lessons in analysis, and to take the suggestions which are given here; because they will help you to think; and in chemical analysis one must always have his wits about him or else he cannot be sure that even the simplest reaction may not have its exceptions. And in closing this lesson I will give one or two more exceptions which may open your eyes to the possibilities of the simplest fundamentals of analysis. Suppose that somebody should come to you with a solution of, say, water glass (silicate of soda), asking you to test it offhand to see what it is; and suppose that you should go through the group analysis, using first hydrochloric acid and then hydrogen sulphide, and so on. Now, suppose that you add hydrochloric acid to this solution of water glass; you may get a heavy white precipitate, or you may get a thick colorless jelly, so thick that you can turn the test tube upside down without losing a drop. All this is natural and correct and yet you have no silver nor lead nor mercurous mercury of the first group present.

In your quandary, you stop and think of your friend litmus. You find that your solution of water glass is strongly alkaline; and at once you begin to get your wits about you, as you realize that hydrochloric acid is not acting here as a chloride (for any soluble chloride, even common salt, will throw down silver, lead or mercurous mercury from the first group), but as an acid; and hence, in adding hydrochloric acid (and you could have added either sulphuric or nitric with the same result) you have simply thrown down insoluble silicic acid. Then you ask, why don't the books tell about these things? Well, why don't they? Perhaps because these lessons should also be labeled: "A Lesson of Litmus."

At all events you will remember that as a rule soluble bases can precipitate insoluble bases and soluble acids can precipitate insoluble acids. Hence you will want to make out for yourself a new table of the analytical groups, and under silver, lead and mercury you will include such acids as silicic acid and others which may be precipitated by strong acids like hydrochloric acid from alkaline solutions. In the same way you might precipitate by hydrochloric acid, lead hydroxide from a solution of sodium hydroxide in excess, or aluminum hydroxide from a solution of sodium hydroxide in excess. Similarly, if you make a [illegible] solution of borax, $Na_2B_4O_7$, sodium tetra borate (sodium four borate), and acidify this strongly with sulphuric acid and set it aside to stand awhile, in an hour or two you will notice a beautiful growth of crystals of insoluble boric acid; all of which is only another illustration of the chemistry of acids and alkalies in these lessons of limewater and litmus.

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## Selective Economy in Raw Materials*

The keen, aggressive competition of modern business demands the most careful scrutiny of every element of manufacturing cost. In spite of this, observations extending over a number of years, under peculiarly favorable conditions, have sharply emphasized the fact that the economic selection of raw materials is not given the painstaking, systematic consideration which this vital detail of every industry deserves. It is no exaggeration to state that there is probably not one manufacturing concern in operation today for which a substantial saving cannot be made in the cost of at least one, if not several, of its raw materials, without the slightest detriment to the quality of its finished products.

Where a true selective economy is exercised in the purchase of raw materials, the choice is not determined by either quality or price, but by the relative industrial efficiency of the materials under consideration. The opportunity to economize may, therefore, lie in the substitution of a high-priced material for a cheap one; in a change from a coal which the fireman likes to one which gives more heat for a dollar; in selecting lubricants with reference to their physical constants instead of by brand; or, very commonly, in discarding altogether some particular material long in use in favor of another more efficient at the price.

Coal is so universal a raw material, and coal economy so important and such a specialized subject, that an extract from a recent publication of this laboratory is well worth quoting. It says: "In buying steam coal the amount of heat that may be developed from it is the measure of its value to you. There is no byproduct that may be utilized, except that in some cases the sale of ashes might be considered in this connection, but their removal is generally an additional expense. Two coals at the same price and containing the same number of heat units may not be equally desirable. The difference in volatile matter might cause the lowe to prove more satisfactory under cer tain conditions of smoke restriction, whi the higher volatile coal would probabl be more applicable in a plant with fluctua ing load. The amount and nature of as in regard to the formation of clinker ofte need to be considered.

"The liability of spontaneous combu tion of one coal more than another, m make it advisable to pay several cen per ton more for one coal containing more heat units than the other."

Referring to seven different coals, th analyses and results of evaporative tes of which are tabulated, this publicati shows that of the seven neither the trinsically best nor the lowest-priced co would be the cheapest to buy.

As for lubricating oils, opportunities f economy can be found in most factori In one of the largest corporations in t country, an expensive cylinder oil w being used on its machinery where heavy machine oil would have answer equally well, with a saving of over $20 per year. There are many instanc where equally efficient but cheaper o can be substituted for more expensi ones; this is particularly true of cutti oils. But probably the greatest sou of saving will be in the knowledge th one mill will be using the identical that the mill next door is using, but only paying two-thirds the price for the

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*Extract from a paper presented at the annual meeting of the American Chemical Society, at New Haven, Conn., July 3, 1909, by Harry S. Mork, engineering chemist with the Arthur D. Little laboratory, Boston, Mass.

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I think it to be evident that very m the greater part of all that goes to m up our civilization is directly or indirec to be traced to our utilization of c and it is just as evident that when stores of coal get exhausted the grea part of all this wealth and evidence civilization must disappear. The wo will not be left in its old state. T old state was like that of an earnest, p young man, with great hopes. The n state will be that of the spendthrift wh fortune is gone, but whose expens habits remain. Then will come the t of great struggle for Niagara by all civilized nations of the earth. The w power of the west of Ireland will f a new center of civilization, as will hills of Switzerland, and all places of h tide round the coasts of the world. T will be the time when men will try utilize the stores of energy which seem to be insignificant or hopelessly of our reach: the direct radiation f the sun, or the internal heat of the ea —Prof. John Perry.

---

The amount of electricity develope n Canada during the past year amounte o 494,358,966 kilowatt-hours. Of this l e amount, 359,280,286 units were expo d and 135,075,680 consumed in Canada. e exports were, of course, largely f n Niagara Falls production.

# Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think,
Know or Want to Know About Your Work, and Help Each Other

## WE PAY FOR USEFUL IDEAS

## The Weir Pump

Although little known in stationary wer plants, the weir pump, however, ves itself an ideal pump for feeding h-temperature water into a high-pres- boiler. This pump is used on most the first-class English, German and er steamships. The North German yd. for example, has used this pump all its steamships for many years, and added importance is attached to this, in view of the fact that all its vessels and their equipment, with the exception of weir pumps and heaters, are built in Germany.

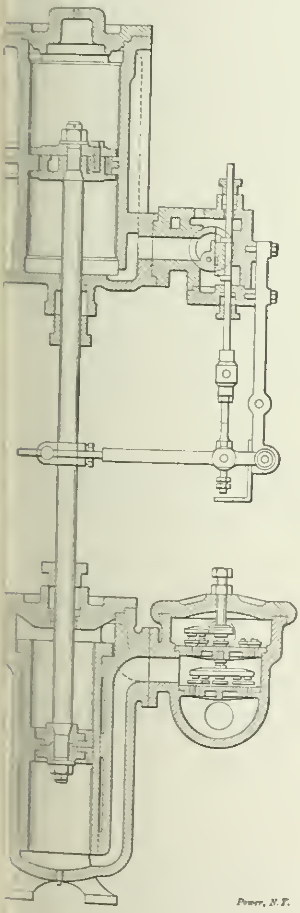
Power, N.Y.

FIG. 1

Referring to the sketches, Fig. 1 is a section through the steam and water cylinders and valve chamber. The port for the bottom end of the steam cylinder is shown and the steam valve open for admission; also, the port for the bottom end of the water cylinder and the water chamber for the bottom end The dotted lines show the port, in both steam and water cylinders, for the head end of the cylinders. In each seat grating or deck are 12 or 16 valves of the miter-valve type of solid brass, about 1¼ inches in diameter; they have a lift of not more than 3/32 inch. The suction valves are provided with springs. That these pumps work so well with the very hot water is to a great extent due to the many small valves and the low lift.

The water piston shown in the section is made exclusively of cast iron, and is the simplest and best that the writer has found in his long practice, and they will last for years under all conditions The packing rings are in angle form with grooves in the circumference (labyrinth packing).

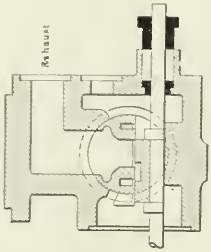

FIG. 2

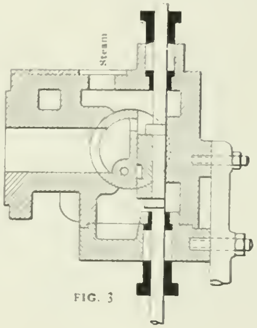

FIG. 3

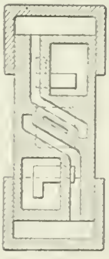

FIG. 4

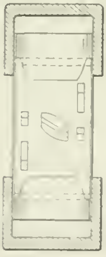

FIG. 5

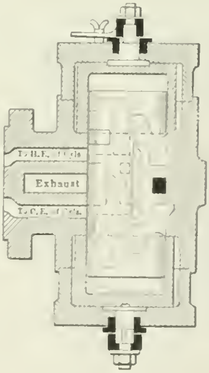

FIG. 6

Power, N.Y.

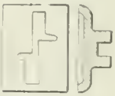

FIG. 7

Figs. 2 to 7 show the details of the steam valve. Fig. 2 is a section through the steam chest, showing the exhaust port and valve open for exhaust. Fig 3 is also a section through the steam chest, showing the steam port and valve open for admission. Fig 4 is a longitudinal section of the piston valve Fig. 5 shows the valve with the flat side for the auxiliary valve. Fig. 6 is a longitudinal section through the steam chest. Fig. 7 shows the auxiliary valve. Although this valve gear looks complicated, the writer never had any trouble with it, and never heard of any trouble.

The Weir pump occupies very little space, as the water end can be set in a pit as far as the head of the water cylinder, or in the bilge, as on board ship. Every part is easily accessible for inspection or repairs. The pump valves, for example, can be easily lifted out by taking off the cover which holds the seat gratings in place by means of a set screw.

The Weir pump is a simple and durable machine, with smooth and noiseless action. It does not seem economical to use either live steam, or steam which has only been used in the high-pressure cylinder, for heating the feed water; yet the writer has received the best results by doing so.

HANS KLUENDER.

Elizabeth, N. J.

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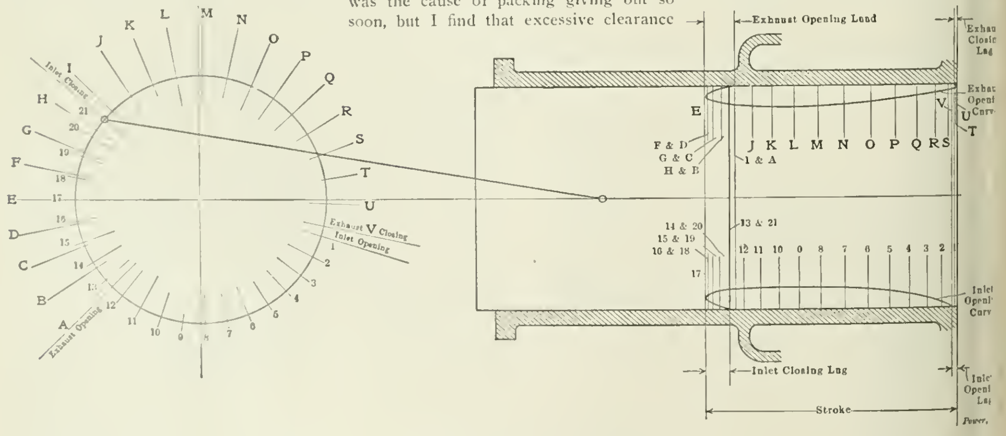
## Valve Opening Diagram

In order to study to best advantage, the valve action of gas engines in relation to piston travel and position of crank pins, it is essential to plot the curves of valve openings. As an excellent method of showing this relationship, the writer presents the accompanying diagram. It is believed to be original, although perhaps it may have been used.

The positions of the crank pin at the opening and closing points of the valves are indicated on the crank-pin circle, and knowing the length of the connecting rod and piston, the corresponding positions of the piston head can be found. By the usual method the valve openings or "lifts" of the valve can be ascertained for intermediate positions, and using the line representing the cylinder wall as a base line, lay off these distances at right angles to it. The curve drawn through the points thus determined, is the valve-opening curve.



DIAGRAMS OF VALVE OPENING

In the diagram the inlet curve is shown on one side and the exhaust curve on the other, so that they can be readily compared. Of course the valve openings for the inlet and exhaust, corresponding to a given position of the piston, do not occur simultaneously in the case of an ordinary four-stroke cycle motor, but on succeeding revolutions of the crank shaft.

With this diagram, the valve action for a particular motor can be easily understood and studied with a view of possible improvements in the cams.

J. C. AUSTIN.

Detroit, Mich.

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## A Packing Trouble

Following is how I overcame a packing trouble in two Harrisburg engines:

I used to have to pack the piston rods about twice a week and tried nearly every kind of packing on the market. Finally I took a ring of metallic packing that had been tried and found useless and put it in the bottom of the stuffing box, to close up the excessive clearance around the rod. Then I filled the box with a square packing with a core of rubber and put one nut on one side of the gland and one on the other, in order to keep the gland from moving and hammering the life out of the packing.

I used to think that the oil from the crankcase of the inclosed-type of engine was the cause of packing giving out so soon, but I find that excessive clearance around the rod is responsible for the biggest part of the trouble.

A diagonal packing is good, treated this way, but for a long life I find that a square expansion packing is better. Packing treated this way will last about ten times as long as any other way I have ever tried.

H. B. ADCOCK.

Newnan, Ga.

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## A Grunting Piston

When I entered upon the duties of as
sistant in the plant where this engin
was in use, I was told that at times th
low-pressure piston would do a lot c
grunting, and whenever it was necessar
to start this engine I should be ver
particular about giving it plenty of cy
inder oil.

During my first two weeks the engi
gave no trouble, and on starting up o
morning the low-pressure piston bega
to grunt and the vibration from the cy
inder would cause the whole engine
tremble. As it was necessary to run th
engine that day the chief said to "gi
her plenty of oil and she will be all rig
when a little more load comes on," whi
proved to be correct. I asked him wh
was the cause of the grunting, and l
said they had been unable to locate it.

Fibrous packing was used on this e
gine and as the vacuum was none t
good at best, I was instructed to screw
on the packing each time before startin
After a little time I noted that if I fo
lowed the instructions the piston wou
grunt, while if I neglected to screw up
the gland it would not. I called the
tention of the chief to this fact but he sa
that that made no difference. Howeve
not long after this the low-pressure pist
rod was packed with new packing whi
was screwed up good and plenty, a
when the engine was started the grunti
started as well, and cylinder oil and ever
thing else was tried but did no go
Finally the chief told me to shut
down, take out the piston and see if
cause could be located. On removing
piston the rod was found sprung, wh
caused all the trouble; for after tak
it to the machine shop and having
straightened the engine ran O. K. .

A. K. VRADENBURGF

Albany, N. Y.

## Repairing Burnt Commutator Insulation

Some time ago a 15-horsepower 500-olt motor melted the fuses, and upon eplacing them and starting the machine, noke began to roll out of the armature st back of the commutator, before the tarting resistance was half cut out. I topped the machine at once and began eling each armature coil to see if any ere short-circuited and was rewarded in few minutes by having my fingers rned.

As soon as I found this coil I traced the ads from it to the commutator and bean to look for the trouble. The face f the commutator had a fine polish and ere was not any evidence of trouble, t on the end I found a small burned lace about as large as a pea. At this lace I cut the metal back into the comtator for 3/16 inch so that the mica as clear, and upon starting the machine ran fine.

The next day I turned 3/16 inch off the nd of the commutator also 1/32 inch

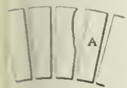


FIG. 1

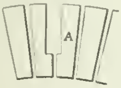


FIG. 2

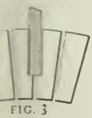


FIG. 3

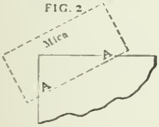


FIG. 4

Power, N.Y.

the face, and after thoroughly examing and testing it, shellacked it and let g. If there had not been sufficient k to stand this turning, I would have ewed the burned mica segment.

turning a commutator always cut y the stock until the mica shows clean l clear; then very carefully remove all vings or chips which might be stick- between the bars, test the machine and thoroughly paint or shellac the l of the commutator, so that oil in rking out from the shaft cannot shortuit the bars. Oil on the commutator es a great deal of trouble, especially h 500-volt machines. The oil works its to the outer edge of the commutator there it remains until it has collected gh dust to short-circuit two bars. en there is a puff and a burned place i the mica. This continues until the and segment resemble *A*, Fig. 1, and t n if not remedied the machine will pbably burn out.

o repair one of these places take a hk saw and cut out the burned mica uil the line *A A*, Fig. 4, is perfectly clear al straight, then file the copper until the s resembles *A*, Fig. 2. Clean the slot thoroughly and then cut enough mica to fill the slot, but do not wedge it in until you have thoroughly soaked both it and the slot with shellac or armature paint, then wedge the mica in as tight as possible after which it should resemble Fig. 3.

Next take a blowtorch and bake the repaired segment until the shellac or paint is thoroughly set; then cut the mica off smooth with the face of the commutator and polish with sandpaper and repaint. I have four of these patches which have been on for two years and they are all right today.

H. G. Schuler.

Kansas City, Mo.

## A Dangerous Boiler

Seventeen years ago an enterprising farmer living near Boston purchased a portable steam pump and boiler for use in watering his farm. Every summer he has had one of the young men in the neighborhood run it, under the supervision of "Mike," the foreman, whose word was law. This summer the boiler leaked so badly that the facts came to my attention.

The boiler has been so overheated that the tubes are all leaking. In former years when they leaked too badly, "Mike," with a hammer and chisel, would hammer them until they were somewhat riveted up. Several years ago the steam gage was stolen, and since that time the "engineer" has estimated the pressure by the rate the pump worked when the throttle was opened wide. How he estimated it when the pump was not running was not made clear to me.

The water used in the boiler was the same as that used in the pump, i.e., from a dirty frog pond. Small fish and eel grass were continually thrown out of the nozzle, and the natural inference is that they were just as frequently thrown into the boiler. The water glass was so dirty that even if there had been any water in it, it could not have been seen. As the foreman explained, "it was so stuck up with mud that you couldn't even depend on it, anyway."

The foreman once (long ago) opened a handhole to clean out the boiler but, as he said, "there was such a mess in there that it would have taken a whole day of overtime to get it clean, and what was the use, 'cause it was running all right as it was," and the mud stayed in then.

In all these seventeen years no repairs have been made, the boiler has never been inspected, the inside has never been cleaned out, its safety valves and steam gage (when it had one) have never been tested, and it has never had anyone with a license to run it.

In spite of all this the owner refuses to have any repairs made, saying that "it isn't worth it, and as long as it will pump water let it alone and don't fool with it."

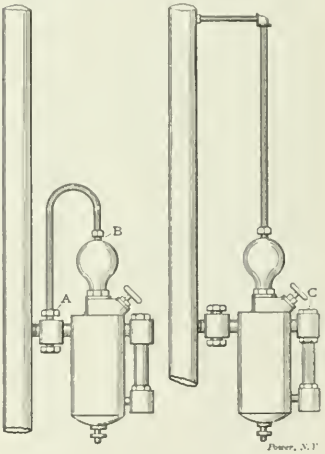
Ernest M. Symmes

Winchester, Mass.

## Changing a Single-Connection Lubricator to a Double-

Several years ago the writer took charge of a plant where there were two single-connection lubricators on the boiler feed pumps and, as has been my experience before with this type, they were very unsatisfactory, on account of stopping as soon as you got away from them and were congratulating yourself on having found the trouble this time, sure.

After the changes, as shown in Figs. 1 and 2, were made, they worked satisfactorily. The short brass condenser pipe was taken off and a small, round piece of sheet iron and gasket put in nut *A*, forming a blank joint. The thread at *B* was filed off, which left this part the right size for 1/4-inch pipe thread.



Power, N.Y.

For a liquid in the sight-feed glass, I can recommend silicate of soda (liquid glass); engineers will find it much better than glycerin, and very cheap.

Why will manufacturers of lubricators put the filling plug at the top of gage glass, as at *C*, Fig. 2, and thereby get a left-handed blessing every time an oiler or engineer has to stand close to a hot cylinder, with the temperature in the room anywhere from 100 to 130 degrees Fahrenheit, and wait until the thing gets done sputtering and spitting before another spoonful can be put in, etc.

I believe that a good hydrostatic lubricator is better than a force-feed lubricator. One reason is that the feed regulation will be given more attention and so save oil. Another reason is that I have used many hydrostatic [illegible] for years without repairs, but never a force test.

A mistake often made with lubricators is to use a wrench on the filling and draining plugs. This is not necessary on a new one, and when they get worn they can be easily repaired by cutting a lead ring and using it for a disk.

W. C. Schiffler.

East St. Louis, Ill.

## An Iron Smokestack Constructed in a New Way

My attention was called a short time ago to a novel method of erecting an iron smokestack. The usual method has been to place the laps on the outside of the stack, so that the rain flows down and runs off on the outside without lodging in pockets. No account was taken of the fact that the rain also runs down on the inside and lodges in the pockets formed, at each lap joint, as shown in Fig. 1 at *A*; also, that the soot and ashes lodge at *A* in the same pockets.

Everyone who has had charge of ash-conveying machinery knows how very destructive wet ashes are to the iron, and how short-lived the iron conveyer buckets are. All gas-plant men also know that gaspipes must not be laid in ground containing ashes.

By constructing the smokestack so the laps are reversed, as shown in Fig. 2, the rain runs down on the inside without collecting in pockets filled with ashes, as there will be none with this method of construction. The pockets formed on the outside with the Fig. 2 construction can be looked after and kept painted, whereas it is a difficult matter to get at the lap joints on the inside of a stack after it has been sooted up. It has also been noticed that the iron stacks always start to rust out first at the joints on the inside of the stack. This is, as mentioned, due to the ashes in the pockets being wetted by the rain. It is claimed that this reverse method of construction will give double the length of service compared to the old style.

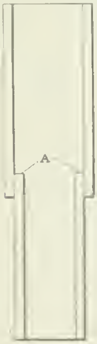


FIG. 1

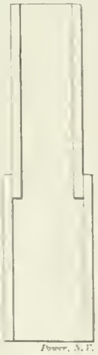


FIG. 2

W. N. Zurfluh.

Dayton, O.

## A Boy's Vigilance Prevented Disaster

A small concern had an engine and a tubular boiler 42 inches in diameter. It was not much of a job to take care of and it was intrusted to a boy who had other duties as well. One day the boy came around to see that everything was all right and was worried because his water level was lower than he expected to find it, although there was still plenty of water in sight, so he covered the fire and reported to the boss what he had seen and done. The boss told him that a handhole or tube was leaking, but examination showed nothing of the kind and, believing the boy's story and not wishing to take any chances, they pulled out the fire, and, as soon as the boiler was cool enough, sent a man under the boiler to see if anything could be found.

At one point he found the ashes wet and evidence that water had been running down the brickwork. A hole was cut through the brick at that point and a crack about 3 inches long discovered. Word was sent to Hartford and an inspector had pressure put on and then hit a blow with a hammer, when a crack opened up about 3 feet long.

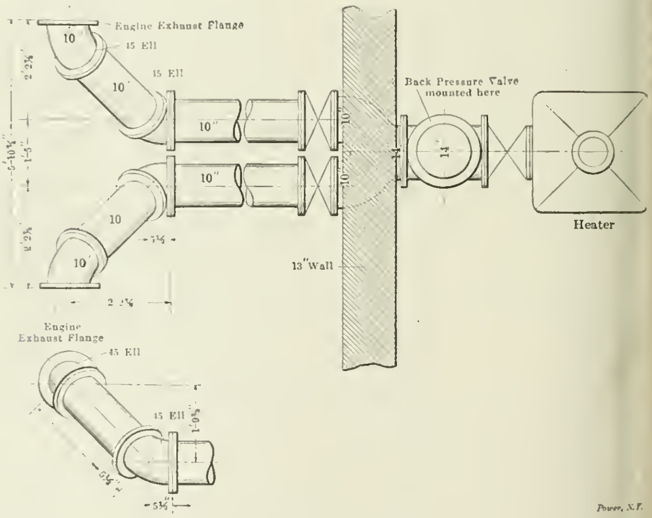
There appears to be no moral attached to it, simply a boy could not understand why more water could be used during an interval than had been the custom, and ordinary prudence used i looking up the cause. The boy did not get a scolding for his prudence.

W. E. Crane.

Waterbury, Conn.

## A Difficult Piping Job

The accompanying sketch shows an arrangement which gave great trouble. A shown on the sketch, the exhausts from the two engines face each other. At th exhaust flange of each engine is placed a 45-degree ell turned toward the wall as shown. To this is connected a straigh piece, and another 45-degree ell turns th pipe into the horizontal plane, in lin with exhaust opening on the heater.



A DIFFICULT PIPING JOB

The two 45-degree ells and straig pieces were chosen in place of 90-degr ells in order to lessen the back pressu Of course, the length of the straig pieces had to be calculated. I have r given this dimension on the sketch. Pro ably some readers would find interest working it out.

As the arrangement was declared by t engineer to be impossible, I should li the opinion of Power readers on t points: Could the job be piped up t way? How much saving in back pressu would be effected by this method over similar arrangement with 90-degree el

J. A. Collat

Atlanta, Ga.

The thirtieth annual convention of American Water Works Association be held at New Orleans, April 26 to 1910.

# Subjects Under Discussion

Comment, Criticism and Debate upon Various Articles, Letters and Editorials Which Have Appeared in Previous Issues

BRING OUT YOUR IDEAS

## Trouble with Motor-Driven Exciter Set

Referring to the answer of T. A. Lees my query concerning the trouble with motor-driven exciter, I will say that re is another cause which contributes he trouble beside the one he mens. It is true that the lowering of the rnator voltage due to the short-cir greatly decreases the torque of the tion motor, giving it a tendency to p out." The torque of an induction r varies with the square of the volt at its terminals; consequently, with lowering of the voltage there is a decrease in the torque.

The other cause mentioned is this: en the heavy rush of current takes in the alternator armature, due to rt-circuit, the field strength of the nator is greatly reduced. With the en lowering of the field strength e is induced in the field winding of alternator an e.m.f. which is in the e direction with the exciter e.m.f. e.m.f. is due to a transformer action he field winding, caused by the sud-hanging of the number of lines of threading through the field coils. result of this action is considerably increase the field current, putting a ater load on the exciter, which in- l load, together with the decreasing e of the induction motor, causes the pping out" mentioned. Of course, all the extra energy necessary to carry this sed load is not taken care of by the r a part of it being furnished by rce of the increased e.m.f., but the n the exciter is increased, as is by the following example:

pose that an alternator field wind s a resistance of 1.2 ohms and ex g current is supplied at 120 volts rding to Ohm's law the field current ll be

$$I = \frac{E}{R} = \frac{120}{1.2} = 100$$

peres. The power expended in watts ld be

$$W = EI = 120 \times 100 = 12,000$$

tts or 12 kilowatts. Now suppose the ced e.m.f. to be one-half that of the iter, or 60 volts. This would be added that of the exciter, making a total of volts tending to send current through field winding. With the increased voltage an increased current would result, as follows:

$$I = \frac{E}{R} = \frac{180}{1.2} = 150$$

amperes. The watts expended under these conditions would be

$$W = EI = 180 \times 150 = 27,000$$

watts, or 27 kilowatts. This load would divide between the two sources of e.m.f. (the exciter and alternator field) in direct proportion to the e.m.f. of each. Since the exciter furnishes two-thirds of the total e.m.f., it will take two-thirds of the load, or 18 kilowatts. Thus it is plain that the load on the exciter has increased 50 per cent. without any increase in its e.m.f.

In the example given the self-induction of the field winding has not been considered. In actual practice the current might not increase in the manner stated, as the self-induction of the field winding would tend to choke it back, although the demagnetizing action of the armature current has a direct tendency to reduce this self-induction of the field winding. But the example proves that the load on the exciter will be increased by the addition of the induced e.m.f.

C. L. Greer.

Handley, Texas.

## Kerosene in Boilers

I have read a great deal about the use of coal oil as a scale solvent and have been doing quite a little experimenting both with coal oil and soda ash, which was recommended by the boiler inspector. The feed water is taken from a river, and two analyses of a piece of the same scale do not correspond, one being:

| | Per Cent |
|---|---|
| Moisture and organic matter | 7.61 |
| Silicates | 1.17 |
| Iron and aluminum oxides | 1.02 |
| Calcium sulphate | 78.37 |
| Calcium carbonate | 10.39 |
| Magnesium | 0.61 |
| Oil | trace |
| Undetermined | 0.53 |

The other analysis is:

| | Per Cent |
|---|---|
| Calcium sulphate | 87.2 |
| Alumina | 5.8 |
| Magnesia | 0.3 |
| Silica | 3.9 |
| Organic and volatile matter | 2.8 |

Both analyses show the principal salts to be calcium sulphate.

A trial was made on three Babcock & Wilcox boilers to determine whether coal oil or soda ash was a benefit in removing scale. Each boiler was cleaned in its turn and all were fired about the same length of time.

In No. 1 boiler coal oil was used, being fed with the water and about 1 gallon put in the mud drum when washing out.

In No. 2 boiler 150 pounds of soda ash was placed and kept boiling slowly for five days.

In No. 3 boiler nothing was used. All were cleaned by chipping the drums and using a turbine cleaner in the tubes. About the same amount of scale was taken from each boiler and very little difference was noted in the hardness of the scale.

The cost of cleaning No. 1 boiler was $56.85; the cost of cleaning No. 2 plus the cost of the soda ash was $63.27; the cost of cleaning No. 3 boiler was $48.21. Part of the saving on No. 3 should be credited to a change in workmen, however.

These boilers are blown down one gage every six hours. Three or four years ago a certain well known boiler compound was tried in these boilers, compounded after an analysis of the feed water, and the cost of the compound ran as high as $20 per month for each boiler. This compound had been in use about one year when I went into the plant and found the worst dose of scale I ever saw. We had to replace from one to six burned-out tubes every week. This soon settled the compound and we got two turbine cleaners, and since getting rid of this scale our tube renewals have been a great deal less, although we are using a very bad water and it is necessary to wash the boilers every two weeks. Sometime ago I made a solution of eight parts of water and one part of soda ash, in which I put several pieces of scale. I also put several pieces in a can of coal oil. After soaking for one month the scale was just as hard as before. Of course these conditions are somewhat different from those inside of the boiler, but it seems to me that they should have had some effect on the scale in the pails, if they would in the boiler.

Coal oil or soda ash may be a great help in removing some kinds of scale, but I have found that a good mechanical cleaner is the cheapest method to free the boilers from scale. Scale should not be allowed to get into the boiler in the first place, and it can be kept out by the use of a purifying system to soften and purify the water and neutralize the scale-forming salts before they get into the boiler.

J. C. Hawkins.

Elyria, O.

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I have charge of a heating boiler that seems to enjoy accumulating cylinder oil and a small amount of silt that is contained in the make-up water, by mixing them, coating the tubes, building small mounds on the back head and forming a ledge on the shell at the water line. The lower half of the shell remains practically free from oil deposit and this has prevented any injury to the boiler. The first time I treated the boiler for oil I used a compound, obtained from a boiler-compound company, which was guaranteed to do the work, but it brought down only about a quart of the deposit; I next used soda ash, which brought down about half of what was in view from the manholes. The boiler was then closed up for the winter and the usual precaution taken to prevent further accumulation of oil.

When the boiler was opened in the spring, the old oil was still there and some more with it, so I decided to try kerosene. About ten gallons of kerosene was put in and the boiler slowly filled with water, requiring twenty-four hours to fill; then the water was run out during the next twenty-four hours and slowly filled again, which made three times the deposit was exposed to the kerosene. Then the water was kept boiling for a week, carrying about five pounds of steam. After cooling, the water was run out, but the oil and mud were still there. I thought that after this treatment, soda ash might do the work, and tried it, but with the same result as before. After this experience, the boiler was allowed to stand open a few weeks, in order to think up some different method of treatment.

I then made a discovery: that the deposit had dried and was falling off; a little heat was applied to hasten the process and after a few days drying, a heavy stream of water from a hose brought out about two bushels of deposit, besides what got away. To make a good job, scrapers were made, the tubes and shell were given a thorough scraping, and after washing again the boiler was perfectly clean, the first time in three years.

J. A. Mawhinney.

Franklin, Penn.

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Several years ago I had charge of a steam plant in Montana, consisting of three Atlas 60-inch by 16-foot horizontal return-tubular boilers, a 14x16-inch hoist, 14x16-inch air compressor and a 14 and 16 by 6-inch station pump. I used two boilers and kept the third to use when cleaning time came, every two weeks.

When I took charge they were using all three boilers and steam and hot water were flying from every joint. As the plant (mining) ran twenty four hours a day every day of the year, it took some manipulation to stop the leaks and keep things moving. With the leaks stopped I "killed" one boiler and when one considers that we burned green pine cordwood right from the axe, and frozen at that, you may imagine that we "forced" some.

Upon inspecting the "dead" boiler I found a hard, white scale from ¼ to ⅜ inch thick. I put two men to work chipping the scale, and as we had no compound, I immediately began using kerosene in the other two boilers, feeding about three gills, or nearly a quart, to each in twenty four hours. After doing this for nearly a week I cut in the boiler we had cleaned (I say cleaned, but there still remained a great deal of scale) and cut out one of the others. I found the same amount of scale and just as hard. The kerosene had not "touched" it.

I immediately filled the boiler with water and got up about 20 pounds steam, to heat it thoroughly. While this was being done I made a "squirt gun," pulled the fire and emptied the boiler. Just as soon as I knew the boiler to be empty, I knocked in the manholes and with the squirt gun I shot kerosene into every nook and corner. In about six hours I again filled the boiler and steamed up to 60 pounds. After this pressure was reached the boiler was allowed to cool gradually and when cold was again opened. Imagine my surprise to find all the scale on the bottom, eleven wheelbarrow loads, and the shell and tubes as slick as a whistle.

When I cut this boiler in again I began at once to feed kerosene with the feed-water. Four weeks later it was closed down to clean and I found scale ⅛ inch thick. Now, why did the kerosene so effectually "knock" the scale and yet did not prevent its forming?

I might add that after my boilers were clean, two boilers easily kept the steam and saved 43 cords of wood a month, at $3.75 a cord.

John H. Hieber.

Spokane, Wash.

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## Watch the Safety Valve

The editorial "Watch the Safety Valve" brings up a matter which is often neglected even in large power plants. There is, of course, less danger from neglect with the spring-loaded valve than with the lever pattern, as it is more self-contained and the load is applied directly to the disk instead of through the lever, which is subject to derangement from many causes. The old type has the advantage of having its loading device exposed to view, so that extra weight can be immediately noticed.

With the spring-loaded valve an incompetent man may screw down the adjusting screw until the spring coils touch eacl other, and the valve may go in this condition for a long time, if the boiler is connected with others.

In a plant having several boilers an two safety valves to the boiler, it seem impracticable, or at least unusual, to caus each valve to blow by steam pressur every day, as they can't all be made t blow at exactly the same pressure (perhaps it is safer that they don't). Whe tested, one valve usually does all the blowing.

I think it a safe practice to give th safety valve an accurate test when fir put into service and at reasonable intervals thereafter, especially when ther has been any repair or adjustment mad on it, and after the boiler has been lai off.

When the boilers are in service th pressure should be raised to nearly th blowing-off point, and the valves opene by hand every day, or at least once week. An experienced person can te whether the valves are within two three pounds of blowing off.

When testing pop valves, the closin pressure should be noted as well as th opening pressure. Sometimes the valv closes too soon and sometimes it lowe the pressure entirely too much. The writ has in mind two pop valves furnishe with a new boiler; one lowered the pre sure only 1 pound before closing ar the other 9 pounds.

Walter S. Griscom.

Buck Hill Falls, Penn.

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## How Shift Changes Waste Mone

After carefully reading the article "How Shift Changes Waste Money," J. M. Whitham, on page 498 of th September 21 issue, I should like ve much to have Mr. Whitham enlighten on certain points. For instance, just h near the running point does the stea pressure remain when this "blank which he speaks of is put on, and which direction does the pointer of steam gage travel when "the fires becor honeycombed and large openings appear

What particular type of plant did Whitham have reference to? Could be the railway power plant? Anyo would be led to believe from reading article that the 12-hour shift was the o referred to, and it would be fair to pr sume that 6 a.m. and 6 p.m. were changing hours. If so, can any engin with experience in this type of plant member when the load was so accomm dating as to fall off during these hours

Perhaps Mr. Whitham had in mind manufacturing plant which runs 24 hou If so, the heavy coaling on which so mu stress is laid could be only possible by large falling off in load, which would mean that during the changing of the shift in the factory things were nearly at a standstill. Mr. Whitham speaks of a 1000-horsepower plant. Now, in a manufacturing plant using this amount of ower it would be reasonable to suppose hat 1000 operatives are employed. Suppose they also take 30 to 35 minutes to get ready for home, which they must do in order to keep the load light for the 30 35 minutes the firemen are tak- g life easy. Doesn't it seem strange at any of these concerns can pay a ividend?

Looking at it in another light, if a reman could take so much advantage of s work between 5:30 and 6 o'clock, why ldn't he do so right through the shift? r instance, if he can make it easy for nself and waste one ton of coal in one- lt hour, as Mr. Whitham states, why ldn't he take it easy all day and waste tons of coal? Then the night firemen ight make it easy for themselves and aste 24 tons. About this time we begin think of who's going to take out the hes, how long the coal mines will hang t and if the fireman really does love shovel coal.

Even if there were any truth in Mr. hitham's assertion, plant owners who quire their men to work 12-hour shifts uld lose all that Mr. Whitham claims y lose and more.

I should like to ask Mr. Whitham if in experience of which he speaks he has l in front of and fired boilers run- g at or above their rated capacity for period of, say, 11½ hours, and if so, was interest in abstracting the last tenth a unit from a pound of coal as keen at the beginning of the shift?

Long before I knew a boiler from a d-water heater I used to visit a boiler m where my playmate's father was an. While sitting with him one day an old box, I said: "Don't you have a ?" The reply which he made me ll live long in my memory and has been ght forcibly to mind on many oc- ns. He said: "You don't stay around l watch me all day, and even if you did uldn't be like doing the work your- s

L. C. Tucker.

Newburyport, Mass.

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r Whitham should have thought a l longer before he started in to put t anufacturers "wise" in so brave a f ion. One plant is no standard to go b he should have looked around a little. n the first place he says the firemen t ow on three tons of coal a half hour c ly and that about 45 minutes elapse b ore the new gang takes hold to work t fires. By that time the fires are so l it takes two or three tons more to b ng the steam back. I may be wrong b I think that is pretty stiff firing for a 00-horsepower plant.

The ordinary plant does not use more than three pounds per horsepower per hour, so that the three tons Mr. Whitham talks about ought to be good for about two hours' running, without the extra two or three tons to help out.

In the second place, he says the day firemen leave the minute the night gang comes, or *vice versa*. Now, if he looks around a bit he will find that ordinarily the relief gang is on the job ten or fifteen minutes before time, ready to go to work when the other gang quits.

William F. O'Regan.

Brighton, Mass.

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I desire to take issue with J. M. Whitham on the waste of coal in changing shifts. I am at present handling a 1500-horsepower plant, consisting of six 250-horsepower water-tube boilers, five of which are in service, with one spare one, which gives me a rated capacity of 1250 horsepower, and I am carrying a full load.

We use the alternate method of firing and the fires are charged about every six to eight minutes with about three or four small scoops of coal to cover one-half the grate surface, or 24 square feet. Now three tons of coal would cover those five sets of grates about 9 inches deep, and five minutes later steam would be down 10 pounds, and at the end of one-half hour the engines would be stopped for lack of steam; so it is necessary to tend the fires right up to quitting time, and my firemen are washed up and ready to leave the plant promptly on time and the night turn is ready to take charge of the fires at once, as they are cleaned at this time because the load is lighter then and any man caught firing heavily at this or any other time would be promptly discharged.

I will admit the statement Mr. Whitham makes that "the men are tired out with their long hours of labor and prepare for a speedy departure," but they are not so tired but what they can care for some of the other men's fires while they are washing up, and the men who have washed can throw three or four fires without getting more than their hands dirty. There might be a tendency among some men to fire "about three tons of coal one-half hour before the relief comes," but this heavy charge of coal would immediately drop the steam pressure, and that fireman would hear from the engineer at once.

Further on Mr. Whitham says: "It takes the oncoming turn sometimes 25 minutes to exchange greetings and get ready for work," but here he is mistaken, because some of them are always ahead of time, and in any event can be ready to take care of the fires till all are ready to take their shares.

I should like to have him show me an average plant of 1000 horsepower that can be run 40 or 45 minutes with only one heavy firing, as he states. This method, if used, would no doubt waste some coal, but a great deal less than two or three tons per 24 hours. In practice this plan will not work because the fires will not go that long without attention and his experience and observations certainly must have been on a very poor grade of firemen and in plants that were run in a very slipshod manner, certainly not the average condition in a plant of 1000 horsepower.

The fireman is as honorable and as worthy of respect as the chief engineer or superintendent, and no other class of men are more imposed upon or receive less pay for the same amount of work as a rule, and while there may be exceptions, I will wager that there is not one plant in fifty of 1000 horsepower in which conditions such as stated by Mr. Whitham are practised.

J. C. Hawkins.

Elyria, O.

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I believe that if there are any readers of Power who work on 12-hour shifts, they will resent Mr. Whitham's imputations.

Most of us who have had practical experience know that the 12-hour shift is long enough, but when a prominent engineer suggests adding 50 minutes to it, I fear that the poor firemen will be somewhat discouraged.

Take a plant where the times for changing shifts are at 6 a.m. and 6 p.m. Beginning in the morning, the day gang would need to arrive at 5:35 a.m., and the night gang could not get away until 6:25 a.m., and *vice versa*.

Such a plan would in most cases work disastrously, because most self-respecting firemen would give up their jobs, and it would be necessary to find men who did not care whether they washed up or not. The grade of firemen would be so much lowered that there would be more coal wasted in other directions than in the manner described.

There isn't much doubt about there being serious loss when two or three tons of coal are thrown on the fires of a 1000-horsepower plant at one time, and unnecessarily.

With the 1000-horsepower plant fitted with hand-fired furnaces, two firemen will be required if the boilers are run at their rated capacity. In this case one fireman should start to wash up about an hour before changing time, after seeing that his fires are in good condition, and let the other man look after all the boilers.

Before the second man goes to wash up he should have all the fires in such condition that the man who has washed up will need to coal only once, and that needn't soil his clothes, and it isn't much of a job to wash his hands.

When the new gang comes in, they should, after ascertaining that the water level and steam pressure are correct, look at all the fires and fix them so they won't burn too low before they get into their working clothes. Moreover, they needn't spend the 25 minutes getting into their working clothes which Mr. Whitham allows them.

However, the outgoing gang should not be in too big a hurry to leave, when the new shift comes on, but should at least greet them pleasantly, and inform them of any changes that may have occurred during the day, such as new coal, change of load, etc. This will help make things go better all around.

In many cases it would be better if all the men didn't come and go at the same time, but this of course needs to be varied according to circumstances.

In conclusion, I will say that with 8-hour shifts, Mr. Whitham's plan would be just, but for 12-hour shifts it would not.

WALTER S. GRISCOM.

Buck Hill Falls, Penn.

Mr. Whitham is very right indeed, and we will find that bad custom in about all plants where only two shifts are employed. I know of such a plant in New Jersey, located about twenty-five minutes from the next town and no houses or flats could be had close to the plant at reasonable rents, so the firemen had to leave home at 5:15 a.m., in order to be ready for duty at 6 o'clock. As the engines ran with a heavy load during the noon hour, the firemen were busy, too. From 6 to 6:20 o'clock was spent in washing up and they got home at 7, fourteen hours from home. From 7 to 8 p.m. was spent at supper and in reading the daily news and then, too tired to read POWER or study some good book, they went to bed. A man who works this way day by day ought to sleep at least 8 hours. Can one blame them if they are tired with their long hours of labor and prepare for a speedy departure long before the relief appears? Mr. Whitham's remedy is to permit no fireman to wash up and change his clothes until his relief has got into firing togs and is in a position for duty and work. That is the best remedy for a plant with three shifts and I am sure every reliable and good "8-hour" fireman will obey this order. But, the best remedy for a plant with only two shifts is to hire a third shift.

Some time ago a fellow engineer told me of the change in the plant where he is employed. There they had the same old bad custom during shift changes. When the chief, a smart man, who remembered very well the time when he fired, took charge of this plant, he hired men for the third shift. This proved very satisfactory to the company and to the firemen. I hope Mr. Whitham will add my suggestion when sending a copy of his paper to clients.

W. G. WERBECK.

Saratoga, N. Y.

## Effect on Exciter of Cutting Resistance In and Out

I feel it my duty to correct a statement made by William Westerfield, in POWER for August 31, in an article entitled, "Some Simple Kinks," regarding an exciter which he has been "doctoring." He states that "to cut in resistance in the armature circuit of the exciter (which is the field circuit of the generator) will cause a greater load to be on the exciter." This is not true, because to cut in resistance in this circuit is to decrease the load on the exciter and to cut out resistance is to increase the load on the exciter. If the fundamental principles of electricity were kept in mind when thinking a thing of this sort out, one would not make an error of this kind and cause others who read for instruction to be misled. The principle which may be applied to the case of load on a generator (the exciter is a small generator of course) is this: The product of volts and amperes = load in watts. Let the voltage remain the same and introduce resistance into the circuit, thereby decreasing the amperes flowing and the product = less load in watts.

T. M. UTLEY.

Superior, Wis.

## "Some Erroneous Ideas"

In the September 14 issue H. C. Hartley says that the aggregate unbalanced pressure on the back of an engine valve is not dependent upon the size of the valve but upon the size of the ports under it. His explanation of this theory is excellent as far as it goes, when he says that no degree of steam pressure would press it upon its seat if there were no ports under it. This is true, for the reason that steam would probably leak under it and equalize the pressures. If, however, we take a slide valve with ports of any size leading to the atmosphere or a region of less pressure, the pressure will not be equal on the top and bottom of the valve and the latter will be forced against its seat with a solidity determined only by the steam pressure on top of it, not by the size of any hole or port which may happen to exist under it, once the steam has leaked from that space. The only effect of small ports would be the longer time required for the steam pressure to exhaust itself through them, and hence longer for the difference in pressures to evidence itself.

Mr. Hartley states that "piston rings are sometimes made with a lip or flange on one side under the mistaken idea that the steam on entering the cylinder will press the ring outward against the cylinder wall and aid in making a steam-tight piston." He says that the only re sult thus achieved is the increasing of th clearance by this amount, a disadvantag of course. It would seem that if M Hartley would accept the position of chie designing engineer for some large en gine-building concern these ideas woul pay for themselves a great many time over. For it is such small economies a this would be which in this age of kee competition make possible the supremac of one firm over another.

Had the designers of these engin with the recessed piston rings not prove the accuracy of the theory which, co trary to Mr. Hartley's opinion, does sho that the piston ring is spread again the cylinder wall, they surely would n have increased the expense of the m chine work in this way. Of course if t ring were simply dropped or suspend in a region of any pressure, it would n be affected in shape or size. If, ho ever, as in the case in question, the ste pressure is admitted to the under si while it is kept from exerting itself an opposite direction, with equal for the ring will tend to take a new sha which produces the result desired.

Difference in pressures is the soluti of both of these questions, but in t cylinder-head-bolt proposition, I agr with Mr. Hartley that no additio strain is brought upon the nuts bolts on account of the steam pr sure exerted against the head from t inside. I differ with him, however, t there are any thinking men who w argue to the contrary. The explanati is too simple to allow of a difference opinion to exist for long. If the b are drawn up to an initial strain of, s 1000 pounds, the admission of 100 pou of steam to the cylinder simply remo the corresponding amount of press from the ends of the cylinder walls the joint with the head. The two pr sures mentioned added together still eq the pressure on the nuts and there is further effect or change of pressure.

L. F. WILSON

Chicago, Ill.

Mr. Hartley states that, an errone idea held by a great number of engine is that the cylinder-head bolts are jected to a stress from steam press in the cylinder in addition to the st which results from setting up the n I believe that the great number of e neers who hold this idea are correct Mr. Hartley is in error. He also st that when the nuts on the cylinder-h bolts are properly set up an initial st or tension is set up in the bolts and additional stress will be brought on bolts by steam pressure until the press of the steam against the head exceeds pressure with which the head is against the cylinder by the bolts.

The men who design and build eng put in sufficient bolts and of a size hey are more than strong enough to ithstand the working steam pressure, nd many of us have seen cases where dose of water has blown a cylinder ead out; but instead of the bolts breaking, the cylinder casting let go a few nches from the end. This shows that ere is often an excess of strength in e bolts.

Suppose that the cylinder in question as a piston area of 10 square inches and he flywheel is blocked so that the engine nnot turn; and bear in mind that pres- re exerts itself with equal force per it of area in all directions, regardless f the shape or size of the vessel con- ining the pressure. In this case let us ssume 100 pounds pressure. The cyl- der head is bolted on so tightly that the tal stress in the bolts is 2000 pounds m setting up on the nuts. The area of e head subjected to steam pressure is square inches and this multiplied by o, the available steam pressure, gives force of 1000 pounds due to the pres- re of the steam against the cylinder d. The force of the steam against the ad is just half as great as the force at holds the head against the cylinder.

Mr. Hartley claims that this does not t any strain on the bolts. I claim it es. The force the bolts now have to thstand is 3000 pounds, 2000 due to tening the head and 1000 to the force the steam tending to push the head off.

uppose we do not set up on the nuts, this case, but just push the head up g against the cylinder, and screw all nuts up against the head without mak- them tight, there being no strain or ess on the bolts. Now turn on the am and although the joint leaks the pply of steam is sufficient to maintain full 100 pounds pressure, and we have rce of 1000 pounds tending to force head off, and the force is held by the s, or in other words, this force pro- es a stress of 1000 pounds in the bolts. stress in the bolts equals the force st the head and we only have a on the bolts equal to the force rted against them. If it were possible to follow up against this steam force by wing up the nuts without striking against the cylinder no additional strain could be put on the bolts except by raising the steam pressure, but the head is against a solid iron-cylinder wall and when we set up on the nuts we press the head against the cylinder, and since the is noncompressible, any tightening of the nuts only squeezes or tightens the head against the cylinder, and every ounce force with which the head is pressed on the cylinder increases the strain on the bolts. If we continue to force the head against the cylinder until it presses against it with a force of 2000 pounds we then have a strain of 3000 pounds on the bolts.

n a case such as Mr. Hartley cites, of the spring balances; if the spring were blocked at the 20-pound mark, the compressive force against the block would be 20 pounds, and the hook is outside of the block and any weight hung on the hook relieves the block of that amount of compressive force. Thus if 10 pounds is hung on the hook the spring is still subjected to a tension of 20 pounds, but 10 pounds is weight and 10 pounds is compressive force exerted against the block. Now suppose we apply this 10-pound weight to a coil of the spring between where the ends of the block are in contact, the strain on the spring is now 20 pounds just as before, because the spring yields to the force. In the case of the cylinder head this is not so because the bolts are of a size sufficient to hold the force without springing sufficiently to be relieved of the strain. The head is pressed against the cylinder with a force of 2000 pounds. A force of 1000 pounds is applied against the head from inside the cylinder, and presses the head against the nuts, and because the bolts and nuts are not springs this 1000 pounds is an additional strain on the bolts. This condition is true with Mr. Hartley's spring balance. Suppose a weight of 10 pounds is hung on the hook. The tension in the spring is thus equal to 10 pounds. Now press down on the weight with a force of 5 pounds. The total tension the spring is subject to now is 15 pounds. The spring here is in the same place as the bolt in the cylinder head. The weight represents the strain due to screwing up the nuts and the force on the weight is the same as the steam pressure against the cylinder head. Both the spring and the bolts in these two cases are loaded in exactly the same manner.

If the strain on the cylinder-head bolts is sufficient to cause any elongation of the bolts, sufficient to relieve the head of any of the force with which it is pressed against the cylinder, the strain on the bolts would be reduced whatever amount the compressive force is reduced by the stretch of the bolts; but as long as the bolts are strong enough to hold the cylinder head against the cylinder as tight as necessary, plus the force due to the pressure of the steam in the cylinder acting against the head, without being loaded up to or beyond their safe working stress, just so long does the strain on the bolts increase with every ounce of increase in the steam pressure, or by tightening up on the nuts, regardless of which force in itself is the greater.

If an engine's cylinder-head bolts require a force of 8000 pounds to break them off and the nuts are screwed up until the strain on the bolts is 7500 pounds, requiring only 500 pounds more force to break the bolts, according to Mr Hartley, the force in the cylinder acting against the head that would be necessary to supply this 500 pounds would be (7500 pounds plus 500 pounds) 8000 pounds, because he states that, *"no additional stress* will be brought on the bolts by steam pressure until the pressure of the steam against the head *exceeds the pressure with which the head is held against the cylinder by the bolts."* It is at once apparent that 500 pounds force exerted against the head from the steam pressure is sufficient to produce a force of 8000 pounds and break the bolts, and hence Mr. Hartley's statement is seen to be in error.

Therefore, I believe I have proved that in a steam engine the cylinder head bolts receive directly all the force due to the pressure of the steam exerted against the head, also all the force due to the tightening of the joint between the head and the end of the cylinder.

Harry W. Benton.

Cleveland, O.

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## Feed Water Treatment

A recent editorial on feed-water treatment ought to bring out something that will be of much value for those who have had little or no experience along that line. We are going to install an open feed-water heater in place of the closed-pressure heater we now have, and I intend to see what I can do in regard to getting most of the impurities out of the water.

I intend to use a small force pump to pump the reagents into the water just before it enters the heater, the pump to be driven by the boiler-feed pump and have it possible to adjust the length of the stroke to feed greater or less amounts of the reagents. We expect to have this installed inside of six weeks.

I have used compound for a number of years, but have failed to get the results desired; that is, when the compound was fed into the feed water just before going into the boiler.

Following is the analysis of our feed water:

| Scale-forming solids— | Grains. |
|---|---|
| Calcium carbonate | 6.122 |
| Calcium sulphate | 3.780 |
| Magnesium carbonate | 6.471 |
| Total scale-forming solids | 16.382 |
| Nonincrustating solids— | |
| Organic and volatile | 0.521 |
| Sodium chloride | 1.000 |
| Total nonincrustating solids | 1.521 |
| Total solids | 17.903 |
| Free carbonic acid | 2.123 |

George Dreyer.

Gibsonburg, O.

---

Edward T. Adams, of the Allis-Chalmers Company, speaking before the State engineers of Pennsylvania sometime ago, said that he had made some figures to see if 100,000 kilowatts in gas engines could be put into the same space as steam turbines of equal output, and found that it could if units of 5000 horsepower capacity were used for the gas-driven station. The saving came in the fact that the storage space for fuel was less, the producers required less space than the boilers, and the cleaning apparatus required very little more space than the auxiliaries for the turbines.

POWER
AND THE ENGINEER

DEVOTED TO THE GENERATION AND
TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.
355 Dearborn Street, Chicago.
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of POWER solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "POWPUB," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During* 1908 *we printed and circulated* 1,836,000 *copies of* POWER.

*Our circulation for September,* 1909, *was (weekly and monthly)* 141,000.

*October* 5.............. 42,000
*October* 12.............. 33,000
*October* 19.............. 30,000
*October* 26.............. 30,000

*This paper reaches* 42,000 *separate readers each month and* 30,000 *each week.*

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*

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## Vigilance

In the correspondence columns of this issue, W. E. Crane tells of a boy, who, finding the water in the gage glass lower than he expected, was not satisfied until he had run down the cause. The cause turned out to be nothing less than a crack in the longitudinal joint, which opened up to three feet in length when an inspector tapped it under pressure.

This was no large-salaried, highly specialized engineer, only the boy about the shop to whose other responsibilities the boiler had been added. Many a man who would have indignantly denied the boy any consideration as a fellow craftsman would have simply started the pump up a little faster and gone on with never a thought as to what had called for the extra water during the last interval, and without detecting the fracture which, allowed to go a few hours longer, would have meant destruction and death.

## Massachusetts Boiler Laws

On another page of this issue is given an outline of the principal changes made in the Massachusetts laws, governing the operation and construction of boilers used in that State, at the first public hearing held by the Board of Boiler Rules as provided by law. The changes that have been made would indicate that the Board of Boiler Rules is endeavoring to eliminate as far as possible superfluous matter, and broaden the interpretation of the rules so that they may include practically all the forms of safe boiler construction and methods of operation. The only radical change that has been made is the requirement that all boilers must be stamped and certified to at the shop where they were manufactured, by an inspector who is virtually a representative of the State of Massachusetts. While this requirement places the manufacturer who is located outside the State of Massachusetts in the hands of the insurance companies, the manufacturer gains the benefit of getting what is practically a clean bill of health for his boilers at the works, which largely eliminates any liability of future question of his product after reaching its destination. The evident desire, as indicated by the changes, to eliminate inconsequential fractions in the rules is very commendable. There is one change in the rules which was not made or suggested which would have been desirable; this would be to remove the restrictions regarding the use of different brands of steel as indicated by the stamps, and discriminate in the use of material solely on the quality as indicated by the chemical and physical tests which are required. It would appear that material of identically the same physical and chemical quality would be equally safe
whether branded "Firebox" or "Flang
steel. The desirability of uniform la
governing the construction of boilers h
been advocated in these columns p
viously, and it is to be hoped that t
study and thought being given to the s
ject by Massachusetts will ultimately
sult in a set of rules that can be adopt
by other States, when laws governi
boiler construction and operation
passed, as they will be, eventually, by
the States.

## Butt-Strapped Boiler Joints

We print on another page of this is
an arraignment of the butted a
strapped type of joint as usually appl
to boiler construction. We cannot ag
with Mr. Dean that this form of joint
undesirable, but, however, the question
largely one of opinion. It has been p
viously pointed out in these columns t
the cause of the formation of defe
commonly known as lap-joint cracks,
not been properly investigated and
method of formation usually ascribed
such defects is only surmise.

We have previously advanced the ar
ment that possibly the correct forming
the ends of the plate and the butt str
before riveting together is a very
portant factor in rendering even a b
strapped type of joint safe for long-c
tinued use, for it can be readily seen t
a joint of this type might be construc
so that it did not conform to the cur
ture of the shell, and this could cause
so-called breathing action under vary
pressure which is assumed to be the ca
of lap cracks.

The need for properly forming
strap members of butted joints is rec
nized by the Massachusetts Boiler Ru
which demand that the straps be rolled
formed to the proper curvature bef
riveting together; however, it is poss
of even more importance that the ends
the sheets be so formed, for it is comm
knowledge that when rolling the cou
of a boiler a straight section is left
each end of the plate where the j
comes, the length of this section b
approximately the distance between
centers of the bottom rolls. If no ot
method of correctly forming these e
is available, the boilermaker sledges t
to form as best he may and since the r
holes punched to form the seam offer l
of weakness, this sledging bends
sheets principally along the lines of r
holes and not to a uniform curve; co
quently, the plates or straps, or both,
sprung when riveted together.

The form of joint which Mr. Dean
poses to use does not necessarily obv
the defect pointed out above, and in
of the great reduction in efficiency e
neers will hardly follow his lead, u
the reliability of such a joint is act
demonstrated. The efficiency of a j

of the type Mr. Dean proposes to use, with the proper spacing of rivets to permit tight calking, would probably be [illegible] little above seventy eight per cent., while with the usual form of quadruple riveted joint and plates of average thickness, ninety three per cent. efficiency can be easily obtained.

We wish again to make a plea for the [illegible] investigation of the behavior and strength of riveted joints as used in boiler construction by the Government, as such tests, to be of real value, must be made on full-size shells with pressure, and not in a testing machine, the expense of which would doubtless be greater than could be assumed by anyone else, and on account of the national importance of safety in the construction of steam boilers it would seem that this is a legitimate field for Government investigation.

## Clinkered Tubes

In a paper to be presented to the American Society of Mechanical Engineers and published in the *Journal* of that society, F. W. Dean describes "An Experience with Leaky Vertical Fire Tube Boilers." These boilers, each with about 5000 square feet of heating surface and built to Mr. Dean's design, leaked badly about the lower tube ends. When Spring Hill coal was used, the lower ends of the tubes quickly became incrusted with clinker and were partly closed by it, and a little later the clinker would hang in stalactites from the tube ends. Not all of the ends would be closed, but this was the case with a large proportion of them. With New River coal there was less trouble. The incrustation was so hard that it had to be removed with chisels and consisted of molten earthy matter injected by the draft against the tubes and tube plates and then congealed by the comparatively low temperature of the metal. In the horizontal boiler it falls to the bottom of the setting before it arrives at the tubes. In water-tube boilers it can be seen adhering to the lower tubes. It occurs on locomotives which burn anthracite, and even on the locomotives of the Boston & Maine railroad which burn coke. Professor Denton says that clinker accumulated on the boiler tubes of a transatlantic steamship on which he was a passenger to such an extent that men were sent into the combustion chambers to remove it. He also refers to a Manning boiler on which this trouble occurred.

The trouble was overcome in the case of which Mr. Dean writes by lengthening the fireboxes and raising the boilers so that the distance from the grate to the tube plates is now 12 feet 2¾ inches. There is still some incrustation, but it is light, brittle and easily crushed and can be blown off by a rotating multiple tube blower in the smokebox.

Clinker attaching itself to the furnace lining is one of the common circumstances of power-plant operation. The [illegible] work at the boiler is not [illegible]. We [illegible] from our readers on this line.

## The Advantage of a Formula over a Rule

Every engineer knows the rule for finding the area of a circle:

Multiply the square of the diameter by 0.7854.

This rule may as well be written:

Area = 0.7854 × diameter × diameter.

or even,

$$A = 0.7854 \times d \times d.$$

A little figure placed over a quantity indicates how many times it is to be taken as a multiplier. Thus,

$d \times d = d^2$ read *d-square*;

$d \times d \times d = d^3$ read *d-cube*;

$d \times d \times d \times d \times d = d^5$ read *d to the 5th power*.

If this is understood the formula can be written:

$$A = 0.7854 \times d^2,$$

and the multiplication sign can even be left out, making it,

$$A = 0.7854\ d^2.$$

This last is a great deal shorter and simpler than the rule, and many arithmetical operations can be indicated simply and positively in this way, whereas to detail them in words requires a lengthy explanation, if the operation is to be unmistakably described, and frequently an attempt to do so results in a possibility of misunderstanding through an effort to be too concise.

But this is not the only nor the principal advantage. The expression as it stands above is called "an equation." The quantity or quantities to the left of the equality sign are equal to those to the right. If two equal quantities be multiplied or divided by the same quantity the results will still be equal.

Suppose we divide both sides of the above equation by 0.7854. Division is indicated by writing the divisor below the quantity to be divided, so we have

$$\frac{A}{0.7854} = \frac{0.7854\ d^2}{0.7854}$$

The 0.7854s in the right hand member of the equation cancel each other and the equation becomes

$$\frac{A}{0.7854} = d^2,$$

showing that if we have the area and want to find the diameter we can get its square by dividing the area by 0.7854. The square root of this square of the diameter is the diameter itself, and if you cannot extract a square root you can look it up in a table. Anyone who can do long division can learn to find square roots in an hour, and it is worth an hour of any engineer's time to learn it, for [illegible] enter into many engineering problems.

If we take the square root of the quantities on each side of the equal mark the equality will still be retained, so we can say

$$\sqrt{\frac{A}{0.7854}} = d.$$

[illegible] square root of $d$ [illegible] the radical sign $\sqrt{\ }$ [illegible] square root is to be taken.

There are other ways of indicating roots. $d^{\frac{3}{2}}$, for example, would signify that the square root of the 3d power or cube of $d$ was required. It means that the square root of the 3d power or cube is wanted. This last may be written $d^{1.5}$, for $\frac{3}{2} = 1.5$.

The first power of a quantity is the quantity itself. $d^1$ is the same as $d$. then $d^{\frac{1}{2}} = d^{0.5}$ (for $\frac{1}{2} = 0.5$) means that the square root of $d$ is wanted. The square root of $d$ then may be indicated in any of the following ways

$$\sqrt{d}, \text{ or } d^{\frac{1}{2}}, \text{ or } d^{0.5},$$

and the square root of $A \div 0.7854$ may be written

$$\sqrt{\frac{A}{0.7854}}, \text{ or } \left(\frac{A}{0.7854}\right)^{\frac{1}{2}}, \text{ or } \left(\frac{A}{0.7854}\right)^{0.5}.$$

The square root of a fraction is the square root of its numerator divided by the square root of its denominator, so that this quantity can also be written:

$$\frac{\sqrt{A}}{\sqrt{0.7854}}, \text{ or } \frac{A^{\frac{1}{2}}}{0.7854^{\frac{1}{2}}}, \text{ or } \frac{A^{0.5}}{0.7854^{0.5}}.$$

The square root of 0.7854 is 0.8862 (nearly). This can be substituted for $\sqrt{0.7854}$ and make the formula:

$$d = \frac{\sqrt{A}}{0.8862}, \text{ or } \frac{A^{\frac{1}{2}}}{0.8862}, \text{ or } \frac{A^{0.5}}{0.8862}.$$

The "reciprocal" of a number is 1 divided by that number. The reciprocal of 4, for instance, is 0.25; the reciprocal of 0.8862 is

$$1 \div 0.8862 = 1.1284.$$

You get the same result by *multiplying* by the reciprocal of a number as you do by *dividing* by the number itself: $60 \div 4 = 15$ and $60 \times 0.25 = 15$, also.

The formula for the diameter can then be written:

$$d = 1.1284 \sqrt{A}$$

$$d = 1.1284\ A^{\frac{1}{2}}$$

$$d = 1.1284\ A^{0.5}$$

Knowing these few things you are able to twist the well known rule for the area of a circle around so as to get two or three rules for finding the diameter, which will give a certain area, and to understand a lot of curious-looking formulas which are, after all, nothing but symbolic arithmetic signifying that very common and easy arithmetical operations are to be performed with the quantities for which the letters stand.

# Power Plant Machinery and Appliances

## Original Descriptions of Power Devices
## No Manufacturers' Cuts or Write-ups Used

## MUST BE NEW OR INTERESTING

### The Harris-Anderson Purifier

The apparatus is for the purpose of absolutely removing oil, both free and in emulsion, from the boiler feed water of condensing engines. It is manufactured by the Harris Patent Feed Water Filter, Limited, 82 Victoria street, Westminster, S. W., London, England.

Owing to the necessity of preventing oil in exhaust steam from getting into steam boilers, engineers have hesitated to employ such water from surface or jet condensers for boiler-feed use, having found by experience that the oil invariably contained in such water produces disastrous results upon the boilers. As a consequence the water is allowed to run to waste and pure water, which costs money, used in its stead, thus causing a loss from heat thrown away with the condensed water, and the additional cost of fresh water to take its place.

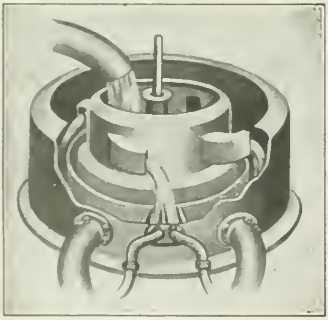


FIG. 1. THE DISTRIBUTOR

The Harris-Anderson purifier, which, it is claimed, completely removes all oil from condensed water, is illustrated and described herewith. The complete purifier includes the apparatus which is designed for automatically supplying the reagents in definite quantities, and always in proportion to the flow of water, however it may vary. Also a mixing device for the water and reagent, a treatment vessel in which the reaction takes place, a primary filter for the removal of the bulk of the precipitate, and secondary filters for completing the clarification.

The principle of the method employed is always supplying to the feed water a definite fraction of its volume of solution for definite strength; for instance, if 5000 gallons of water per hour were passing, 25 gallons per hour of reagents would be supplied. Where double the amount of water is passing, double the amount of reagents of the same strength is furnished, and so on. To do this the cold water is first passed through an apparatus in which it is divided, two small fractions being parted off which bear the same relation to the total flow of water, whatever variations there may be in such total flow. These small fractions are the led to two solution making apparatus which are charged with the reagents i the solid form, and in any quantity, and in which the fractions of water are automatically converted into solution of an desired strength. This makes the suppl of reagents automatic, and the amount o substance added is always in exact pr portion to the amount of water passin It is claimed that the only attention required is at stated times, when the receptacles are to be charged with th solid reagents, but that the machine i self performs the duty of weighing the out.

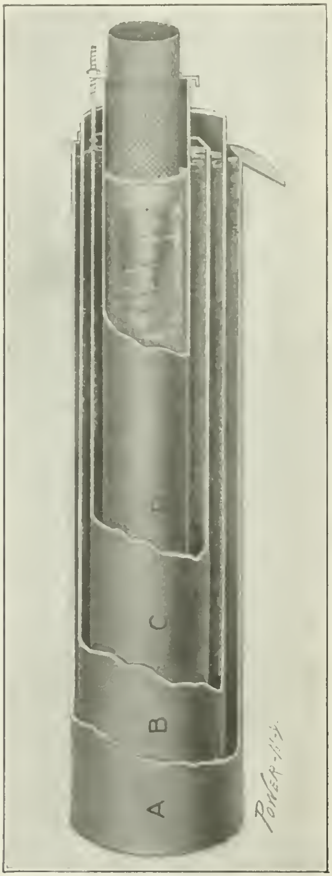


FIG. 2. THE SOLUTIONER

In Fig. 1 is shown the distributor; consists essentially of a turbine, int which the water to be treated is led. A it rotates, the nozzles discharge into a outside tank, in which the turbine float

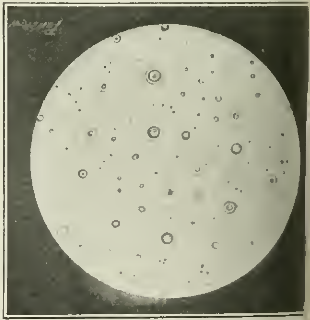


FIG. 3. SAMPLE OF CONDENSED WATER

In effect, the whole of the water is d tributed uniformly over the trough, whi in order to divide up the total water the desired proportion, is divided by dial partition so as to form compartments in the same proportions, provid with separate delivery pipes.

In order to remove the emulsified c four compartments are usually made the distributor, two of which receive ea ½ per cent. of the total flow, a two larger ones 49½ per cent. each.

The next step is that of making t two fractions of ½ per cent. each ir solutions of the reagent of defin strength. This is attained in what called the "solutioner." The apparat consists of an outer cylindrical casing open at the top and closed at the b tom. In this are suspended three other cylinders, *B*, *C* and *D*, opening both above and below. The cylinders *B* and *D* are fixed in position, and *C* is adjustable vertically by means of a screw.

A lip, or scallop, is cut out at one part of the edge of cylinders *A* and *B*, and that on cylinder *A* discharges into a spout to guide the solution to the desired point

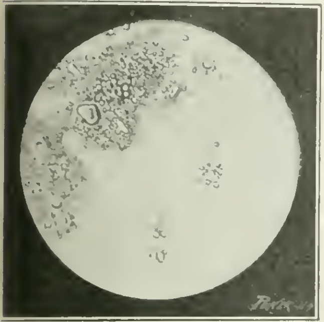


FIG. 4. THE SAME WATER SHOWING ACTION OF REAGENT

The lip on cylinder *C* is set at a slightly higher level than the lip on cylinder *A*, this difference of level determining the strength of the solution.

The water to be made into solution is fed by a pipe into the space between cylinders *B* and *D*, where the substance to be dissolved in any quantity is placed in a wire-gauze cage in cylinder *D*, from where it drips down into the water. Water passes down the space between *C* and *D* and, meeting the strong solution descending from the cage at the bottom of the apparatus, is carried with it into the outer space between *A* and *B* and over the lip to the spout. This outer space then contains a column of solution, which is balanced by the column of water in the space between *C* and *D*. This column of water must be longer than the column of solution, so that as the solution increases in strength the level of the water in the space between *C* and *D* rises. When the overflowing solution attains a certain strength water overflows the lip on cylinder *C*, passes down between the space between *D* and *C*, mixes with the solution at the bottom of the outlet space, and prevents it from getting any stronger. The amount of water flowing over this lip automatically adjusts itself to keep the solution at the constant strength.

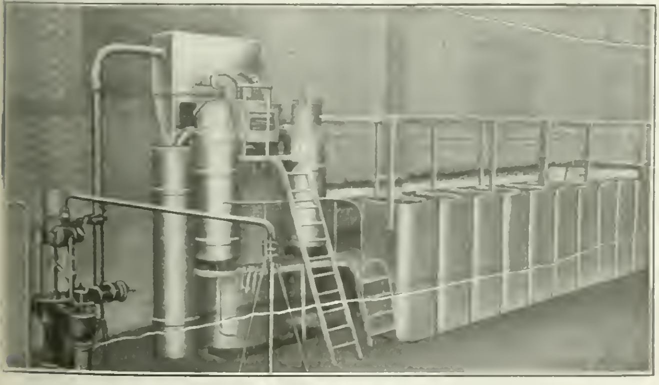


FIG. 5. A 22,000-GALLON PER HOUR PURIFIER INSTALLATION

The apparatus is said to deliver the solution at any desired strength by adjusting the movable cylinder *C*. Raising this increases and lowering it diminishes the strength. It would seem that the strength of the solution thus made is independent of the amount of water passing through the apparatus, and of the amount of solid reagent present, and wholly depends upon the setting of the movable cylinder *C*.

Next comes the apparatus for mixing the water with the reagents. The mixing tube consists usually of two tubes, one inside the other, so that the water can pass down the center and up the space between them. Usually three such pairs of tubes are supplied, each half of the water is thoroughly mixed with one of the reagent solutions in one such pair; they are then mixed together in the third pair of two. This insures that the two reagents shall uniformly act upon one another throughout the whole mass.

The treatment vessel may be made of any shape, but is always provided with partitions to direct the flow of water, and prevent it from taking a short cut from the inlet direct to the outlet. In this vessel the two reagents act upon one another and on the oil, and before leaving this vessel the separation of the precipitate is complete and the water ready for filtration.

The primary and secondary filters are precisely similar, and consist each of one or more units of suitable dimension and shape, which are packed in a special manner with wood wool. The water from the treatment vessel first enters the primary filter from below, and then passes upward through the mass of the medium. In general it is more clarified by this first filtration, but to make perfectly sure and to provide against the passage of any of the precipitates from the primary filter when cleaning is being carried on, the water is conveyed to the secondary filter and again passed upward through the medium precisely as in the first filter. Thus, after the water has passed through the process of filtration, it is said to be free from oil and fit to be at once conveyed to the feed tank for use.

To show just what this purification method means, when an air pump discharges water, whether from a jet or surface condenser, it will be observed that the water is more or less of a milky color. If such water is filtered through some close fabric, such as felt or filter paper, this appearance will be little, if at all, affected. This is due to the fact that innumerable tiny globules of water are suspended throughout the mass of the water, which globules pass without difficulty through the pores of any filtering material that can be practically employed; therefore the water is not purified from the emulsified oil contained in it. The globules contained in the water, though quite invisible to the eye, are readily distinguished under the microscope. Fig. 3 gives a representation of the appearance of such water under a high-power magnifying glass, and represents a perfectly fresh sample of condensed water drawn under the microscope, magnified about 1100 diameters. In Fig. 4 is shown the same sample after the addition of the reagents used in the device described herewith, which shows complete artificial aggregation, the precipitate in which the globules are embedded being transparent and not visible under the microscope; the magnification being, as before, 1100 diameters.

As the actual quantity of oil present in this freely divided condition varies greatly according to the type of engine in use and the nature of load, a very common amount found in the water will be from 4 to 5 grains per gallon, or about 10 to 12 ounces per 1000 gallons. This makes it perfectly clear why so much trouble is experienced with boilers which are fed with water which is not thoroughly cleansed from oil.

A purifier having a capacity of 22,000 gallons per hour is shown in Fig. 5.

## Device for Lining Up an Engine

This device is for use in lining up engines, and is the invention of Joseph O. Gibbins, Box 120, R. F. D. No. 1, Fruitvale, Cal.

At *B*, Fig. 1, is shown an end elevation of the [illegible] the [illegible] be- [illegible] section on the line [illegible] in the [illegible] and [illegible] are [illegible] of the mov- able [illegible] centering de- vice and showing the [illegible] from [illegible] longitudinal sections on an enlarged scale of the glass plates employed in the centering devices. Fig. 2 is a longitudinal section through an engine and a top view showing the apparatus in position ready for use.

In this device are two centering devices identical in form save as regards the apertured glass plate employed at the center. In Fig. 1 is illustrated one of the two centering devices, in which there is a casing, made of two oppositely disposed plates *H* and *J* which supports the movable arms *K*, *L* and *M* and the gear wheel *N* used for moving the arms radially in respect to the casing by engaging with the inner surfaces of the plates, the gear wheel being rotated by a nut to which a wrench may be fitted. When the gear wheel is rotated, all of the bars are brought toward to their limiting position by rotating the gear wheel in the reverse direction, all of the bars may be moved outwardly.

In the outer end of the nut *O* of one of them is provided a glass plate which has an aperture slightly greater than the diameter of the cord used. The nut of the other centering device is provided with a glass plate with an aperture of the same size as the cord to be employed. The glass plates are held concentric with the opening through the gear wheels. The apertures in the plates are materially smaller than the apertures through the gear wheels, so that the alining cord contacts solely with the glass. In connection with the centering device is an adjustable tripod for holding the opposite end of the cord, Fig. 2.

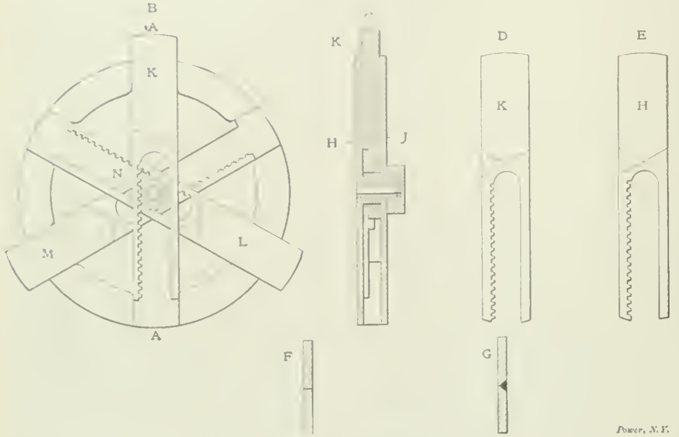


FIG. 1. PARTS OF GIBBENS LINING DEVICE

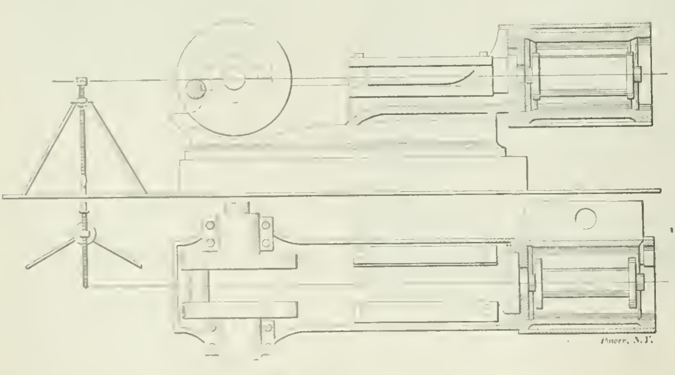


FIG. 2. [illegible] DEVICE IN POSITION

To operate, the piston and one cylinder head are removed, and the two centering devices inserted within the cylinder, one at each end. The centering gear on each is then rotated to extend the arms until they engage with the inner surface of the cylinder wall and hold the centering devices in position.

The centering device and the glass plate holding the cord are placed at the end of the cylinder farthest from the crank shaf and the cord extended through the glass plate in the other centering head. The opposite end of the cord holding the weight is suspended over the end of the rod shown, and by the vertical and horizontal adjustment of the rods the cord brought to such a position that it extend through the aperture of the glass plate at the crank end of the cylinder without touching the sides. The crank shaft i then adjusted in such position that th cord crosses the wristpin half way between the ends of the latter, and across the center of the crank shaft. With th crank shaft supported in this position th bearings may be rebabbitted or otherwis adjusted properly to support the shaft.

By providing the centering devices wit transparent plates, it is possible for person adjusting the tripod or support, t glance along the line and through th glass plate to ascertain more readily th direction in which the end of the rod mu be adjusted to bring the cord out of con tact with the sides of the aperture.

## The Adams Feed Water Regulato

In this regulator the flow of water governed by a single valve which actuated by a float and lever, and op erated by the fall and rise of the wat in the boiler. The body is tapped at and Y for the regulation water-gage cock water gage and glass, and contains th float, lever, fulcrum, and high- and low water alarms. It is made of cast iron an tested at 300 pounds hydrostatic pressur In the top of the float chamber is whistle *O*, for sounding the high- an low-water alarms, the whistle being o erated by the float *A* coming in conta with the lever *H*, attached to the whist valve *I*.

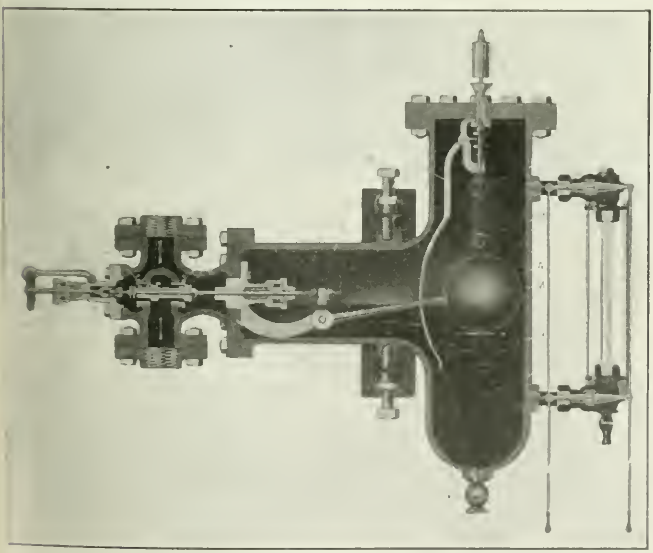
The float *A* has a plate attached to i under side to prevent it from jumpin under the action of the pumps. The val housing is of heavy cast iron attached the main casing by a flanged connectio The balanced valve *B*, which controls t supply, is made of bronze metal, as a also the bushings or seats *C*, which a screwed into the valve housing.

A threaded stem *D*, through the ba anced valve *B*, is attached to t lever in the main casing by the adjusti nut *E*, the lever being operated by t raising or lowering of the float *A*, as t water level in the boiler changes.

This opens and closes the balanc valve *B*, and the float, being in open co tact with the water in the boiler, is sensitive to a change in the water le e opens wide and closes tight with less than an inch of change in the water line of the boiler, thus insuring a constant flow of water to the boiler depending upon the amount of evaporation taking place, instead of admitting it in large quantities for a short period and then remaining closed until the level has fallen sufficiently to open the valve wide again as most regulators do.

The stem *D*, passing through the balanced valve *B* to the lever, also extends through the valve housing to the outside. To the stem *D* is attached a wheel or handle *F*, with which to change the position of the float *A*, by shortening or lengthening the distance between the balanced valve and the lever to which the float is attached, by shifting the position of the adjusting nut *E*, thus changing the hight of the water line in the boiler.

The valve stem *D* is attached to the hub on the wheel *F* by a slotted groove and pin connection. This permits free play of the balanced valve when operated through the float connection, yet permits the valve to be opened and closed from the outside if the lock lever *G* is raised, by pushing in the handle *F*, so that the end of the slot or groove comes in contact with pin *P* in the valve stem proper. The regulator is attached to the boiler

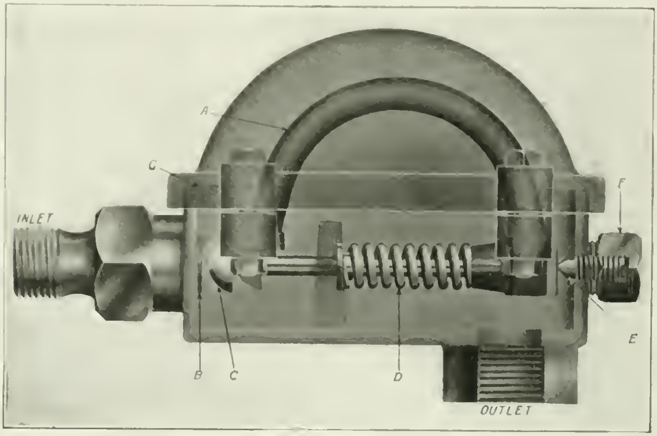


ADAMS FEEDWATER REGULATOR

ll by the bracket *J* and the hight is justed by the adjusting screws *K* m and water connections to the boil- are made through the tappings *L*.

This regulator is made by the Adams rnham Company, 417 Sixth street, th, Minneapolis, Minn.

# Haines Automatic Vacuum Controller



HAINES AUTOMATIC VACUUM CONTROLLER

When the exhaust steam from an engine is used for heating purposes a back pressure is exerted on the piston at each stroke, of from 1½ pounds upward, depending upon the system in use. The more friction in the heating pipe, the greater the back pressure will be on the engine and consequent loss in mean effectiveness. If a vacuum is created on the heating system, the steam will flow through the heating pipe into the vacuum, thus relieving the back pressure on the engine and making the engine more efficient, while the same result as to heating is obtained in the system. In order to obtain successful and economical operations of a vacuum system each coil or radiator should be equipped with some device by means of which the supply is automatically cut off as soon as the radiator is filled, opening again as water of condensation collects and drawing in fresh steam as required, without waste. Such a device is believed to have been found in the Haines automatic vacuum controller, the valve of which is controlled by a tube spring strong enough to overcome any ordinary resistance and practically instantaneous in its action. The construction permits the use of a valve of large capacity, which insures rapid circulation and reduces the opportunity for clogging to a minimum.

The construction of the Haines controller will be understood by reference to the accompanying interior view. There is but one movable part, which consists of a crescent-shaped spring-tempered steel tube *A*, which contains a fluid and is hermetically sealed, a change in temperature of one degree making the tube open or close the valve, the amount of condensation governing the distance the tube moves the valve from the seat. The valve seat *B* is constructed with a tapered drawn piece driven into the case of the trap. The valve head *C* is of bronze, screwed on a brass stem and attached so that the movement of the tube will operate it. The brass-spiral spring *D* has nothing to do with the working of the controller, beyond keeping the ends of the tube against the adjusting screw *E* which acts as a pivot. A cap *F* covers the adjusting screw *E* as shown. Between the lid and case is a gasket *G*, to make a tight joint.

It is claimed for the device that there [illegible] in the steam [illegible] in the [illegible] because the back pressure on the [illegible] is reduced to practically zero, and that no air or water remains [illegible] in the radiator, hence more heating surface is available. There are no air valves to [illegible], and each radiator can be easily regulated and adjusted to changing weather conditions. This vacuum control is manufactured by the Wil[illegible] S. Haines Company, 136 and 138 South Fourth street, Philadelphia, Penn.

## Society Notes

Charles Buxton Gowing, Managing Editor of the *Engineering Magazine* delivered a lecture, entitled "Industrial Engineering, Its Province, Limitations and Ideals," before the student section of the American Society of Mechanical Engineers in the chapel of the Brooklyn, N. Y., Polytechnic Institute on Saturday evening, October 16. The lecturer dwelt largely upon the ethical phases of the subject and treated it in a highly interesting way. At the close a lively discussion took place, after which the members and guests adjourned to the president's room, where an appetizing lunch was served.

The meeting rooms of Stevenson Association, No. 44, N. A. S. E., on Broadway, New York, were filled with members and friends on Saturday evening, October 16. The occasion was the welcoming home of one of its most active and earnest member, J. Douglas Taylor, who had been elected, at the convention recently held in Columbus, Ohio, to the office of secretary-treasurer of the Life and Accident Department, connected with the organization. Mr. Taylor was presented a very handsome floral design, in the shape of a horseshoe, the center of which was occupied by a portrait of himself. Interesting and appropriate speeches were made by National President William J. Reynolds and Past National President Herbert E. Stone. The "Bunch" entertained enjoyably. Refreshments were served at intervals.

Hoboken Association, No. 5, N. A. S. E., of Hoboken, N. J., tendered a reception to National President William J. Reynolds, on Wednesday evening, October 13. Mr. Reynolds is an old and highly esteemed member of No. 5. The occasion was largely attended, delegations being present from all of the nearby associations. After a short business session, an adjournment was made to the dining hall, where about one hundred and fifty found places at the tables. When the coffee was reached, A. B. Snook, the chairman, introduced Herbert Stone, who made an interesting address, and proved an excellent toastmaster. All of the speakers expressed the conviction that Mr. Reynolds's term of office would be most successful. Those who made addresses were: Joseph F. Carney, William Crowley, R. O. Smith, J. Douglas Taylor, William T. Wheeler, James F. Coe, John J. Reddy, L. D. Everson, John J. Callahan and Judge McGovern.

The Dearborn Drug and Chemical Works furnished a band of music, which enlivened the evening. Before the company departed, Mr. Reynolds thanked his many friends in a feeling manner.

## Business Items

The New York office of the American Goetze Gasket and Packing Company has removed to New Brunswick, N. J., where they will build a factory for the manufacture of their gaskets and metallic packings.

The Bigelow Company, New Haven, Conn., reports recent boiler sales as follows: Nashawena Mills Corporation, New Bedford, Mass., 6800 horsepower of Manning boilers; Whitman Mills, New Bedford, Mass., 900 horsepower of Manning boilers; Arlington Mills, Lawrence, Mass., 4000 horsepower of Manning boilers, the boilers comprising this order being of 500 horsepower capacity each, an exceptional capacity for a boiler of this type; Erwin Cotton Mills, West Durham, N. C., 1600 horsepower of Manning boilers; Aetna Construction Company, New Haven, Conn., for the new plant of the Shore Line Electric Railway Company, at Saybrook, Conn., 1875 horsepower of the Bigelow-Hornsby water-tube boiler; the Connecticut Company, for its new plant to be erected at Waterbury, Conn., 2000 horsepower of the Bigelow-Hornsby water-tube boiler (second order).

## Help Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

AN ENGINEER to operate a 200-horsepower gas plant near New York. Box 53, POWER.

WANTED—Good mechanical designers and detail draftsmen for machinery manufacturer located in Wisconsin. Box 98, POWER.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

AGENTS WANTED to sell Burgmann celebrated engine packings in territories not yet covered. See our advertisement on page 85.

WANTED—Man to invest $1500 in electric-light plant and take management; town of 2000; Middle West; new plant. Box 58, POWER.

WANTED—First-class draftsman as assistant in drafting department; must be thoroughly familiar with engine and boiler work. Address P. O. Box 512, Erie, Penn.

WANTED—Night engineer to take charge of boilers, engines, ice machines, pumps, etc., with proper assistance; give reference, salary wanted and notice required. Box 55, POWER.

WANTED—First-class draftsman and estimator for high-class steam power and heating work. Address, giving full particulars, references and salary wanted, Box 826, Charlotte, N. C.

WANTED—Young man as steam engine salesman; only replies giving full details of past experience, training and remuneration will receive consideration; all replies confidential. Box 43, POWER.

CHIEF ENGINEER WANTED—For water power and steam plant located in the country within two hours of Washington, D. C., capable man with executive ability wanted; only first-class men need apply, stating in full, experience and salary; seven-room house near power house can be had, or board can be obtained nearby. D. M. S. Box 52, POWER.

## Situations Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

MILLWRIGHT, twenty years' experience, wants position. Box 60, POWER.

ENGINEER: young man, 26, three years' experience with boilers, engines and dynamos would like position as night engineer in smal plant; Iowa or North preferred; have own tools and do my own repairing. Address Box 56, POWER.

PRACTICAL ENGINEER, age 26, all-roun mechanic, desires permanent position wit good firm anywhere that needs a man for results: steam, electric, hydraulic or ice machinery; New York license and best references. Box 57, POWER.

CHIEF ENGINEER wants position; licensed in Massachusetts; experienced in electricity, refrigeration and large compound condensing engines; graduate of State steam engineering school; age 29 years; married, a present employed. Box 59, POWER.

## Miscellaneous

*Advertisements under this head are i serted for 25 cents per line. About six word make a line.*

PATENTS secured. C. L. Parker, Solicit of Patents, 4 McGill Bldg., Washington, D. (

ANY FIRM or engineer in charge of steam plant that is troubled with scale in th boilers can get absolutely free, the best ind cator and reducing wheel made, with velve lined mahogany case. For particulars, ad dress Great Lakes Chemical Works, Manit woc, Wis.

AUTOMOBILE auxiliaries pay large pr fits; we have something every owner shou have; liberal commission; any serious-mind energetic man who would look after our i terests can add considerable to his income. H draulic Oil Storage Company, 602 Penobsc Bldg., Detroit, Michigan.

## For Sale

*Advertisements under this head are i serted for 25 cents per line. About six wor make a line.*

FOR SALE—$60.00 for International C respondence School electric lighting and ra way course; one-half finished. Box 54, Pow

FOR SALE—20x48 Wheelock engine a two 72"x18' high pressure tubular boilers good condition cheap. Address "Enginee Box 2, Station A, Cincinnati, Ohio.

FOR SALE—500-horsepower tandem co pound Fleming single valve, automatic; a two small engines, cheap for cash. Sc Manufacturing Co., 1801 Third National Ba Bldg., St. Louis, Mo.

FOR SALE—250-horsepower Lane & B ley Corliss engine, 18x42 cylinder; engine small for our work and will be replaced so with one of greater power. Wm. A. Coon Milling Co., Coldwater, Mich.

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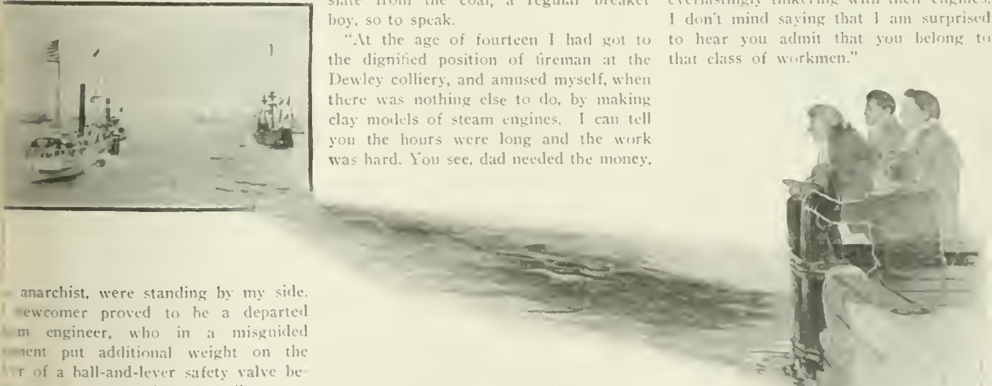
# upernatural Visitation of James Watt

## Watt, Fulton, Stephenson and a Departed Engineer View the Hudson-Fulton Naval Parade, Listen to Stephenson and Awake the Author

### BY WARREN O. ROGERS

he visits of James Watt continued ring the early fall; Fulton's also be e more numerous, and as the date e Hudson-Fulton celebration drew r his visits became almost nightly, his rmost thoughts being of the great cement that had been made in steam ation since his day, 100 years before. n the day of the so-called naval e from New York to Albany, I de- l to view the sights from a dock on ver front, and as I stood, I felt the nce of those from the other world turning, found that my friends of revious visit, with the exception of anarchist, were standing by my side. ewcomer proved to be a departed m engineer, who in a misguided nent put additional weight on the r of a ball-and-lever safety valve be- g to a second-hand boiler over nty-five years of age. The boiler ex- ed, he said, although it had always a mystery to him as to what was the cause, and seeing that additional in- ation would be of no value to him, arthly usefulness being past, I re- l from enlightening him.



HE SAT DOWN ON THE WHARF AND WATCHED THE CHANGING PANORAMA ON THE RIVER

turally, the conversation was mostly ried on by Fulton, seeing the day was g celebrated in his honor, and while stened to his reminiscences and hed the changing panorama on the r, I felt that I could forgive him, to onsiderable extent, as he turned to phenson and said:

It will be a cold day, 'Steve,' when ple make such a fuss over your in- ntion—the locomotive. Why, discover- g the North Pole cannot be compared th it; no use talking, I've got you aming."

As there was plenty of room on the wharf, we sat down, and after Fulton tired of talking, at the suggestion of Watt, Stephenson told us something of his early struggles and achievements.

"I was born a 'bloomin' Englishman,'" he began, while we all puffed our cigars in an after-dinner manner; "and Wylam, near Newcastle, was the town. The event occurred June 9, 1781, and there isn't any high-class blue blood flowing in my veins (and the spirits all grinned), seeing my father fired a colliery boiler. We were mighty poor, and when I got big enough I got a job driving a horse at the colliery gin, and later on was put picking slate from the coal, a regular breaker boy, so to speak.

"At the age of fourteen I had got to the dignified position of fireman at the Dewley colliery, and amused myself, when there was nothing else to do, by making clay models of steam engines. I can tell you the hours were long and the work was hard. You see, dad needed the money, and in order not to get discharged I used to hide when the owner came around, for fear he would say I was too small to work.

"I did a lot of thinking those days and made up my mind that the thing for a fellow to do was to get some kind of an education, and so I began to study and dig out a little here and a little there, until at the age of eighteen I could read and write, thanks to the night schools. When I was at my first job—firing—I got one shilling a day, and our family of eight was living in a one-room shack."

"Talk about multimillionaires and the lower east side of New York," observed Watt, with a grin; "why, you had a patent on both."

"It was no joke then," replied Stephenson, as he bit off the chewed end of his cigar and spat it in the river. "However, if I had had everything I desired I should have never made the effort to get on that I did. In those days automatic machinery was unknown, and my work, at the age of seventeen, was to regulate the pump to suit the varying conditions of steam and water. It was while on this job that I learned how to take my engine and pump apart and put them together again."

"A regular monkey-wrench fiend," observed Fulton with a sneer. "I am told that there are engineers today who are everlastingly tinkering with their engines. I don't mind saying that I am surprised to hear you admit that you belong to that class of workmen."

"That is all right," replied Stephenson, "you are having your day now. Tomorrow someone will lick Johnson or swim across the English channel, and you will be forgotten, but at the same time thousands of miles of railroad will be in operation and almost countless cars and engines running over them."

"Never mind, 'Steve,'" said Watt, in a soothing tone, as he saw that Stephenson was getting nettled; "go on with your story."

"Well, at the age of twenty I was made a brakeman and, having a night job, I studied and mended shoes of the other workmen. Two years later I was made a full-fledged engineer, and then I got married."

"I don't see how you could afford to do

[illegible] never mind."

"Well, I said, young Stephenson, seeing I was getting $500 a year. Things went on about the same for four years, when the mine flooded. A little later I with [illegible] made a contract to work the engines of what was known as the Killingworth pit, and owing to the fact that I got an old Newcomen engine, that wouldn't do its work, into order and made it get down to business, I was appointed chief engineer of the colliery."

"Let's see, you got into a controversy about something about that time, if I recollect correctly, with a fellow named Humphrey Davy, didn't you?" questioned the engineer.

"You bet," replied Stephenson. "It was about a mine safety lamp and we jawed several years over the thing. I got a present of $5000 and an address out of it. I don't know what became of either.

"I supposed I was one of the first successfully to use a traveling engine, seeing I had one operating in 1814 for the purpose of hauling tramcars between the colliery and the shipping point, nine miles distant. As the thing was a success, I turned my attention to improving my first locomotive, and got out a patent in 1815 for the improved machine."

"I tell you, fellows," exclaimed Watt with enthusiasm, "they can't get ahead of us old fellows no way you look at it."

"I should say not," chimed in Fulton. "Why, I read the other day in a New York newspaper that the chief officers of the great Cunard steamships only get $100 per month, or a little more than twice what Stephenson got as an engineer in his day. Why, my men on the old 'Clermont' got almost as much."

"In 1819," continued Stephenson, "I built another tram road, for another mine, and used five locomotives, each capable of hauling sixty-four tons at a rate of four miles an hour. But it was in 1825 that my first railroad was put into operation, which carried passengers and freight. The first train was made up of six cars of coal and flour, a passenger car for the directors and 21 cars for the passengers. We made a speed of six miles an hour."

"A regular Twentieth Century Limited," joked Fulton, his eyes lingering on the outline of the "Clermont" as it glided past our viewing point.

"Well, we made a great income from the passenger traffic, which is something the railroads don't do now—so they say. Be as it may, this was the turning point in railroad construction, and I was made engineer of a line running between Manchester and Liverpool."

"I wonder if he juggled the railroad stock for personal profit," whispered the engineer to Fulton, who was busy watching the great naval parade.

"I struck a snag at that time, for in my judgment it was safe to run a train at a rate of 12 miles an hour with a locomotive, but a lot of the old fossils wanted to stick to the old methods of having a fixed engine distributed along the line and draw the cars by means of a cable. In the end I won out, and the directors offered a competition prize for $2500, the conditions being that a mean speed of ten miles an hour was to be made, with a steam pressure not to exceed fifty pounds per square inch. The trial took place October 1, 1829. We had a h——"

"Be careful, 'Steve,'" exclaimed Watt, "remember there are ladies present."

"As I was saying," went on Stephenson, as if no interruption had occurred, "we had a hard time building that railroad. It was twenty-nine miles long, of which there were miles of bog, miles of tunnel and a two-mile cut, eighty feet deep in places, cut out of solid rock. Not only that, but we had to build sixty-three bridges and a viaduct seventy feet high. So you see we had just as difficult conditions to overcome in those days in railroading as they do today, and we did not have the facilities for doing the work."

"Well, how did the speed competition pan out?" inquired Fulton, removing his gaze from the "Clermont" long enough to strike a match.

"Just as I expected. My locomotive, the 'Rocket,' won out, of course. In fact, it was the only engine ready for the trial and twelve miles in fifty-three minutes was made, which is as good as the Erie railroad does now.

"From that time on until I was sixty years of age I was identified with railroading, when I gradually withdrew and passed the work over to my son Robert.

"I passed in my checks August 12, 1848, at the age of 67 years, but I have had a lot of satisfaction in seeing the advancement that has been made in locomotive practice since I first got into the game.

"Fulton sits here and watches a replica of his first steamboat steaming up the Hudson river, while I have but to look across the banks at the great New York Central to see the great development of my locomotive. This celebration should have some bearing on my achievement, as well as upon his, seeing it was but five years later, or ninety-five years ago, that I built my first engine. I have an idea that the Twentieth Century Limited will hold her own against anything that has developed from Fulton's efforts in steamboating."

As Stephenson said this he arose and tossing his half-burnt cigar into the water, where it went out with a splutter, walked away, followed by his ghostly companions.

I remained where I sat, thinking of all I had experienced in these visitations from the spirit world. As I allowed my mind to dwell on the strangeness of it all a chill seemed to creep up my spine. A thousand ghostly devils danced around me, who took delight in jabbing me with red-hot spears and pointed pitchforks, while one larger than the rest grabbed m
by the throat with a grip that tighten
tighter and tighter, until my brea
failed me, while his companions, with fi
spurting from their mouths, eyes a
nostrils, kept up their jabs with red-h
instruments.

Consciousness was fast leaving me, a
making one final effort to free mys
from my tormentors I seized my capto
cold, bony hand, and with the streng
of a despairing, dying man tore the co
clammy, clinging hands from my thro
There was a ripping, tearing sound, t
air was filled with cries of departi
demons, which echoed and reëchoed in t
stillness of the night. When I fully ca
to myself I found that the bed cloth
had been torn to shreds, my wife w
looking at me with wide-eyed astonis
ment and the moon was looking on t
glistening frost on the window pane. T
choking sensation I had experienced w
due to the bed sheet becoming twist
around my throat. The tortures of t
ghostly devils, with their spears, the
feet of the frost and disarranged b
clothes, and my experiences with Jam
Watt and his companions were nothi
but a dream.

## The Mercury Rectifier

By Norman G. Meade

When first introduced the mercu
rectifier was used principally for charg
electric-automobile storage batteries wh
alternating current only was availa
It is now used for many other operatio
such as charging storage batteries for
uses, including ignition batteries for
ternal-combustion engines; operating
lamps, searchlights and similar apparat
supplying small direct-current moto
railway and signal systems, etc.; elect
plating, and in fact almost innumera
kinds of service.

The mercury rectifier consists essenti
ly of a glass bulb, in which the merc
vapor is established and which conta
several electrodes; an autotransformer
regulating the voltage of the alternati
current, and suitable switching devic
The regulation of the voltage at the
ternating-current side of the rectifier d
away with the use of resistance in t
direct-current side; hence the high e
ciency.

The autotransformer shown diagra
matically in Fig. 1 consists of one or m
coils of insulated copper wire, dependi
on the number of phases of the sup
current, wound upon laminated iron cor
the terminals are connected to the alt
nating-current supply circuit. A numb
of taps are taken out from the coil a
are led to a multipoint switch, *C* and
The line wires are connected to cop
plates *A* and *B*. The taps are connect

to the metal contact buttons 1, 2, 3, 4. When the switch is in the position shown, the blades C and D are in contact with the buttons 1 and 1 and the rectifier receives the full line voltage. When the switch is turned to contact with the buttons 3 and 4 the rectifier receives the minimum voltage owing to the drop in potential in the autotransformer winding. Intermediate

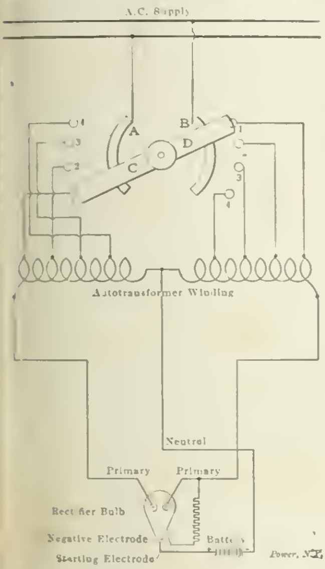


FIG. 1 WIRING DIAGRAM OF AUTOTRANSFORMER

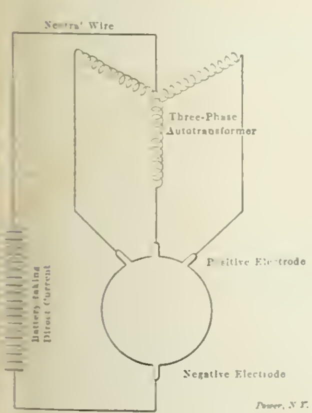


FIG. 2. THREE-PHASE RECTIFIER

ons give voltages proportional to their istances from the central point of the inding.

All types of mercury rectifier have one gative electrode connected through the ceiving apparatus to the neutral point f the supply system, and in addition ereto as many positive electrodes as there are main leads to the supply circuit. The active circuit is from the negative electrode continuously to first one and then the other of the electrodes, according to which, at each instant, is at a higher potential toward the negative electrode. Thus the conducting path is automatically shifted from one of the positive electrodes to the other with the reversal in direction of the electromotive force.

In a three-phase rectifier, a diagram of which is shown in Fig. 2, there are three main or positive electrodes, and it is evident that once the apparatus is started it will operate continuously because at no instant can there fail to be an electromotive force in the right direction upon at least one of the main electrodes. The converter is usually started by means of an auxiliary electrode between which and the negative electrode there is formed a mercury-vapor path when the glass bulb is properly tilted, either by hand or automatically by means of an electromagnet.

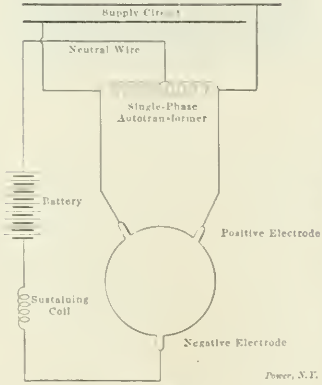


FIG. 3. SINGLE-PHASE MERCURY RECTIFIER

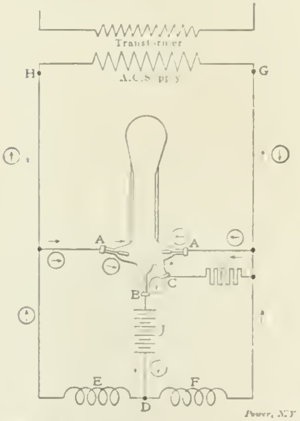


FIG. 4. SINGLE-PHASE GENERAL ELECTRIC RECTIFIER

In the single-phase mercury rectifier, a diagram of which is given in Fig. 3, there are two main electrodes connected to the two supply leads and one "negative" electrode connected through a storage battery to the neutral point of the autotransformer. In order to prevent the current from being interrupted at the end of the half cycle before the current from the opposite positive could be established, a reactance (frequently referred to as the sustaining coil) is connected in the negative lead, or at any point in the delivery circuit, the result of which is to delay the decreasing current from one main electrode until the increasing current in the other is sufficient to maintain the flow through the mercury vapor.

Rectifiers are designed primarily to operate on 60-cycle current, but they can also be designed to operate on any commercial frequency between 25 cycles and 133 cycles. The average power factor of a rectifier operated under proper conditions is approximately 90 per cent.

A striking characteristic of the mercury rectifier of either polyphase or single-phase type is found in the fact that the power lost in the converter itself is directly proportional to the current and not to the square of the current; the reason for this is that the converter maintains a constant voltage drop of about 15 volts across its terminals, regardless of the current. The efficiency would remain constant at all loads if it were not for the heat losses in the autotransformer,

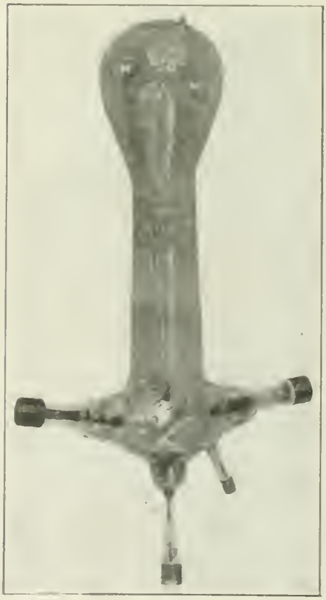


FIG. 5. A 30-AMPERE GENERAL ELECTRIC MERCURY RECTIFIER TUBE

the sustaining coil, the regulator and other incidental apparatus. The voltage regulation is excellent at all loads. Since the voltage drop is constant, it is evident that the higher the operating voltage the higher will be the efficiency of the apparatus.

A complete mercury rectifier outfit for charging storage batteries has an efficiency of about 80 per cent. when the battery electromotive force is about 115 volts. It is worthy of note that, when a rectifier is used for supplying energy to storage batteries it is impossible for the batteries to discharge back through the converter, because the positive electrodes cannot become negative, on account of the presence of the initial negative electrode resistance. When the alternating voltage decreases below a certain value or fails entirely, the rectifier ceases to operate, but if an automatic tilting device is used it starts again automatically when the voltage returns to its normal value.

Fig. 4 illustrates the General Electric Company's form of single-phase rectifier. There are two graphite main electrodes *A*, *A*, one negative mercury electrode *B*, and a starting electrode *C*. The main electrodes are connected to the alternating-current supply circuit through a transformer and also through reactances *E* and *F* to one side of the load. The negative electrode is connected directly to the other side of the load. As the current alternates, first one and then the other main electrode becomes positive, and there is a pulsating flow of current toward the negative electrode and thence through the load and back to the opposite side of the supply through one of the reactances. At each reversal the reactances discharge, thus maintaining the arc until the voltage reaches the value required to maintain the current against the counter-electromotive force of the load, and also reducing the fluctuations in the direct current. This arrangement produces a practically continuous current with very small loss in transformation. Fig. 5 shows a rectifier bulb of this type.

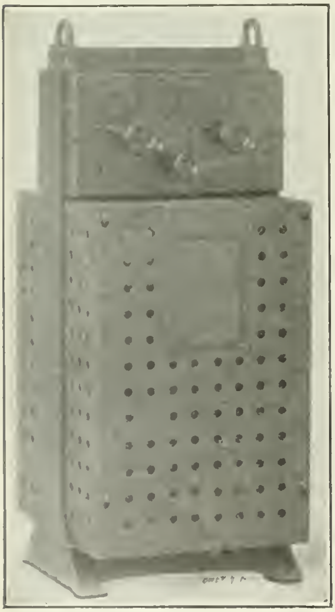


FIG. 6. WESTINGHOUSE "TYPE A" MERCURY RECTIFIER

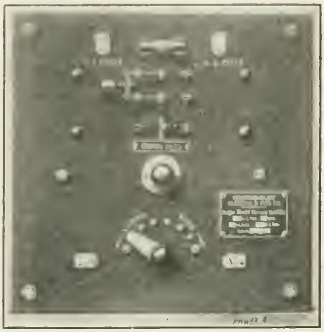


FIG. 8. WESTINGHOUSE "TYPE E" MERCURY RECTIFIER

The Westinghous Electric and Manufacturing Company has put out several types of mercury rectifier auxiliary apparatus for various conditions of service. Two of these are illustrated in Figs. 6 to 9. The Westinghouse "Type A" mercury rectifier is shown in Fig. 6 and Fig. 7 is the diagram of connections. The leads marked *A* and *C* in Fig. 7 are connected to a 60-cycle alternating-current circuit through a double-pole switch and fuses. The leads marked *D*— and *C*+ are connected to the load, taking account of the proper polarity.

The dials are set as indicated by a table of adjustments sent out with the apparatus; the left-hand regulator gives "coarse" adjustments and the right-hand one gives finer gradations. After the load is connected, the alternating-current main switch is closed. To start the rectifier, the small knob between the dials is turned to the right to unlatch the starting circuit. If left in circuit the rectifier will continue to charge the battery with gradually decreasing current until the proper voltage is reached, when the bulb will "drop out." If operation is interrupted before completion of the charge, the bulb will be restarted by the relay controlling the starting device. In operating the rectifier the primary switch should not be kept closed while the direct-current load is not connected up.

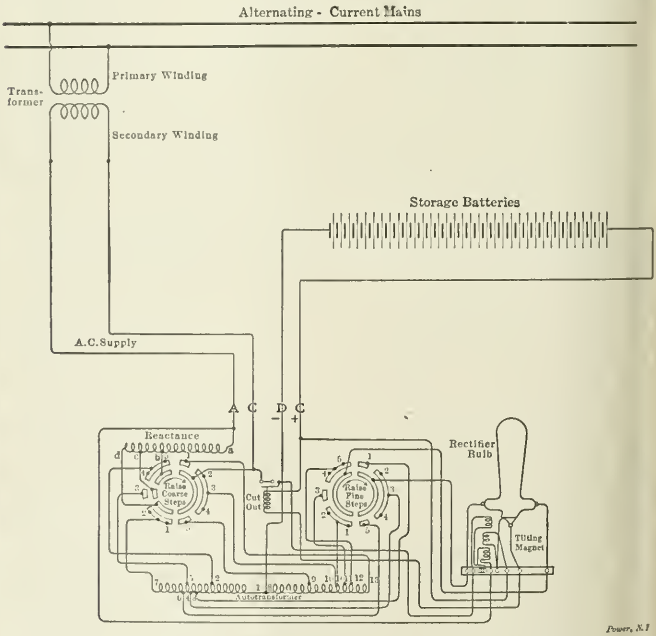
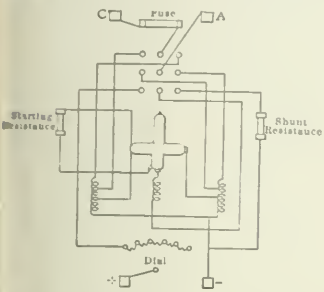


FIG. 7. DIAGRAM OF WESTINGHOUSE "TYPE A" RECTIFIER CONNECTIONS

Fig. 8 shows a Westinghouse "Type E" rectifier control board and Fig. 9 is th diagram of connections for this type. Th clips marked *A* and *C* are connected directly to the alternating-current suppl circuit and the clips marked + and −

are connected to the corresponding terminals of the battery. The double pole double throw switch at the top of the panel, when thrown to the left, gives a low voltage, and in the right-hand position a higher voltage.

To start the rectifier the spring starting switch is held over to the left after the



Power, N.Y.

FIG. 9. REAR VIEW OF "TYPE E" CONNECTIONS

switch and dial are adjusted to the proper positions for the number of cells in circuit, and the tilting knob is turned to the right as far as it will go and then released. After the bulb starts, the starting switch is released. To stop the operation of the rectifier the double-pole switch at the top of the panel is opened.

## An Engineers' Daily Report

By R. O. Richards

Fig. 1 shows a daily report blank for a certain mill. Glance over it and see the amount of really useful knowledge it will tell one about his plant, when properly filled out. "Nothing unusual," you say, when a plant is equipped with apparatus that will show these results." But this engineer did not have the manufactured articles—he had neither scales to weigh the coal and ashes, nor meter to measure the water evaporated; but he had the will, and he soon found the way. Believing that his methods will be of interest, a short description of his scales, meter, draft gage, etc., follows: For the sake of simplicity, let us follow in his steps. Taking them as they appear on the report, the first "difficulty" to be confronted was the temperature of the feed water. This, probably, suggests drilling the feed pipe and placing the thermometer in oil or quicksilver. An easier way is to tie the thermometer to the feed pipe so that the bowl touches the bare iron or brass, and then plaster it with asbestos, as shown in Fig. 2. One thermometer on the feed pipe near to where it enters the boiler and another on the pump side of the heater will give the initial and final temperatures of the feed water. The latter should be taken every time the boiler is fired, and the result noted on a slate hung within easy reach. Two minutes' calculation at the end of the run will give the average for the day, which is noted down on the report. By allowing 0.9 per cent., or roughly 1 per cent., for each 10 degrees the water is heated, the net saving by the feed-water heater may be determined, and the loss by running the pump in slip-shod fashion may be noted.

Next in order is the weighing of the coal and ashes. Everyone concedes the importance of weighing the coal, but it is noteworthy how few weigh the ashes. Much has been written on buying coal on the B.t.u. basis, but correctly to determine this, needs an expert, while every engineer can determine its value on the ash basis, and here in the East at least, poor coal and lots of ashes almost always go together.

Mills.

ENGINEER'S DAILY REPORT Date . .

APPARATUS IN OPERATION

| | Hrs. | Total | | Hrs. | Total | | Hrs. | Total |
|---|---|---|---|---|---|---|---|---|
| Eng. No. 1 | to | | Boiler No. 1 | to | | Feed Pump | to | . |
| " " 2 | " | | " 2 | | | Injector | " | ..... |

TEMPERATURE

Feed Water Temp. Initial Final Av Diff .

COAL AND ASHES

Total used Wet or Dry For heating Ashes . ...
L. Steam on off Tot. hrs Per ct ashes.. .

METER READINGS

Gas Start Fin Diff Evaporation per lb. coal ...... ..
Elect. " " " Draft
Water Gal. Lb A.M in. P M . .....in.

GENERAL CONDITIONS.

Safety valves tested? Gage cocks tested? Blowoff valves tight? .......
Repairs to boilers .......
.......
Repairs to engines .......
.......
Automatic stop in good condition? Sprinklers in good condition? .....
Watchman's clock in good condition? Shut off at on at ....
Water tower full? Free from ice? Which rooms? . .
Remarks
Electric lights went on at off at
Overwork started at stopped at No. of men
Worked on
. ..
Stock received. . .
Stock used ..

FIG. 1. . ............. Engineer.

Fig. 3 shows the scales as made by the engineer. The 2-inch pipe X is filled with water. Then a diaphragm is placed between the pipe flanges at A and B. The wheelbarrow platform rests on one of these and the lever and weights on the other. The weights balance the platform and the empty wheelbarrow, and should be placed at such a distance for the fulcrum that the finger C will stand at zero. It will be noticed that there are two balance levers, D and E. The latter is pivoted at F and connects at the other end with the light spring G, which in this case was taken from an old butcher's spring scales. A fine, well stretched and dampproof line connects the dial pointer C to the spring hook H. This, to be correct, must rise and fall in a straight line. A box lies alongside the scales, into or out of which the fireman throws or extracts enough coal to set the finger C at the coal mark. In a like manner, though probably not quite so correctly, the ashes are weighed. The weight of the water to wet them is extracted from the result. To keep the scales steady while wheeling on or off it, four small eccentrics L are placed under the platform, and connected to lever K in such a manner that when K stands upright all weight is taken off diaphragm A.

Application should now be made for a water meter. If it is tabooed, and you are still anxious to go ahead, then proceed to make one similar to that shown in Fig. 4. At A is an old angle check valve (any globe valve can be turned into a check that will answer the purpose), to the rod or [illegible] is attached the small rod which in turn connects with the elongated stem of a small radiator air valve [illegible] A B is another small air valve, attached to the former by pins driven through the handwheel disks. A piece of flexible rubber tubing E connects tank F with the air valve. If now the water level in this tank (which floats in the water supposed to be in the barrel) is at G, then it is apparent that every time the disk of the check valve A lifts, some water will flow out of air valve D. The amount will depend on the lift of the check valve disk, which is controlled by a spring placed on top of it, see Fig. 4B. Thus the amount of water escaping from tank F through air valve D is in direct proportion to the amount of water passing under the disk of the check valve A.

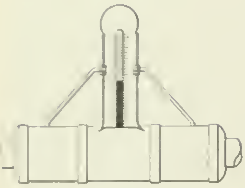


FIG. 2

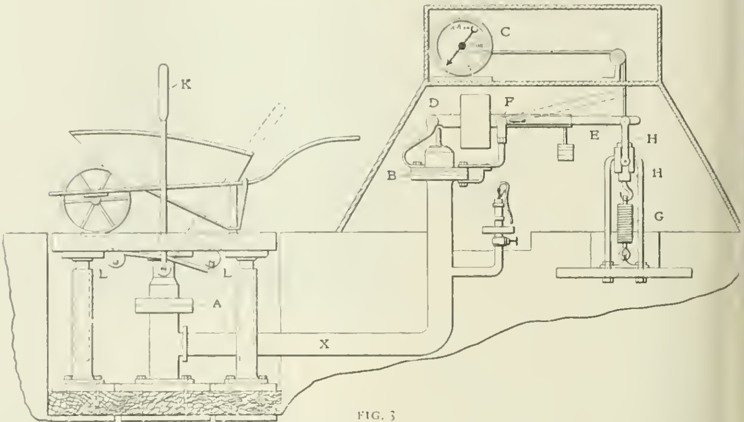


FIG. 3

It is, however, necessary that the weight of water in tank F above the air valve be kept fairly constant. To accomplish this the weights H are introduced and will support a certain column of water above the water line in the barrel. Thus as the water lowers in tank F the weights will raise the tank and keep the water level above the valve D fairly constant throughout the day's run. It is now possible either to measure the water delivered by the air valve, and by computing so much to the 100 gallons, find the total number of gallons delivered to the boilers, or the dial and scales shown in the illustration can be easily made. The illustrations in Figs. 4 and 4C show the method so clearly that little need be said concerning it. The number of gallo per revolution of the pointer on the lar dial depends on the diameter of the dru K. The cord should be dampproof a well stretched and the bearings should l well lubricated.

In the case referred to, the water tank F lowered ¾ inch to each 500 gall s of water delivered to the boilers, so y making the circumference of the drum K 1½ inches, the pointer revolved on its axis once for every 1000 gallons. To it

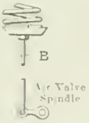


FIG. 4 B

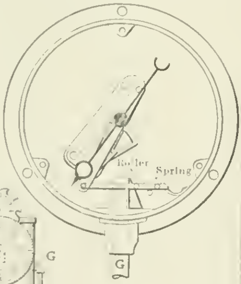


FIG. 5A

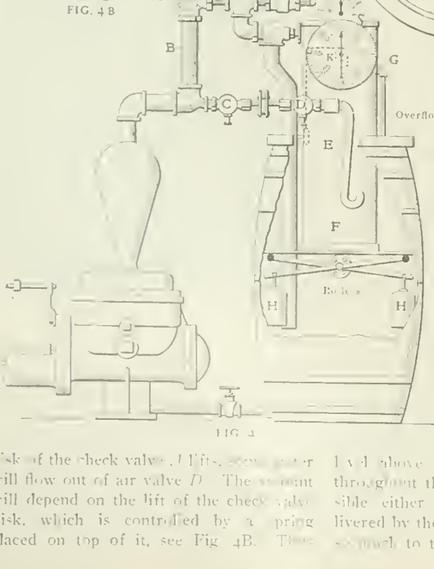


FIG. 4

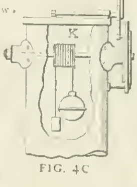


FIG. 4C

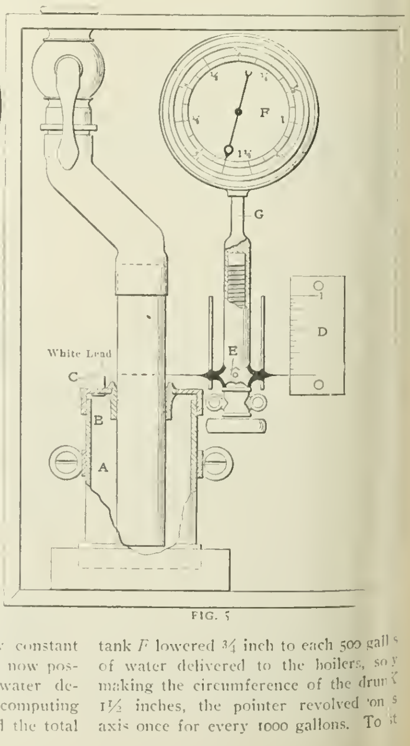


FIG. 5

e meter and graduate the tank, two marked barrels were used, and after borrowing the relief valve from one of the engines that happened to be idle and adjusting its spring so that the pressure against the pump would be equal to that of the boiler, it was so piped that it could discharge to either barrel. Also both barrels were connected to the pump suction, thus using the same water over and over. If it is found that the water discharges too fast from tank F, then the stem of the valve should be drilled and tapped, and a plug added that will choke the outlet to suit the size of the tank.

From data previously obtained it is possible to find the evaporation per pound of coal. No engineer's record is complete without taking into account the intensity of the draft, and the method employed at this plant is shown in Fig. 5. A piece of 1¼-inch brass pipe capped top and bottom was used. The top cap was drilled for a ¾-inch hole, and then partly filled with babbitt B, which in turn is accurately drilled tightly to accommodate and support the ½-inch glass as shown. A little white lead poured around the glass in the countersink will make it tight. The glass should be clean and clear and should be within ½ inch of the bottom cap. A small overflow pipe C has been provided, which serves as a ready means of quickly filling A to a uniform hight. The scale D is about 1 inch or so long, and fastened at such a hight that the finger E will just cover when the water is level with the overflow C. At F is an old recording gage the inside tube of which has been removed. The micrometer [illegible] is attached to the mechanism as shown in Fig. 5. Over the dial is glued a piece of white paper and on this is marked the intensity of the draft in inches. [illegible] the finger E 1/32 inch at a time and noting the position of the gage pointer, it is easy to mark the paper to read the draft intensity very closely. The gage pointer will travel a considerable distance for each 1/32-inch rise of [illegible]. To operate, connect the glass by means of a rubber tube to the flue or [illegible], then raise the pointer E level with the water as shown in the glass. The gage finger will now point the exact intensity of the draft in inches of water, if the dial has been correctly marked. In marking the dial it is understood, of course, that the reading is twice the amount that finger E is raised, i.e., if E is raised ½ inch, as shown by the scale D, 1 inch should be marked on the dial.

The rest of the report shows what the engineer added when he woke up to the usefulness of the engineer's record.

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There is all the difference in the world between an attempt to study by mere reading and a real study through the actual doing of work.—PROF. JOHN PERRY.

## Some Points About Drips

By George W. Martin

Taking care of the innumerable drips from separators, cylinders, steam jackets or receivers is one of those details in the construction of a steam-power plant that is not always given the attention it deserves, and it requires no little experience to determine the best manner of arranging the piping to give satisfactory results.

Fig. 1 shows a high-pressure trap arranged for discharging the water from a separator in the steam line of a cross-compound engine, and also from the receiver coils between the high- and the low-pressure cylinders. The discharge from the trap is ordinarily to a Cochrane feed-water heater, but a "free blow" to a sump is also provided in case it should be desired at any time to clear the lines dripped without discharging to the heater. Blowing out is done through the bypass, the latter, as will be seen, also providing for the cutting out of the traps for repairs. All the high-pressure traps in the plant were connected in this way.

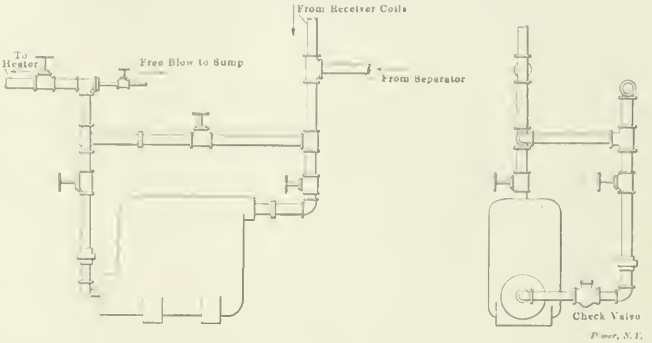


FIG. 1

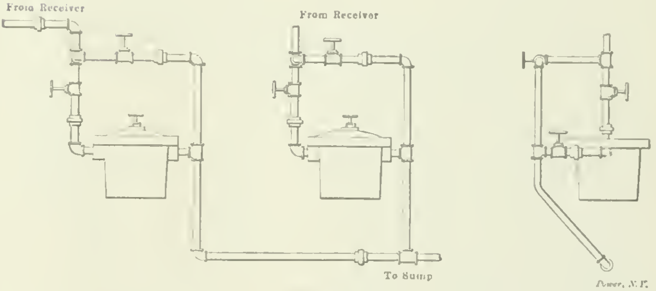


FIG. 2

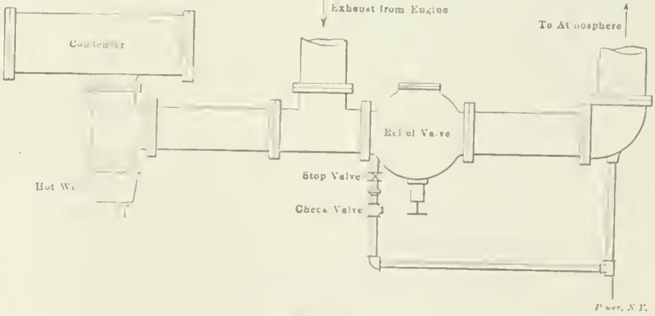
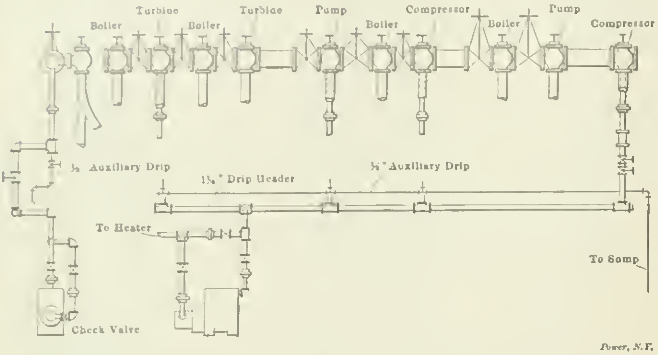


FIG. 3

A number of these traps were placed in service and the discharge of each was connected to a header which at first it was intended to connect to the bottom of a riser in a hotwell pump discharge to the heater. A little thought, however, showed that even though a separate dis-parate line to the heater would provide a head of water to be discharged against, connection to a low pressure discharging from another source would perhaps not result in the best action by the traps, so the separate trap discharge header was extended to the heater, a distinct improvement in design.

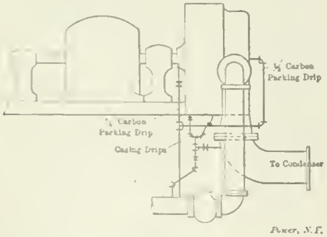


*Power, N.Y.*

FIG. 4

Fig. 2 shows two low-pressure traps connected to the receivers of two cross-compound engines. The discharge in this case is into a sump, as the pressure in the receiver—10 to 15 pounds—would not be sufficient to discharge the water into the hotwell-pump discharge or the high-pressure-trap discharge lines already mentioned. These traps are also provided with bypasses for disconnecting the traps for repairs or for blowing out the receivers when warming up the engines. As the traps have no head of water to discharge against, no check valves are necessary in the discharge lines.

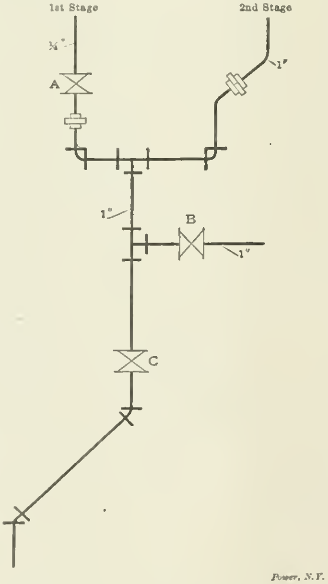
Fig. 3 shows the arrangment for taking care of the drip from both sides of an atmospheric relief valve in an exhaust line when the engine is running noncondensing. When running condensing, of course, any water in the horizontal run is drawn into the hotwell, but when exhausting into the atmosphere, the water could not pass the relief valve and out to the elbow drip, until it had risen about half way in the pipe, owing to the construction of the relief valve. Hence the relief valve is tapped on the condensing side, the stop valve closing the drip when running condensing and the check valve acting as a safety device to preserve the vacuum in case the stop valve should not be closed. The check valve is placed so that the pressure of air from the outside will close it. The elbow drip has no valve, as all that side of the exhaust line is always open to the atmosphere.



*Power, N.Y.*

FIG. 5

Fig. 4 shows a drip system for a 10-inch steam header. The latter may be sectionalized so that a very flexible arrangement of units and boilers may be obtained. At certain points, as indicated in the illustration, the header is tapped and connected to a 1¼-inch drip header which discharges through a trap into open heater. When any section of t header is cut out, the drip connection that section must also be closed, to pr vent water from the drip header backi up into it. This would leave the dead se tion without any means of drawing off t condensation from the steam remainin if the ½-inch auxiliary drip was not pr vided. This draws off the condensati to the sump, and remains shut when t header is again in use, the 1¼-inch d thus being opened.



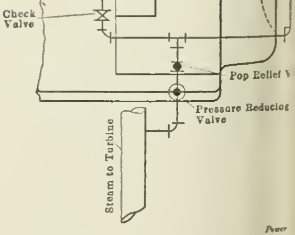
*Power, N.Y.*

FIG. 6

The system of drips from the m recent type of horizontal Curtis turb also affords an interesting example of t care necessary in this matter of det. Fig. 5 shows the general arrangement the drips from the casing of the turb and also from the carbon packing at steam and exhaust ends. Fig. 6 shows arrangement of casing drips more in tail. The ¼-inch drip from the f stage connects with the 1-inch drip fr the second stage, both discharging into line connected to the atmospheric haust. A side connection with the va *B* is taken off and tapped into the haust to the condenser.

Under normal operation—condensin the ¼-inch valve *A* is "cracked," valv is open and valve *C* closed to allow condensation from the first and sec stages to discharge into the conden When running noncondensing, howe *A* and *B* are closed and *C* is opened, condensation then being drawn from second stage and discharging into atmospheric exhaust.

The ¾-inch pipe from the carbon pa ing at the steam end joins with the



*Power*

FIG. 7

inch line from the exhaust end and l s to the atmosphere or to any place e from back pressure. The ½-inch pip s open at all times, but the ¾-inch lir s open only when running noncondens g. The reason for this will be apparent w n the arrangement for sealing the carbon packing is understood. This is shown in Fig. 7. A tap is taken from the steam line to the turbine, and a pressure-reducing valve and a pop relief valve are provided to keep the steam pressure on the carbon packing at about 12 pounds. When running noncondensing the carbon packing at the steam end is sealed by the steam pressure in the first stage, and as this pressure is more than 12 pounds the check valve prevents the excess pressure from backing up on the packing at the exhaust end. When running noncondensing any drip from the carbon packing at the steam end would be forced out by the excess pressure, but when running condensing the drip would be drawn into the turbine, hence the ¾ inch valve is open only when running noncondensing.

## A Suggestion for Flywheel Design

By H. S. Brown

With the present high speeds in the engine field great care should be taken in [illegible] and finishing the flywheel, both in the foundry and machine shop. In the foundry, unless proper methods are adopted, there is great danger of setting up tremendous internal stresses in the wheel from shrinkage while cooling. There have been cases in which the arms have been so overtaxed by shrinkage strains that some of them have broken. In other cases they have held together until being clamped on the boring mill for finishing in the machine shop, where they would break, and the fracture would open an eighth of an inch, and often more. It is safe to say that such strains have been the cause of flywheel accidents while overspeeding, but not to the point when a wheel without strains would have let go.

To guard against accidents from high-run speeds, there must be some other material than cast iron in the rim of the wheel. In Fig. 1 are shown side and plan views of a built-up wheel, limited to the diameter that may be shipped in one piece, say 10 feet. The wheel consists of a cast-iron base or body, strengthened by boiler plate on the outside. It would not be a difficult matter to rivet up a steel band for the rim, and shrink it on, if it were possible to arrive at just the shrinkage that would draw the band tight enough to show a close fit and still avoid the tendency to shear the rivets. To get over these dangerous elements, the shrinkage

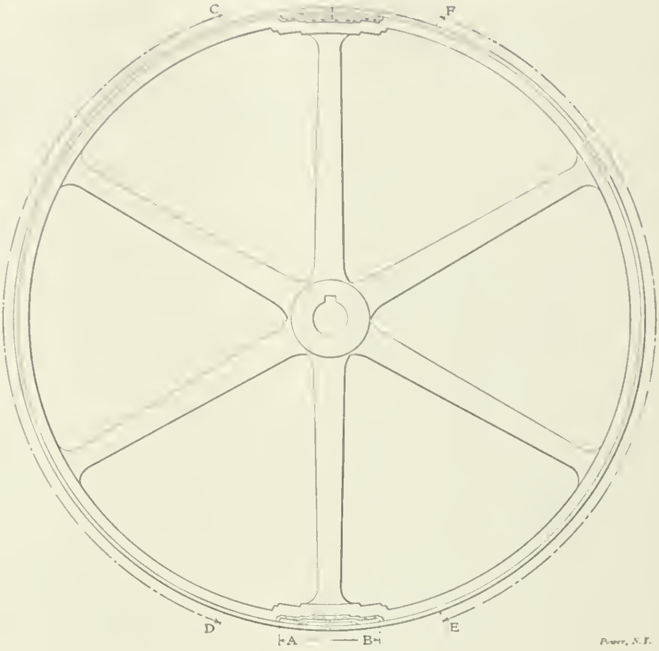


FIG. 3. A FLYWHEEL WITH RIM IN PLACE

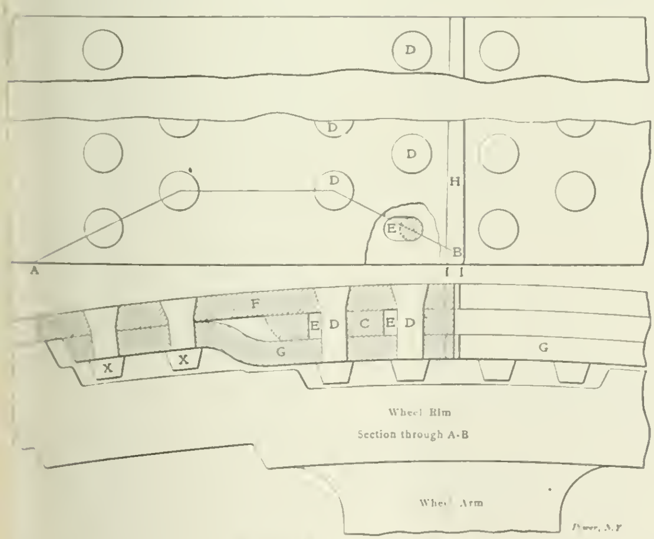


FIG. 1. JOINT OF BOILER-PLATE BAND RIM

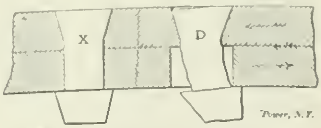


FIG. 2. A POSSIBILITY WHEN USING ONLY TWO PLATES AT JOINT

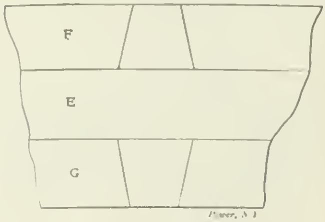


FIG. 4. PLATES PLANED TO A DOVETAIL

plate (Fig. 1) has been introduced in this design. The sectional view is through the line *A B*. The shrinkage plate is fitted between the outer rim *F* and a short plate *G*. This method gives a support to each row of the rivets *D* during shrinkage. The space *E* is to prevent excessive [illegible] strains during the cooling of the outer plate *F*, which would naturally carry the short plate *G* with it. If the plate *F* were not used, and with the [illegible] riveted to the inner plate *G* which would extend from *A* to *B*, Fig. 7, in place of the two *G* pieces shown in Fig. 1, with the shrinkage space *E* in the outer plate, there would be danger of the condition shown in Fig. 3, where the rivet *D* has started and loosened. The rivet *X* in this figure is the same as *X* in Fig. 1.

After the steel rim has been riveted up, the sections *F F* and *C D*, Fig. 3, should be heated to a red color. The riveted sections should not be heated, as the heat would weaken the rivets, and the heating of the rim should be evenly distributed over the sections named, else there will be unequal strains set up in the metal when cooling. There are two riveted sections for the purpose of balancing the wheel and for convenience in handling the plates. The wheel should be placed on the turning mill and the cast iron rim finished with a crown, so that the steel rim will be held central. The crown should be standard for all widths of wheel rim, as this would allow one set of rolls to be used for crowning the plates before riveting them up. The plate *G* may be formed in cast-iron dies.

In shrinking, the plates *F* and *G* will draw apart, as shown at *H*, Fig. 1. This space is to be filled in with a dovetailed taper wedge and the edges of the plates *F* and *G* riveted over, as shown at *I I*, Fig. 1. The plates should be planed to a dovetail, as shown in Fig. 4, before they are formed. In riveting up the band a few of the rivets *D*, Fig. 1, should be left out, and the holes in the plate *C* not drilled. This is for the purpose of fitting in dowel rivets after the first half of the shrinkage is completed. A portable drill should be rigged up to drill the holes in plate *C* to receive the dowel rivets, as shown in Fig. 5. These rivets should be fitted just loose enough to turn in the holes and screw into [illegible] at a dull red heat.

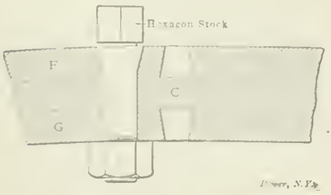


FIG. 5. [illegible] BOLTS

The shrinkage of the dowel rivets will draw the nuts so tight that there will be no danger of their working loose. These dowel rivets will prevent further slipping of the plates *F* and *G* on the plate *C* during the final shrinkage and draw the band plate *F* firmly on the cast-iron rim of the wheel.

It is a good plan to make the dowel rivets or bolts from hexagon stock and leave an end to screw them in by, cutting them off with a hacksaw after all is finished. As there will be fewer of these dowel bolts than the rivets *X*, Fig. 1, they should be made of fairly hard steel, say about 0.14 per cent. carbon. This

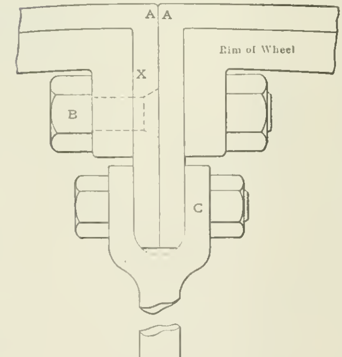


FIG. 6. METHOD OF HOLDING BAND AT JOINTS WHEN WHEEL IS MADE IN HALVES

shrinkage of the band. After the band has cooled down a light cut should be ru over it to true up the surface for th belt.

For wheels made in halves, the meth od of holding the band at the joint shown in Fig. 6. The ends of the boiler plate band are turned inward, as shown a *A A*, and held by the rim-joint bolts *B*

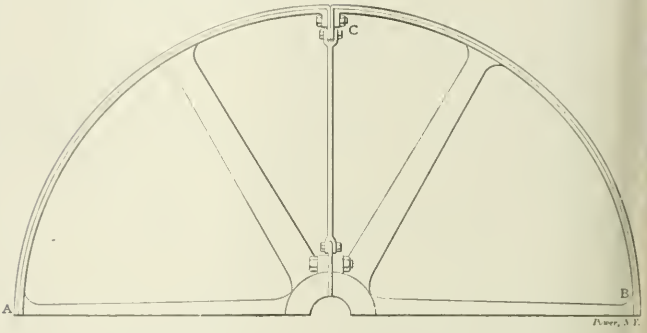


FIG. 7. HALF OF SPLIT FLYWHEEL

will prevent shearing during the fir fitted into reamed holes. The ends of t rim plate extend inward far enough receive the forked end *C* of a stay r that reaches to the hub of the wheel a is connected to a plate held between t hub flanges by bolts that also clamp t wheel hub to the shaft. The plate should be a loose fit between the h flanges, so as to have them clamp t shaft and not the plate. The general a rangement is shown in Fig. 7.

In fitting up the bands for a split whe the shrinkage sections shown in Fig. are located at *A* and *B*, Fig. 7, and of the work at the joint *C*, Fig. 7, sho be done before the shrinkage secti During shipment the bolts *B*, Fig should be put in place to hold the boil plate bands from working out of positi

To prevent the rim plates *A A*, Fig drawing away from the cast-iron wh rim at *X*, dowel bolts are used at this p as shown in dotted lines. They are pla between the rim bolts *B*.

The expense of a wheel of this typ necessarily greater than the ordinary ca iron wheel, but the same thing may said in reference to the automatic engine over the common slide-valve In the author's opinion the result warr the change.

---

"Gas engines of 5000 horsepower here," said Edward T. Adams, of Allis-Chalmers Company, speaking cently of the state of gas-engine deve ment, "and engines of twice 5000 ho power are nearer to us than the 1000-horsepower is, looking backward

# Varying the Speed of an Electric Motor

## An Elementary Explanation of the Principal Methods Used to Vary the Speed of a Shunt-wound Motor Running on a Two-wire Circuit

### BY CECIL P. POOLE

There are many places where electric motors are used and where the service demands several speeds by the driving motor, and the number of such places is increasing rapidly. Therefore, it is of considerable advantage to men in charge of power plants to understand the properties of the various methods of speed control.

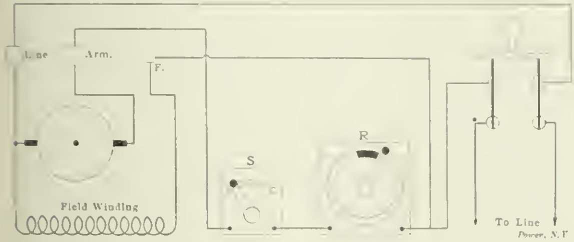


FIG. 1

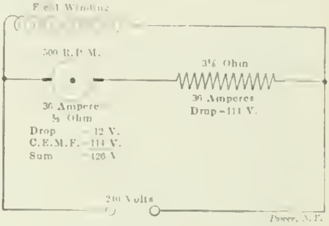


FIG. 2

The simplest and least satisfactory method of controlling the speed of a motor is by means of an adjustable resistance (rheostat) connected in series with the armature only, as indicated by the diagram, Fig. 1, where a shunt-wound motor is represented connected up to a starting box and a separate regulating rheostat. Usually the starting and speed-controlling resistances are located in the same box or frame having a single "faceplate" with two separate arms controlled by a single handle. Sometimes only one set of resistance coils and one arm are employed for both starting and speed control. The mechanical arrangement of parts, however, is of no importance so far as the principle of operation and the behavior of the motor are concerned.

Speed control by resistance in the armature circuit is saddled with two serious objections. The rheostat wastes power and with a varying load the speed of the motor is not anywhere near constant when the resistance is in circuit. Take the following example:

A 10-horsepower motor running at 1000 revolutions per minute on a 240-volt circuit takes 36 amperes in the armature at full load and the resistance of the armature and brushes is ⅓ ohm. Consequently the drop in the armature circuit is

$$\tfrac{1}{3} \times 36 = 12$$

volts and the counter e.m.f. of the motor is

$$240 - 12 = 228$$

volts.

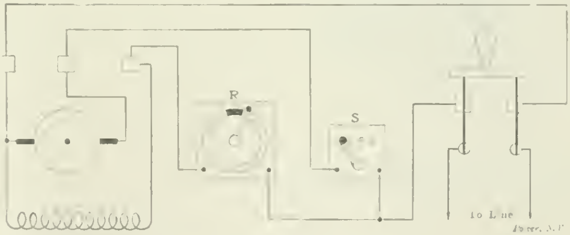


FIG. 3

Now suppose it is desired to reduce the speed to 500 revolutions per minute, with an armature current of 36 amperes passing. At 500 revolutions the counter e.m.f. will be exactly half what it was at 1000 revolutions, or 114 volts. The drop in the armature will be 12 volts, as before, and the voltage at the brushes will therefore be

$$12 + 114 = 126$$

volts. As the line voltage is 240, the control resistance must be such that the drop in it will be

$$240 - 126 = 114$$

volts.

The drop in a conductor is equal to the product of current × resistance of the conductor. Consequently, the resistance necessary to get a certain drop with a certain current is equal to the drop in volts ÷ the current. In this case the desired drop is 114 volts and the current 36 amperes; therefore the resistance of the rheostat must be

$$\frac{114}{36} = 3\tfrac{1}{6}$$

ohms.

Fig. 2 illustrates the conditions; the armature running at half speed gives half counter e.m.f., or 114 volts, the armature drop is 36 × ⅓ = 12 volts, and the rheostat drop is 114 volts; the sum of the three is

$$114 + 12 + 114 = 240$$

volts, or the line e.m.f.

Since the rheostat drop is 114 volts and the current 36 amperes, the loss in the rheostat is

$$114 \times 36 = 4104 \text{ watts,}$$

or more than 4 kilowatts! And as the motor is running at half speed it can give only half its normal power, or 5 horsepower. The equivalent of 5 horsepower is

$$5 \times 746 = 3730 \text{ watts,}$$

or 3.73 kilowatts, hence the resistance used to cut down the speed would be wasting more power than the motor delivered, at half speed. That is evidently uneconomical.

Now as to speed regulation. Suppose that while running at half speed with full-load current, as described, the load on the motor be reduced until the current is only 10 amperes instead of 36. Then the drop in the armature will be reduced to

$$10 \times \tfrac{1}{3} = 3\tfrac{1}{3}$$

volts, and the drop in the rheostat will fall to

$$10 \times 3\tfrac{1}{6} = 31\tfrac{2}{3}$$

volts. The sum of the two drops is [illegible]

[illegible] armature will speed up until its counter e.m.f. increases enough to make up the difference between [illegible] which is 205 volts.

At 1000 revolutions per minute the counter e.m.f. was 228 volts; consequently in order to give 205 volts the speed must be

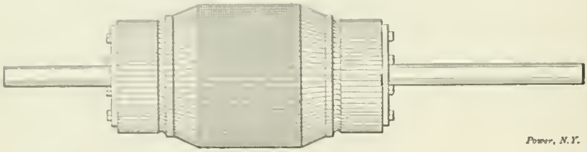
$$\frac{205}{228} \times 1000 = 900$$

revolutions per minute. This means that reducing the load from 30 amperes to 10 amperes, with the rheostat in circuit, will cause the speed to jump from 500 to 900 revolutions per minute. That could not be called even rough speed regulation; it is almost as bad as a series-wound motor would do.

From this example, which is not exaggerated in any particular, it is evident that varying the speed of a motor to any considerable extent by means of resistance in the armature circuit is practical only where the cost of electric supply is not important and where the load on the motor is nearly constant when the speed is less than normal.

### Variable Field Resistance

The next simplest method of obtaining widely different speeds from a shunt-wound motor is by means of an adjustable resistance in the field circuit, as represented diagrammatically in Fig. 3. This method of speed control is based on the fact that the counter e.m.f., which must make up the difference between the line e.m.f. and the total drop in the armature circuit, is directly governed by the field strength and speed. If the speed is constant, weakening the field will reduce the counter e.m.f.; on the other hand, if the field is constant, any change in speed will produce an exactly corresponding change in the counter e.m.f. Therefore, when a motor is running at 1000 revolutions per minute, with a certain load, if its field strength (not the field *current* but the actual magnetic flux) be reduced 20 per cent., the counter e.m.f. will be momentarily reduced 20 per cent. and there will be an increase in the armature current which will pull the speed up until the counter e.m.f. is brought up almost to where it was before. It will not need to be quite as high as before, because the increase in armature current increases the drop in the armature. Therefore, the increase in speed will not be exactly proportional to the decrease in field strength. The discrepancy, however, is so slight in most cases that it is close enough to assume that the change in speed will be proportional to the change in field strength, within 2 per cent.



Power, N.Y.

FIG. 4

For example, suppose a shunt-wound motor runs normally at 600 revolutions per minute and takes 40 amperes from a 250-volt supply line; also suppose its armature resistance is ¼ ohm. Then at full load and normal speed the follow figures would apply:

Line e.m.f., 250 volts.
Armature resistance, ¼ ohm.
Armature current, 40 amperes.
Drop in armature = 40 × ¼ =
volts.
Revolutions per minute, 600.
Counter e.m.f. per r.p.m., 240 ÷
= 0.4 volt.

Now suppose the field strength w weakened exactly 20 per cent. Then counter e.m.f. would fall to 80 per c of what it was before, or 192 volts, the armature current would incre momentarily to 232 amperes. This w increase the torque of the armature more than four times its normal va and the speed would jump up almost stantaneously to such a rate as to cut armature current down (by increa the counter e.m.f.) to the amount ne to pull the load.

Without bothering the reader by g through the calculations, the net res are given below:

Line e.m.f., 250 volts.
Armature resistance, ¼ ohm.
Armature current, 50 amperes.
Drop in armature, 50 × ¼ =
volts.
Counter e.m.f., 250 — 12½ = 2
volts.
Counter e.m.f. per r.p.m. = 0.32
Revolutions per minute, 742.2.

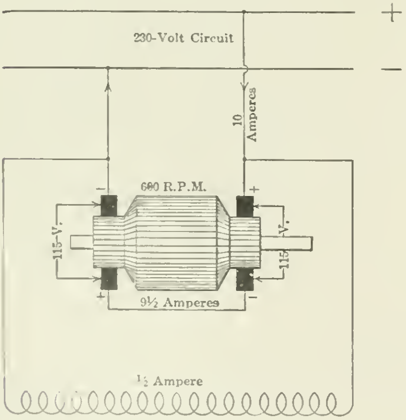


FIG. 5

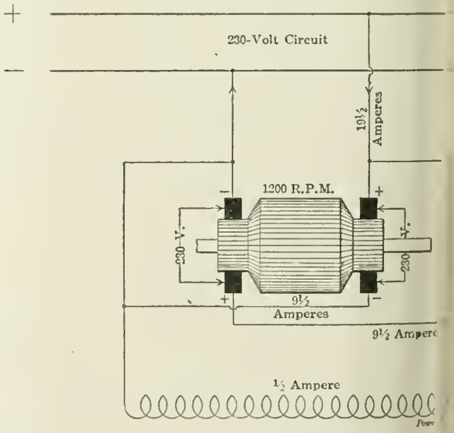


FIG. 6

This shows that the reduction in strength by 20 per cent. increase speed from 600 to 742.2 revolution minute. If the increase had been e proportional, it would have been 2 pe cent. or 150 revolutions per minute, ak- ing the new speed 750 revolution per minute.

The foregoing example is based a change of speed by change of field th- out altering the load conditions, and re-

re causing the load to increase with the speed. If a motor is driving full load at the lower speed, this cannot be done, of course. The load must be reduced before the speed is increased or the motor will be heavily overloaded by the increase in speed. When this is done, the speed changes almost exactly in opposite proportion to the field variation; for all practical purposes, the relation is exact. Thus, in the example just cited, if when the field was weakened 20 per cent. the load had been reduced 20 per cent. also, the figures would have been as follows:

Line e.m.f., 250 volts.
Armature resistance, $^1/_4$ ohm.
Armature current, 40 amperes.
Drop in armature, 10 volts.
Counter e.m.f., 240 volts.
Counter e.m.f. per r.p.m., 0.32 volt.
Revolutions per minute, 750.

Since the torque or "pull" of a motor armature is the result of the mechanical reaction between the field magnetism and the current in the armature wires, any decrease in either the magnetism or the armature current will cause a corresponding decrease in torque. And since the maximum armature current cannot be increased beyond a certain point because of the heating produced, it is evident that any weakening of the field strength causes a corresponding weakening of the torque that can be obtained with the maximum allowable armature current.

For example, suppose that the maximum safe armature current is 10 amperes and the pull at the rim of the motor pulley with normal field strength is 25 pounds. If the field strength should be reduced 20 per cent. to get a higher speed, the pull at the rim of the pulley—or the belt pull, assuming no slip—with the full 10 amperes in the armature would be reduced to a little less than 20 pounds, because the armature itself absorbs some of the pull; therefore the load would have to be adjusted to give no more than that back pull on the belt in order to avoid overheating the armature.

Again, suppose the field to be weakened one-half; the belt pull would be reduced slightly more than one-half, because the armature losses must always be deducted from the total pull of the field magnetism on the armature. Continuous weakening of the field would continue to decrease the *available* torque or pull in greater and greater proportion, until a point would soon be reached where the total torque would be only sufficient to turn the armature over against the frictional and magnetic retarding forces; then, any further decrease in field strength would reduce the speed instead of increasing it. This explains why the speed cannot be increased more and more by successive weakening of the field, until infinite speed is reached with no field, as one might imagine, reasoning from the result of moderate field reduction.

Aside from the question of torque, however, the features of armature reaction and sparking at the brushes come in to limit the extent of field weakening. In an ordinary motor it is not practicable to increase the speed to more than twice its normal value by field control. Motors are built which give an increase of 4 to 1 by field control, but they are specially designed for that purpose and are much heavier and more costly than an ordinary motor.

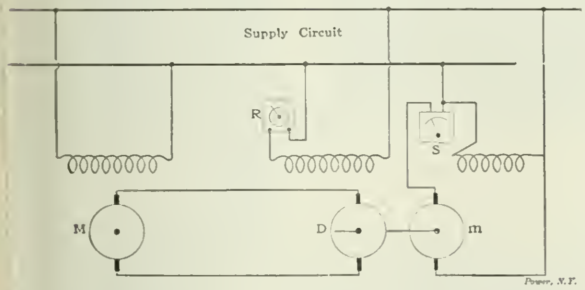


FIG. 7

The advantages of speed control by field variation are that the maximum power is the same at all speed rates; the speed is practically constant at each rate for which the rheostat is set; no complication is necessary in the control apparatus, and the efficiency of the combined motor and controller is not sacrificed, as in the first method described.

Speed regulation is usually downward, not upward. That is, if the normal speed of a motor is 1000 revolutions per minute and it is desired to vary the speed, the other speeds will usually be less than 1000. Consequently, motors controlled by field variation must be larger than single-speed motors. For example, if a 10-horsepower motor is to run at 300 to 1200 revolutions per minute (a range of 4 to 1), it is practically a 300-revolution machine and will weigh at least as much as a single-speed 20-horsepower motor of the same general type built to run at 600 revolutions per minute. From this it will be evident that variable-speed motors controlled by field adjustment are very costly to install but very economical to operate.

### Two Armature Windings

For service where only two speeds are required, the use of two armature windings and commutators presents fewer disadvantages than any other method of speed variation. With this method, the armature core is provided with two separate windings, each connected to a commutator in the regular way. The commutators are at opposite ends of the armature core, as illustrated in Fig. 4, and each has its own brushes and brush leads to terminal posts. The two windings are connected in series for slow speed and in parallel for high speed; the speed ratios are exactly two to one. For example, if the armature runs at 1200 revolutions per minute when the windings are connected in parallel, it will run at 600 revolutions per minute when they are connected in series.

The connections are made usually by means of a double-throw switch that is so interlocked with the starting-box handle that it cannot be changed over except when the starting lever is at the "off" position. Fig. 5 is a diagram of the series connection and Fig. 6 is that of the parallel connection, the speeds, currents and voltages stated on the diagrams being those for a 5-horsepower motor on a 230-volt supply circuit, at 600 and 1200 revolutions per minute.

Like the method of control by resistance in the armature circuit, the motor gives only half the power at half speed that it gives at full speed. But, unlike both of the systems previously described, the double-commutator method wastes no power in external resistances. It is open to the objection, however, that the losses in the armature and field windings are exactly the same at low speed as at high speed; consequently the low-speed efficiency is considerably lower than the full-speed efficiency. If these losses at high speed are 5 per cent. of the mechanical power output at full load, they will be 10 per cent. of the full-load output at low speed. However, that is not serious. A more important disadvantage is that only two speeds are available, and in order to overcome this and still use the double-commutator arrangement, it is necessary to resort to one of two

### Combination Methods

By using two commutators and a two-to-one field variation, it is practical to get any speed desired from the maximum speed down to one-fourth of that speed, without using an abnormally large motor. Moreover, the rate of speed will be practically constant at all points. This method involves the disadvantage that maximum torque is obtained at only two speed rates: With the commutators in series and no [illegible] in the field circuit, and with the commutators in parallel and no resistance in it. A second resistance is inserted in the field circuit for maximum [illegible] that can be obtained [illegible] system [illegible] good control with two commutators.

Another, and less desirable, combination consists of the commutators and an additional resistance (regulating rheostat) in the armature circuit. This is objectionable on account of the excessive losses in the rheostat and also because a single rheostat cannot give the same gradations of speed with the commutators in series that it does when they are in parallel. The reason is that the maximum current in series is half that in parallel, and the drop in the rheostat is correspondingly reduced. Moreover, the speed regulation at any setting of the rheostat is atrocious, exactly as in the case of a single-commutator motor controlled by a rheostat in the armature circuit.

### Variable Impressed Voltage

There are several systems of controlling motor speed by applying different voltages at the brushes. These are properly distribution systems, and do not come in the same category with methods of obtaining different speeds from a motor supplied from a simple two-wire circuit. They will be considered in a future article.

There is only one practical method of speed control by varying the voltage at the brushes of a motor fed from a simple two-wire line. That is by means of the Leonard system, consisting of a motor running at constant speed and driving a dynamo which supplies current to the main or "work" motor which is to run at various speeds. Fig. 7 is a diagram of the connections. The machine $M$ is the "work" motor, which is to run at various speeds; its field winding is excited from the supply line but its armature is not connected to the line at all, the armature current being supplied by the dynamo $D$ which is driven at constant speed by the motor m. This latter machine is driven from the supply circuit, and is an ordinary shunt-wound motor. The dynamo field winding is excited from the supply line and a rheostat $R$ is provided to regulate the field strength and thereby the e.m.f. of the dynamo.

As already explained, the speed of a shunt-wound motor is almost exactly proportional to the e.m.f. applied to its brushes, so long as the field excitation is not changed. Consequently, if the motor $M$ is wound to run at 1200 revolutions per minute on a 220-volt circuit and the dynamo $D$ supplies only 110 volts to it, it will run at about 600 revolutions per minute; if the dynamo $D$ is adjusted to give only 22 volts, then the motor $M$ will run at about 120 revolutions per minute, and so on.

This arrangement gives the best operating results of any, and but for the array of machinery required it would undoubtedly monopolize the field where variable speed is required. With it any speed whatever, up to the highest rate that the system gives, may be obtained merely by adjusting the simple rheostat $R$ in the field circuit of the dynamo. Since it requires three full sized machines to do the work of one, however, it is too costly to put in in most cases.

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## Catechism of Electricity

1006. *Describe the features of the motor in Fig. 324.*

This motor, which is built by the Fort Wayne Electric Works, is back-geared for direct connection and occupies less space than with belt and pulley drive. The field-magnet poles are built up separately of sheet steel and are of a special form and construction to obtain sparkless commutation. They are cast into the circular frame. Fig. 325 shows a view this motor dismantled.

The magnet pole lamination are two different widths. They are slott parallel to the shaft for about half the depth, and this tends to prevent diste tion of the magnetic field.

The ends of the armature coils exte over the drum of the core and are clamp in place. The coil leads are soldered risers from the commutator bars. e risers are riveted and soldered into recesses in the commutator bars to ure a low-resistance joint in the circuit.

A brush holder is shown in Fig. 326.

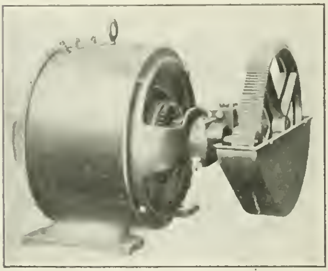


FIG. 324. BACK-GEARED MOTOR WITH UPPER HALF OF GEAR CASE REMOVED

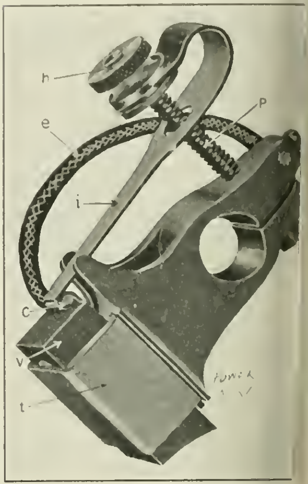


FIG. 326. BRUSH HOLDER USED ON TI MOTOR SHOWN IN FIG. 324

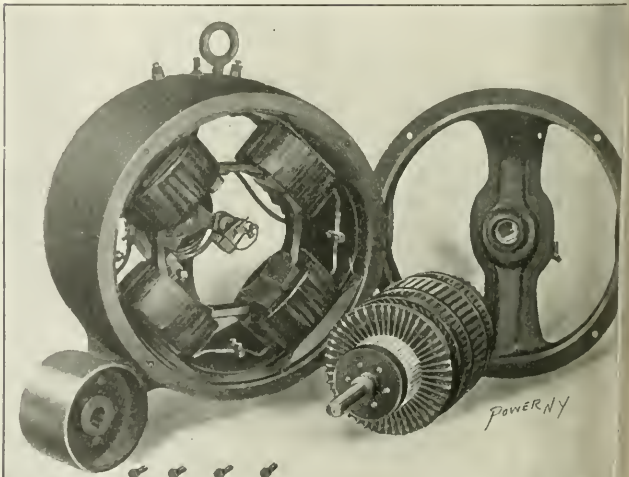


FIG. 325. PARTS OF THE MOTOR IN FIG. 324

copper connection g is bolted and soldered to the back of the brush guard. To this connection is soldered a flexible cable c which is connected to the brush-holder body as shown, shunting the current around the brush box t and eliminating the variable contact between brush

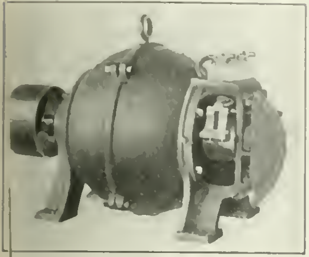


FIG. 327. SMALL ROUND-TYPE DIRECT-CURRENT MOTOR BUILT BY SPRAGUE ELECTRIC COMPANY

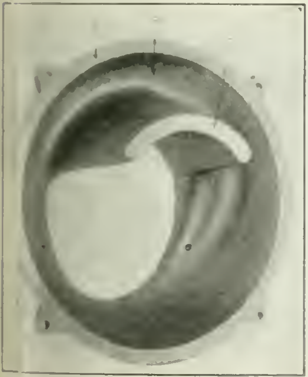


FIG. 328. HALF YOKE AND POLE PIECE OF THE SAME MOTOR SHOWN IN FIG. 327

box from the working circuit of the brush.

The brush pressure on the commutator is obtained by the use of a flat phosphor-bronze spring i, the tension of which is adjusted by a self-locking thumbscrew working on a threaded post or cap screw attached to the brush-holder body. This threaded post or cap screw also serves as the clamping screw which clamps the brush-holder body firmly on the brush-holder stud.

1058. *In what respect does the motor in Fig. 327 differ from other direct-current motors?*

Chiefly in its field-magnet construction. Only one field magnet coil is used to energize the poles.

1059. *Describe the peculiarities of construction of the motor.*

Its field-magnet frame consists of two steel castings a and c, each casting being approximately a hemispherical shell provided with an internally projecting magnet pole, as shown in Fig. 328 at a. The two halves of the magnet frame when bolted together completely enclose and protect the single magnet coil, which embraces and magnetizes both the polar poles. The construction of the brush holder is clearly shown in Fig. 329. This machine is built by the Sprague Electric Company.

1060. *Describe the Sprague motors of larger size built.*

As shown in Fig. 330, the frame consists of a cylindrical yoke m, Fig. 331, to the inner side of which the poles n s, etc., are bolted, each pole carrying a magnet coil r. Cast steel is used for the yoke in the smaller sizes and cast iron for the larger sizes. Cast-iron brackets b, which contain the bearings, are bolted to each end of the yoke, the front bracket carrying the brush rocker arm.

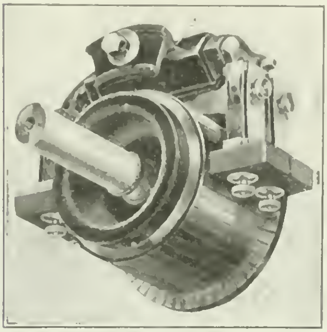


FIG. 329. BRUSH HOLDER AND COMMUTATOR OF SPRAGUE ELECTRIC ROUND-TYPE MOTOR

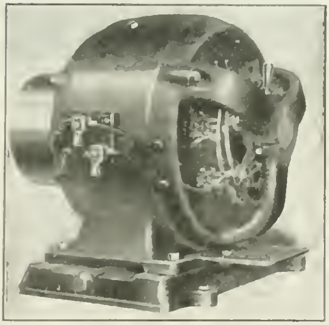


FIG. 330. SIX-POLE DIRECT-CURRENT MOTOR MADE BY THE SPRAGUE ELECTRIC COMPANY

The brush holders shown separately in Fig. 332, are of the box type in which the carbon brushes slide and are pressed against the surface of the commutator by flat, adjustable spiral springs u. A flexible copper lead electrically connects each brush with its holder. The cast iron rocker arm that carries the insulated studs upon which the brush holders are mounted, is supported on a machined seat on the inside of the front bearing bracket. The brush holders are adjustable along the studs, parallel to the shaft.

## Some Limitations of the Steam Turbine

By Warren H. Miller

The glamor of the steam turbine seems to be over us all. We note its quiet, noiseless operation, its apparent lack of complication and repairs, its absence of reciprocating stuffing boxes, and the question inevitably arises, why not have something like this in our plant? Furthermore, in the matter of steam economy we are dazzled by the brilliant results achieved by the large traction-station turbines, equaling if not exceeding the economy of the best gas-engine plants. There seems no reason why a well operated small turbine should not give something better in economy than the corresponding small reciprocating engine. For, the principle to which the large turbine owes its immense economy also holds good in the

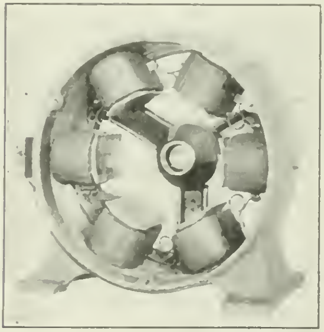


FIG. 331. YOKE AND MAGNET POLES OF MOTOR SHOWN IN FIG. 330

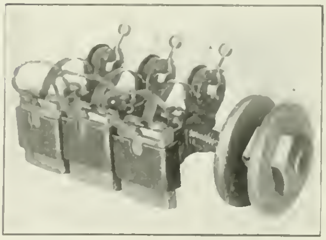


FIG. 332. BRUSH-HOLDER STUD AND BRUSHES OF THE MOTOR SHOWN IN FIG. 330

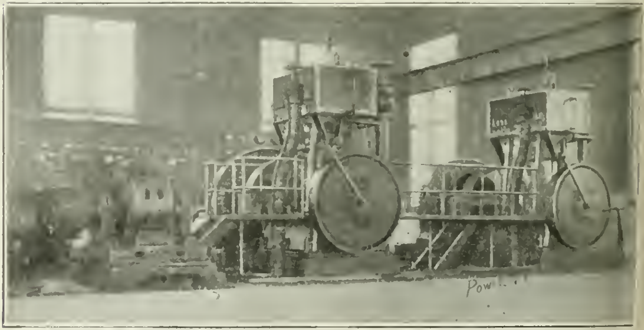
small machine, and may be briefly summed up as follows:

In one pound of steam at 150 pounds pressure and expanded to 10 pounds absolute, there are 155,000 foot pounds of work available. If the expansion is carried on down to 1 pound absolute, there are 275,000 foot pounds available. Now, the best compound engines of 4 to 1 ratio reject into the condenser at not better than 4 pounds absolute, as may be determined by scaling any low-pressure card from a compound engine. The reason of this is that while at 4 pounds absolute a pound of steam occupies 89.8 cubic feet, at 28 inches vacuum, or one pound absolute, it fills 334 cubic feet, and at 29 inches it takes 715 cubic feet. Of course no low pressure cylinder could be built to take care of these enormous volumes and yet it will be readily seen that one-half the work of the steam lies in these lower inches of vacuum. But the steam turbine easily utilizes these lower inches of vacuum, hence its great economy. It is knowledge of this principle which gave rise to the low-pressure turbine which can be put in between the exhaust of a compound reciprocating engine and its condenser and give nearly as much horsepower again without using any more steam from the boiler. By properly designing the nozzles, or by introducing the mixed-pressure feature, the small turbine also can utilize the lower inches of vacuum, thereby reaching a fair economy in steam consumption compared to a corresponding reciprocating engine. Add to these facts the entire absence of necessity of internal lubrication, and the ease of maintenance, and there is little wonder that the consulting engineers of the country rush in to specify turbines for every possible service.

And just here is where so many turbine failures come in, so it would be well to set forth a few practical limitations to the service which can be expected. In the first place the power house of an ordinary industrial establishment comprising a number of buildings all using power is hardly the ideal place for a turbine. The load fluctuates suddenly and violently; the steam pressure is apt to be anywhere from 100 to 50 pounds, as the boilers are nearly always overloaded, and once the pressure gets away from the firemen (through cleaning fires, using an extra quantity of steam or a run of poor coal) it is a slow job to get it back again; the steam for the turbine is very wet and there is no superheating; the vacuum may be shut off without warning; and heavy doses of water in the steam mains are of frequent occurrence.

At the drafting table of the engineering office these things never occur: the line is properly drained and trapped, the boilers are of ample capacity, etc.; but out in the works where everything must be sacrificed to the exigencies of manufacturing—getting out the goods—all these troubles occur frequently. The boilers are hardly in before a new shop is built and put on, taking away all the steam reserve, and the first boiler down to be cleaned makes it necessary to force the others, not to mention the fact that boilers seldom get coal good enough to bring them up to builder's rating and are therefore a little below the designer's intention anyhow. This same tendency of a growing plant to overload its original power equipment is also felt in the electrical end of the equipment, where a little thing like running the generators right up to 40 degrees Centigrade above the surrounding atmosphere for weeks at a time is not at all out of the ordinary.

Now reciprocating engines are not at all disturbed by these departures from ideal practice. They bang right along, through low steam and high steam, wet steam and watershots, and deliver the goods through thick and thin. If anything goes wrong or gets smashed, from a bent connecting-rod fork to a melted-out babbitt lining, the works machine shop has it out, fixed, and back in the engine and running again the same day. In the electrical end continuous overload may bake the insulation and put things a trifle out of balance, but it has no appreciable effect on the power station, and, so long as the coils are not actually charred so as to break down the insulation, the current will be forthcoming no matter how great the demand.



TWO ENGINE-DRIVEN 300-KILOWATT ALTERNATORS

With the turbine there is no such easy time. If the babbitt liners melt out or even have to be scraped, woe to you if you do not get back mathematically in line. If a watershot comes along and strips the blades, the turbine is down and out for weeks. If the steam drops down from 100 to 50 pounds, the turbine will not help to pick it up again, but on the contrary will use enormous quantities of it through the nozzles, and will drop off in speed so that it is hard to keep up the voltage. Shutting off the vacuum from the turbines means almost a shutdown of half the plant, as there is rarel steam enough to spare to permit it.

Examining the electrical end of the turbine unit, the revolving field or armatur is wound with highly insulated wire i heavily insulated slots. This is nicely ba anced to run at 3000 revolutions per mi ute without chattering. Under the co stant overload and change of load it ge in an industrial plant, this insulation be comes dried out and baked, and allow the mass of copper to shift ever so sligh ly. The rotor is then out of balance a the turbine chatters and runs away wi the foundation bolts and generally e hibits the characteristics of a flying m chine. And the heartbreaking thing abo it is, that after waiting weeks for it be rebalanced at the electric company works, it may do the same thing again less than a month of overload.

At the designing table there are st other limitations for industrial-plant se vice. Suppose the frequency is made cycle to provide for probable future g engines. The smallest turbo-genera made for 25 cycles is 300 kilowatts. W Because the field construction limits generator to two poles or 1500 rev tions per minute, and this would call very disproportionate impulse wheels blade areas if attempted on the sma sizes. And yet the 25-cycle frequency so many advantages that it is stea growing in use in industrial-plant w Its worst objection, the alleged "flic of incandescent lamps, is impossible detection unless something is rapidly brated in the light of the lamp. But all practical purposes in shops, dra rooms or offices, 25-cycle incandesc ts are as good as direct current. Ma a large plant has started up with direct r- rent from the exciters in the power h se and later changed the lamp circuits t 5-cycle alternating-current without an ne realizing the change. In the matte of convenient motor speeds, easy parall ng of alternators, capacity to use tun en and tantalum lamps without exce ve aulting, the 25-cycle frequency offers any advantages to the mill engineer, id is by far the best for gas engine drive, which case the steam spares must eds be reciprocating engines if under o kilowatts

The accompanying illustration shows e steam equipment of a gas-engine plant ntaining three 25-cycle three-phase 440-lt alternators, of 700 kilovolt-amperes ich. The steam units consist of two o-kilovolt-ampere generators driven by and 28 by 16-inch compound vertical rine engines built by the Forbes Engine pany, of New London, Conn. These gines, on 100 pounds initial pressure, good for 311 horsepower and realized unds steam economy on actual test. e power factor of the plant is about per cent. the standard waterwheel-led type 25-cycle alternator, with re-ving field magnet, was selected.

As to floor space, these engines and rators are 2 feet shorter than the kilowatt turbine set and 2 feet wider he generator end. The governor is of Rites type and controls both the high l low cutoffs by the rocker arm cross- the front of the engine. This gives lutely perfect parallel operation with tively no hunting or movement of the rument needles. But the real value of engines to the plant came out in st infinite capacity to stand overload, r hammer, low steam and all sorts normal conditions. For, owing to then unsatisfactory conditions of par- operation with gas engines, it was de l to start the plant with the steam es alone, giving time for certain nised improvements in gas-engine gov- ng to materialize. The result was for nine long months these two en- es carried the entire electric load of plant, getting one hour rest each in 4 hours, and carrying anywhere from 1 to 200 per cent. overload for long ds of time As if this were not , the steam pressure was subject to nt long periods of depression from ormal of 100 pounds, averaging about nd often going down to 50 pounds se the other departments used steam gas-engine electric power had been led, thus using continuously the en reserve of the boiler house, which ed to about 2000 horsepower. This steam, combined with occasional les with the water-softening plant, considerable foaming and heavy f water in the power-house steam s, not a few barrelfuls but half an of the gage-glass level would suddenappear from the boiler nearest the r-house main and go sailing over to engines regardless of the numerous and separators interposed. Few en- ers realize the water lifting power of -pressure steam when the demand is t and the engines are condensing power main was only one of four ch mains leading out of the boiler house, and all were trapped and carefully drained, but these precautions are of little avail when a thick rain of water spray is lifted off the whole surface of the boiler water by the huge draft of steam. Such conditions seem abnormal and preposterous to drafting table engineers, but a long experience about large industrial establishments will prove that these conditions often do exist and must be provided for. Either it is a new shop put on without adding to the existing boiler plant, or they want steam for heating or steam for testing; it is always *something* that makes the steam-supply problem, like the poor, always with us.

From the foregoing, it is evident that a big two-fisted industrial plant, whether it is a steel plant, an "ile yard" or a railroad shop, is no place for a small, flimsy turbine. But with a good marine reciprocating engine the case is different. If it is designed for 200 kilowatts and it is necessary to have 400, the engine will lie down and wallow in it but you'll get the goods. If a tubful of water comes along and smashes the piston rings and bends the low-pressure connecting-rod forks 1/8 inch out of true, the machine shop will put in new rings, the connecting rod will go up to the smith shop, get straightened with a tap of the steam hammer, be planed off true and be back in the engine again in ten hours. Not so with the turbine. If the babbitt melts out of the main bearing brasses, all that is needed is a ladle and a scraper to get going again. Not so with the turbine. If the steam drops and drops and keeps on dropping until it is wondered if there is any fire at all under the boilers, the engines will worry along somehow—they'll keep the shops going if there is only a vacuum to give them. The engines in the illustration lose only five cycles on a steam drop of 50 pounds, whereas a turbine will drop much more, besides wasting the steam at the very time such a thing is not wanted. The same is true with a heavy fluctuating load, such as a big crane or elevator.

For the big industrial plant the case may be put in a nutshell as follows: Never tie up the power in anything that the works' shops cannot repair with a few essential spare parts.

In the electrical end there is nothing to worry about, as regards getting out of balance, with reciprocating engines. At any speed below 300 revolutions per minute no change due to shrinkage of insulation will appreciably affect the balance of the set. The real danger with the reciprocating plant consists in getting the generator too small. Generators are cheap compared to engines, and if the generator gets hot before the engine slows down the chances are that its armature or field-magnet coils will be burnt to cinders inside simply because the engine has not yet reached the limit of its overload. They will put on all the engine will take and let the Devil take care of the generator—which he does very effectually. Some day it will be found that just about twice the normal field current is needed to get up to voltage, whereupon a shutdown and examination will reveal the interesting fact that there are no field coils at all—only chunks of wire with some charred cotton left on them. And it won't get fixed the same day either.

A word as to personnel. Get sailor men preferably to run marine-engine-driven generators It is not at all difficult to pick up a crew of them, and they have been shipmates with just such engines before and know best how to get the fine points out of them and repair them quickest in case of trouble. All five of the engineers and oilers in the plant mentioned herein are marine men—as hard a crowd as were ever gathered under the seven seas. An officious foreman from another department attempted to "show them" on the subject of marine engines, and after hearing him through very good-naturedly they just threw him out of the power-house window for good luck, after staving in most of his bulwarks. Another "butter-in" who tried to give them orders about the switchboard, they cheerfully laid hands on and cast him out over the works picket fence, more dead than alive. It is the writer's good fortune to regulate their various doings, and, having been a seafaring man himself in earlier and better days, he can recommend the brand as able, handy and reliable.

## Water Power Development at Metaline, Wash.

The Lehigh Valley Cement Company has awarded a contract to the Sylvester Engineering Company, of Spokane, Wash., to construct a plant capable of developing 10,000 horsepower at Metaline, Wash., to cost between $300,000 and $350,000. The plant will develop the power in Sullivan lake and Sullivan creek, and will be located at the confluence of the creek and the Pend Oreille river, above Metaline falls, where a cement factory to cost $1,000,000 will also be constructed.

A 40-foot dam is to be built at the outlet of Sullivan lake, in which enough water will be stored to maintain an average flow during the dry season sufficient to develop 10,000 horsepower. Another dam will be built across Sullivan creek, three miles below the lake, and the water of the creek will be turned into a large rectangular flume, 6x9 feet This will carry the water three miles farther down stream and discharge it into the power plant, where it will take a sheer drop of 450 feet. When this water reaches the cups on the big water wheel it will be traveling at the rate of 100 miles a minute, so fast, in fact, that the entire volume of water coming down the flume forces its way out and into the cups in the for of a jet less than three inches in diamet

# Safety Devices of Electric Elevator

## An Explanation of Mechanisms for Stopping the Car if the Cables Slacken, also of Mechanical and Electromagnetic Forms of Brake

BY WILLIAM BAXTER, JR.

The slack-cable stop shown in Fig 37 is of the design shown in Fig 31, which differs from that of Fig. 32 only in the way in which the force for throwing *B'* into engagement with *B''* is obtained. The exact construction of the stop in Fig. 32 is shown in Fig. 38, in which it will be noticed that a weight $W''$ is provided to move the lever *B*, instead of the spring around the shaft *S*, in Fig. 37. The construction of the catch at the ends of the levers *B* and *L'* is not the same in both Figs. 31 and 32. In the first-named it is like that presented in Fig. 37; that is, the lever *B* has a pin that engages with a groove in the upper side of the lever *L'*, but in Fig. 32 the construction is as shown in Figs. 39 and 40, in which the pin and groove exchange places. This change in the construction is also shown in Fig. 38.

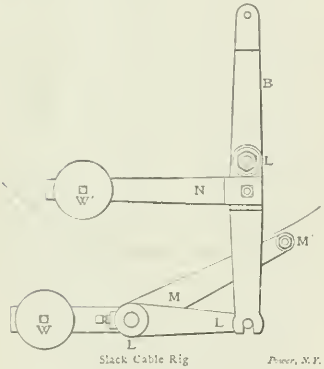


FIG. 38

When the elevator motor is placed at the top of the elevator well the slack-cable stop is modified as indicated in Fig. 41; the weight $W'''$ is used to provide the force to rotate the shaft *L''* whenever the lifting cables *R* become so slacked that the rods *P'* can move to the left to carry the lever *L'* downward as indicated, and thus to free the lower end of the lever *B*. The shaft *L''* runs under the drum from one side to the other, just as in Fig. 37, and there are two levers *P'* to the left-hand ends of which is fastened a rod carrying rollers *P''* that press against the lifting ropes. The lever *N'* is not connected with *P*, nor with *L'*. There are two levers *P* and two levers *P'* which slide through two guide stands *Q*. The shapes of the levers *N'* and *P* and the rollers *P''* are shown in Figs. 42 and 43.

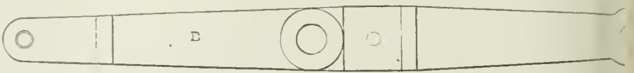


FIG. 39

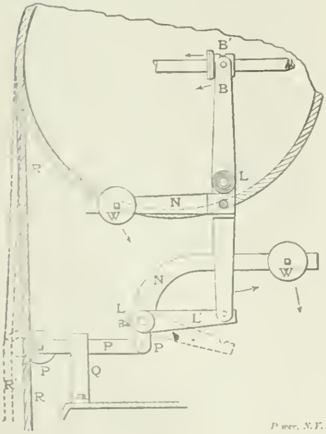


FIG. 41

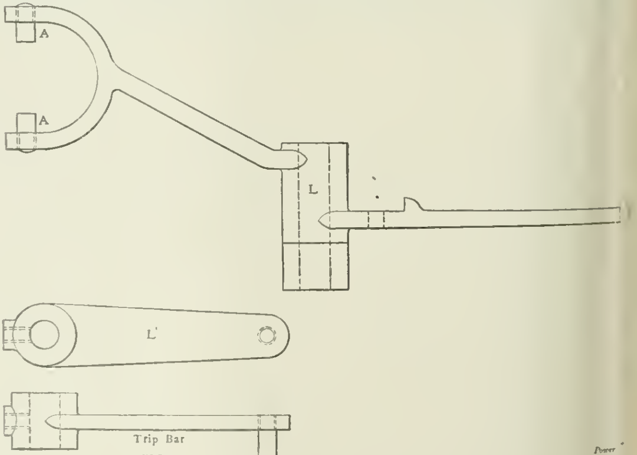


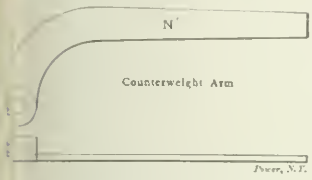
FIG. 40

### MECHANICAL BRAKES

The brake of the machine in Fig. 32 constructed as represented in Figs. 44 a 45, the first giving side and edge vie and the latter a detail of the crowf tightening piece *D*. The brake wheel is formed by extending to the pr diameter one of the parts of the coupl that connects the armature shaft and worm shaft. On the periphery of t part a rim is extended parallel with shaft so as to provide a cylindrical surf for the brake shoes *A'* and *A''* to l against. These shoes are pivoted at *B'*, in the casting *E*, and at their o ends *B B* two connecting rods *C* are tached to connect them with the tight ing piece *D*, which is mounted upon stud *D'*. The lever *D''* is also fir mounted upon *D'* so that when the br actuating rod *F* is depressed the tight *D* rotates clockwise and applies the bra while when it is raised the shoes re moved away from the brake wheel. ne rod *F* is depressed by the crank lev *K* which, it will be noticed by exam ng Fig. 32, is rotated to the position in w ch it is shown in Fig. 44 to stop the le ver. The rod *F* is not made fast to the lower casting *F"*, but can slide freely through it, so that if the movement of *K* due to the bottom position should be more than enough to press the shoes *A'*, against the brake wheel *A*, the spring would compress and permit *F* to slide freely through *F"*. This action will be readily understood by referring to Fig. 44 and noting that the rod *F* extends between the forked sides *a a* of the lower *F"*. The construction of the rod *F* is shown in Fig. 46 and it will be noted that at the lower end the hole is elongated so as to permit a considerable vertical movement without touching the pin that passes through the end casting *F"*. By properly adjusting the position of the nuts *F* at the upper end of the spring the pressure with which the brake shoes are applied can be regulated so as to arrest the movement of the car in any place that may be desired. The shoes are faced with leather, so as to produce uniform friction, and prevent freezing fast.

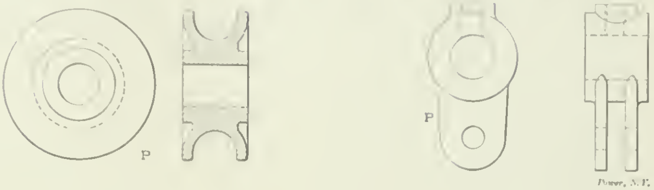
The brake of the machine in Fig. 31 is substantially the same as that shown in Fig. 44, the principal difference being that the shoes *A'*, *A'* are pivoted on a single pin instead of on the two pins at *B' B*.

Another type of mechanical brake used on the Houghton machines is shown in Fig. 47. This is a band brake and consists of a single band made of wrought iron or steel and thin enough to have sufficient flexibility to conform to the curvature of the brake wheel. The part of the band that comes in contact with the brake wheel is lined with leather. The band is supported on the right side by a rod *E'* which is attached to the casing *I* and carries a spring upon which a bracket riveted to the band *I* rests. The object of this construction is to permit the band to center itself with respect to the brake wheel so as to not bear against it on the upper or lower side when the rod *F* is raised to throw the brake off. The construction of the rod *F* is the same as in Fig. 44, the lower end being made with a slot for the pin that connects *F"* and *D"* to work in, the spring *S* being tightened or loosened as may be required, to obtain the proper brake tension. The weight



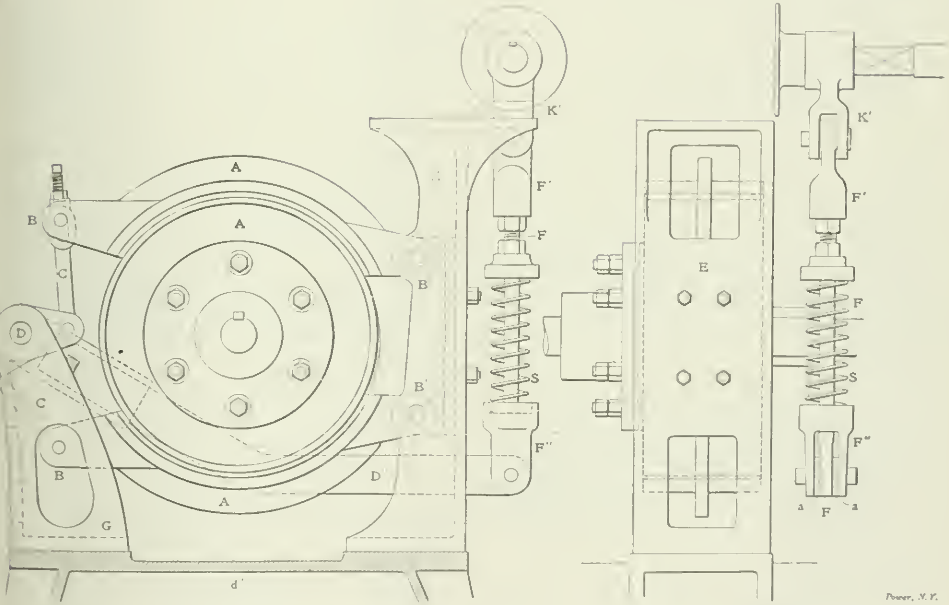
Power, N.Y.

FIG. 42



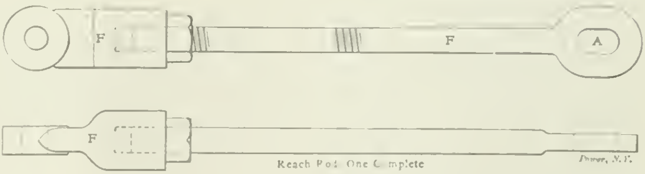
Power, N.Y.

FIG. 43



Power, N.Y.

FIG. 44



Reach Rod One Complete

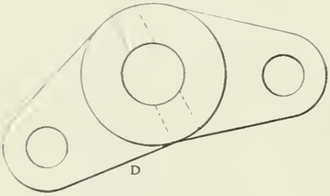
Power, N.Y.

FIG. 46

*W* simply acts to balance the lever *D''* and the rod *F* so as to make the rotation of the crank *K* easier. The casting *D* to which the ends of the brake band are secured swings around the pivot held in the bracket *G* and acts to tighten or release the brake band. The construction of this crowfoot casting is shown in Fig. 48, which gives top, side and end views. The end *B* of the brake band is held in the lugs *a*, *a*, and the end *B'*, which it will be noticed terminates in two screws with nuts is held in the arms *b*. The hole through which the screw *B'* passes is tapered, with the small part at the left side, so as to permit the screw to rock as the casting is rotated in the act of tightening the band. The operating lever *D''* is attached to the part *a'* and the counterbalancing weight *W* is placed on the arm *a''*.

## ELECTROMAGNETIC BRAKES

The brakes thus far described are of the type known as mechanical brakes. They are called mechanical because they are put on or released by mechanical means; that is, when the hand-rope sheave is rotated to start the elevator it not only swings the reversing switch to the running position, but in addition lifts the brake shoes from the brake wheel. In stopping, the brake is applied by the rotation of the hand-sheave shaft at the same time that the reversing switch is turned to the stop position. Brakes are also made to be operated by a magnet, and when so made they are called magnetic brakes. Generally this type of brake is used with machines that are electrically controlled, but it is not uncommon for such hrakes to be used with mechanically controlled elevators.



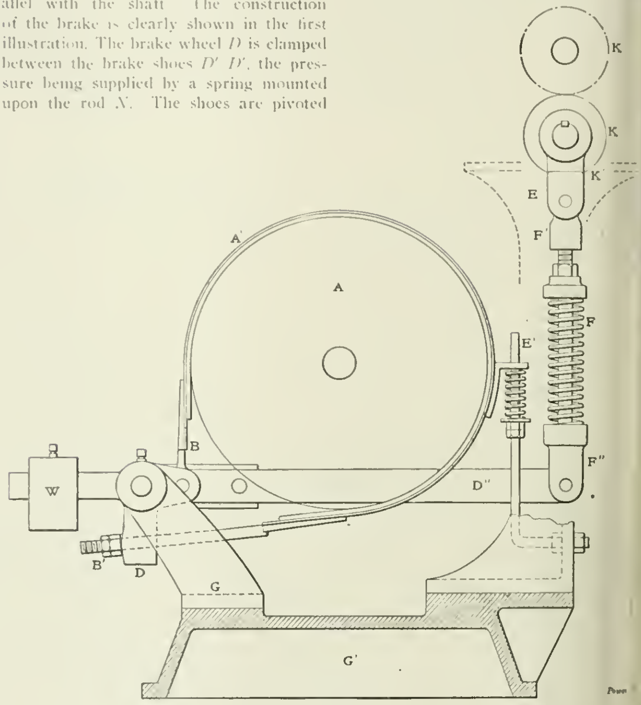
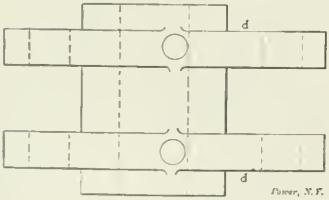


FIG. 47

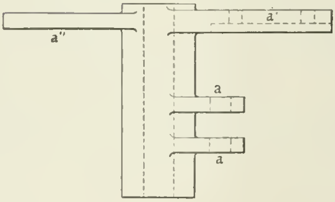


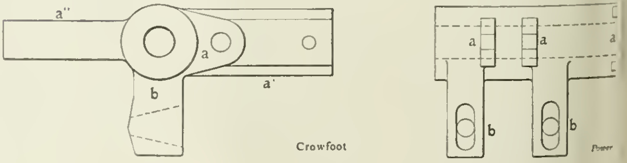
Crowfoot

FIG. 48

The type of magnetic brake used by the Haughton company with mechanical control is shown in Fig. 49. At the left is an elevation at right angles to the motor shaft, and at the right an elevation parallel with the shaft. The construction of the brake is clearly shown in the first illustration. The brake wheel *D* is clamped between the brake shoes *D' D'*, the pressure being supplied by a spring mounted upon the rod *N*. The shoes are pivoted at *E E*, and their upper ends are drawn together, so as to spread the lower ends and release the brake wheel, by the attraction of a solenoid magnet *M*. The rods *M'* carry at their inner ends plungers that work inside of the solenoid coil When a current is passed through coil the plungers are drawn in, caus the lower ends of the brake arms to spread farther apart. When the eleva is running the current is passing thr the coil *M*, and the brake shoes *D' D* held off. When the elevator is sto the current is cut off the coil, and the spring on the rod *N* forces the s *D' D'* together. The screws *p p* are vided for the purpose of adjusting distance through which the brake s can be moved. The frame *F* to w the brake-shoe arms *D'* are pivote

*E E* also forms part of the magneti ircuit of the magnet, and serves as w to hold the magnetizing coil *M* in pos on. This frame is secured to the side c he casing that envelops the worm whe as





Crowfoot

FIG. 48

slwn in the right-hand view, the flange o *I* being bolted against the flange *F*. Ts view also shows a portion of the sto-motion mechanism and the operating slave. It also shows the way in which tl reversing switch is mounted on top e brake-magnet frame *F*. The sprocket w el *A*, on the stop-motion shaft, is con ned with the sprocket on the reversn switch shaft by a chain that is indi d in the drawings by a broken line. T switch itself occupies the position of tl rectangle C in the left-hand view, Fig 4

t portion of the stop motion that c ects with the slack-cable stop is not sl n in Fig. 49. When a magnetic brake s sed, the slack-cable stop can be of the ele l type, and may consist of a modi f the mechanism already de r , or may consist simply of switches a on top of the elevator car, or in sition where they may be opened slacking up of the lifting ropes. In ny ch arrangement, the switch must be nnected with the controller as to c t current off not only from the m r, but also from the brake magnet. Suc devices will not move the stop mo tor however, and on that account will n t return the reversing switch to the stoposition, as this switch is mechanically ved through the action of the stop m n. On this account a mechanical slac cable stop is much the better device tc e in connection with a mechanically c olled elevator.

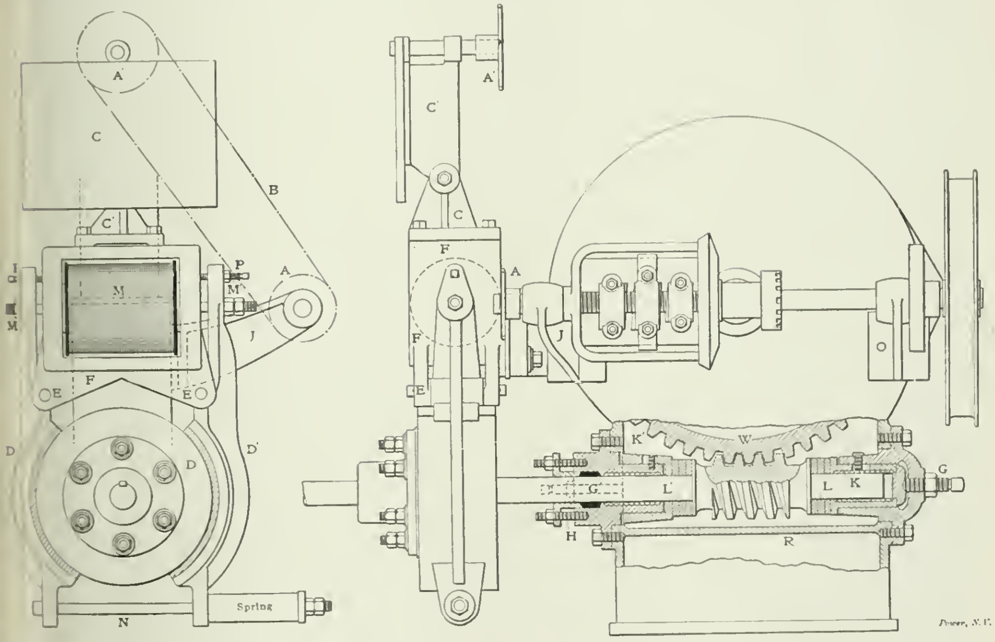


FIG. 49

# Boiler Room Work

At the twenty ninth annual convention of American Water Works Association recently held at Milwaukee, Wis., J M Whitham, of Philadelphia, presented a paper on boiler-room work, entitled "A Boiler Room Symposium." After a highly humorous introduction to the question, Mr Whitham got to the serious part of his paper. He started in with the fireman. He said "The fireman ought to know that a coking coal requires different treatment from a caking coal, and that it does not pay to disturb an anthracite fire; that coal fired frequently in light doses is better than when fired heavily at long intervals.

"There is a difference of 10 per cent. between the work done, in fuel economy, on the day when the fireman is strong and well and the day when he is ill, or has stomach disorder, or has been up with the baby all the previous night. Again, there is 10 per cent. difference between heavy firing at long intervals, with a pipe smoke between times and a yarn spun with a comrade, and light frequent firing.

"In general, aside from the smoke question, it makes little difference whether the coal is spread lightly over the grate by the alternate-door method of firing, or coked in front and then pushed back. In either case, the grate should be covered and continuously covered, and the depth of covering should not be less than six inches in any part." He said: "You may talk about your steam-jacketing of pumping engine cylinders, your receiver reheating, your use of superheated steam and your attenuated vacuum in the condenser, but when a test based upon coal is to be made, the fireman is more important than any of these items singly. If he is important during a dress-parade test, he is important in the everyday operation of the plant.

"If there must be a difference in pay between the stationary engineer operating the pumping engine and the fireman in the boiler room, a want of harmony or symphony, as it were, between them in matters of pay, then in my opinion the fireman should receive the higher pay.

"This is radical advice not likely to be followed, but is justified by the want of symphony between manual labor and skill that must be respectively exerted. The pumping engine generally takes care of itself. You will note that the engineer is generally fat and lazy, while the fireman is an athlete."

Passing from the fireman to the furnace and mechanical stokers, Mr. Whitham said this: "Mark this, there is no device of this kind on the market today which contains any fundamental principle of operation different from similar devices threshed out from sixty to eighty years ago, and when you come down to the best of these devices, this best device will have to hustle to beat the common grate and a skilled fireman using the same coal.

"The furnace ought to be roomy enough to permit the combustion being substantially completed therein. Boilers are generally set too low and the furnaces are too cramped. I have seen the most expert fireman, using the best of coal, operating a boiler under its most economic loading, and after all conditions had been prepared for the test, and obtain results so inferior that had he secured them in ordinary commercial practice he would have lost his job. Why was this poor result? In this particular case there was a cramped furnace. The volatile of the fuel, in this case about 22 per cent., was distilled and reached the heating or refrigerating surfaces of the boiler at too low a temperature for ignition and so passed away unignited and unutilized. The richest part of the coal was lost up the chimney. The gas-analysis apparatus does not indicate this waste, since it is hydrocarbon and all the apparatus shows is the percentage of carbonic acid, carbonic oxide and oxygen; and right here let me advise that there is more to be gained by hiring a fireman who knows his business than by having the boiler-room walls decorated with gas analysis apparatus. The latter is good; but a good fireman is best of all."

As to the extent of grate surface he said: "The extent of grate should be proportioned to the heating surface of the boiler in general, although depending upon the draft, and should be about 1 to 30 for small anthracite; 1 to 40 for semi- and full bituminous, with draft from 0.4 to 0.5 of an inch; 1 to 60 for semi- and full bituminous coals, with drafts exceeding ½ inch."

In speaking of the code of rules for boiler testing adopted by the American Society of Mechanical Engineers, the author said "If the code were followed strictly, each engineer should have a corps of six or seven assistants for a test of a 100-horsepower boiler for ten or twelve hours. Few people can afford to pay for such a luxury, and it is unreasonable to expect them to do so. In a boiler test there are but few conditions of paramount importance, or of much more than trifling moment. They are: (1) A correct determination of the amount of fuel used and the moisture thereof; (2) a correct determination of the amount of feed water used; (3) the pressure in the boiler; (4) the temperature of the feed water. Of course, it is interesting to get a whole mass of data relating to outside and inside temperatures, quality of waste gases, the drafts in the furnace at the breeching and in the stack, quality of steam, etc., but all this auxiliary information isn't worth thirty cents.

"In making a boiler test there should be no jockeying, and the person guilty of such a practice is not an engineer, and is not honest. The points aimed at are truth and fact, and the engineer should not care whether he pleases his employer or not, so far as ascertaining the facts is concerned. With this in mind, it is important that the coal on the grate shall be exactly the same in quality and quantity at the end of the test as at the beginning. It is absurd to start a test with a naked grate and end the test with a burnt-off fire, because this is not commercial, and commercial conditions must control if the results are to be of any value. There is no point in the boiler test requiring such keen observation and judgment on the part of a testing engineer as the determination of the amount of coal on the grate at the beginning and end of the test."

In closing, he said: "In order to secure greater 'symposium' in a boiler room, it is necessary (1) that no man should be sent into a boiler for repairs or cleaning unless his life is protected by two steam-stop valves, both of which should be shut and kept shut; (2) that if the company or municipality owning the water works desires to avoid heating water for the sewer, each boiler should have two blowoff valves in tandem."

## Moisture Contained in the Atmosphere

By N. A. Carle

The amount of moisture which can be held by a given quantity of air increases with the temperature and decreases with the pressure. The air is said to be saturated with moisture when it contains all the moisture which it can hold at that temperature and pressure without condensation.

The moisture in the air is known as humidity and is measured on an arbitrary decimal scale, of which 100 is the saturation point of the air, at which it will hold no more water vapor, and 0 is the point at which the air contains no moisture.

The degree of saturation of the air is expressed by the ratio of the moisture actually present in the air to that which it would contain if it were saturated.

When the temperature of air containing moisture is falling, a point will be reached at which the air is saturated with moisture for that temperature and a further lowering of the temperature will result in a condensation of some of the moisture. The temperature at which this occurs is called the dew point of the air.

Air is never perfectly saturated, not even when it is raining; neither is it ever perfectly dry. Relative humidity is not a proper measure of the moisture contained in the air. At a low temperature even a high relative humidity represents a very small amount of moisture actually present in the air, while a low relative humidity at a high temperature repres
a great deal.

For different saturation temperat
the weight in grains of water vapor
tained in a cubic foot of air is as
lows:

| Temperature of Saturation; Fahrenheit Degrees. | Weight of Moisture in a Cubi Foot of Air; Grains. |
|---|---|
| 0 | 0 56 |
| 10 | 0.87 |
| 20 | 1 32 |
| 30 | 1 96 |
| 40 | 2.85 |
| 50 | 4 08 |
| 60 | 5.74 |
| 70 | 7.98 |
| 80 | 10 93 |
| 90 | 11 79 |
| 100 | 19 77 |

It is not the intention of the writ
discuss the methods of measuring
tive humidity, except to say that
kinds of instrument are used for
purpose, "hygrometers" and "psych
eters." The hygrometer depends o
expansion and contraction of some
stance in the presence of moisture i
air, in proportion to the amount of
ture present. A psychrometer consi
two thermometers; the bulb of on
ing covered with muslin so as to ret
film of water surrounding it. The eva
tion of water from the bulb incas
muslin will cool it to an extent depe
upon the amount of moisture prese
the air. The relative humidity o
air is calculated by means of tables
the temperature of the dry bulb
the difference of temperature betwe
readings of the two thermometers.

The engineer is concerned wit
question of humidity in cold-storage
refrigeration and the ventilation of
ings. Data are usually available re
ing the temperature of the air an
humidity or degree of saturation.
the engineer wants to know is the
amount of moisture present in t
which is to be handled. The ch
page 000 is designed to show the
of water in ounces contained in
cubic feet of air, when the tempe
and relative humidity are known.

### Examples

(1) If the temperature of the ai
degrees Fahrenheit and the humi
75, how many ounces of water ar
tained in each 1000 cubic feet of
Starting with 70 degrees Fahr
read up to the line showing the
of water contained in the air at sat
and then across to 75 per cent. h
and down to 13.7 ounces of wat
1000 cubic feet of air.

(2) If the temperature of the ai
degrees Fahrenheit and the humi
85, how much water is carried
air per 1000 cubic feet?

Starting with 90 degrees Fah
read up to the line showing the am
water contained in the air at sat
and then across to 85 per cent. h idity
and down to 28.7 ounces of water p 1000
cubic feet of air.

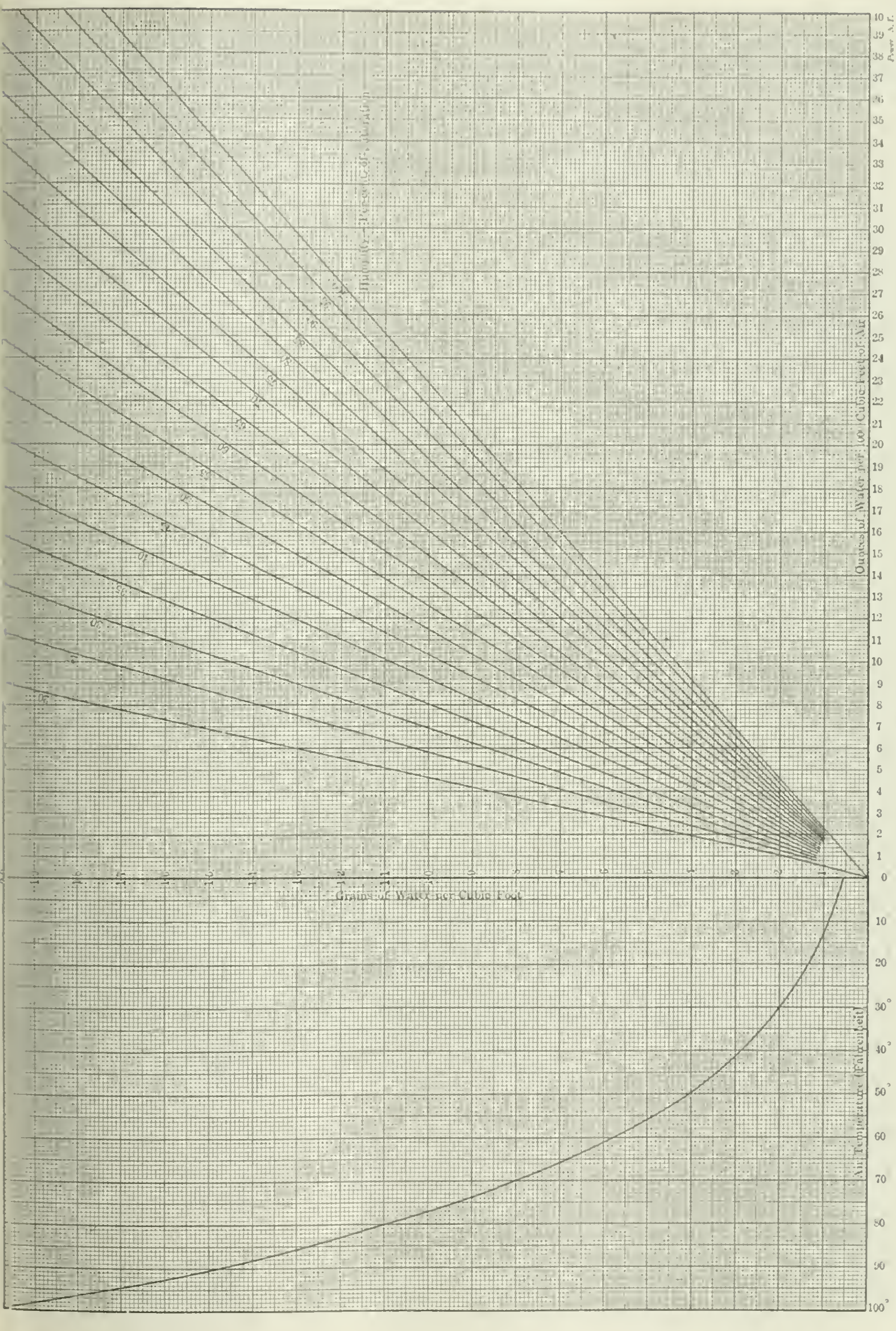


CHART FOR DETERMINING THE AMOUNT OF MOISTURE CONTAINED IN THE ATMOSPHERE

# Some Recent Engine Failures Abroa

## Details of Several Steam- and Gas-Engine Accidents as Reported by the British Engine Boiler and Electrical Insurance Company, Limited

BY H. S. KNOWLTON

During the past year or two there have been reviewed in these columns a large number of failures and defects in power-plant machinery which have been of general suggestiveness to the designing and operating engineer, regardless of his locality. One of the most valuable sources of information regarding engine, boiler and electrical failures is found in the annual report of the British Engine, Boiler and Electrical Insurance Company, Limited, which yearly presents the most exhaustive analyses of power-plant accidents occurring in the United Kingdom, the investigations and reports being made under the direction of Chief Engineer Michael Longridge, of Manchester, England. These reports are sold at a nominal sum, and deserve close study from engineers having the time and inclination to take up accidents which are of local as well as general interest. They have been drawn upon freely in previous articles in the belief that a condensed review of those accidents, which are not peculiar to foreign practice alone, may be helpful to the busy engineer on this side of the Atlantic. The report for 1908 is now in hand, and in the following paragraphs will be given the essential lessons of a number of failures of engines occurring in the company's practice since the publication of the 1907 report.

The first failure of note was that of a vertical engine of the condensing type, with a 14x18-inch cylinder and a speed of from 90 to 130 revolutions per minute under a very variable load. The steam distribution was effected by a cast-iron slide valve, cutting off at about 0.7 stroke, and the speed was controlled by an ordinary equilibrium throttle valve. Steam was supplied through a reducing valve loaded to 60 pounds from six boilers operating at 75 pounds per square inch. Two of these boilers were equipped with downtake superheaters, the delivery from which entered a saturated-steam main supplied from such other boilers as happened to be in service. There was no means of ascertaining the temperature of the steam entering the valve chest, and it was impossible to form any reliable estimate of it. At some of the other engines situated nearer the boilers it reached 360 degrees Fahrenheit, or 53 degrees above the temperature of saturated steam at 60 pounds. As the initial pressure on the piston varied from 60 to 30 pounds, there would also be a certain amount of superheating from wiredrawing through the throttle valve. The side of the valve chest next the cylinder which carried the facing on which the valve moved was worn entirely through on one side and almost through on the other. The metal had been ½ inch thick when the cylinder was refaced fourteen months previously. It appeared that most, if not all, of the wear had taken place during the last two months, or since the engine had been run upon superheated steam. A metal face that had been attached to the valve chest of another engine in the same plant was worn down 1½ inch in less than eight months.

It is possible that with a steady temperature and special arrangements for lubrication, which were wanting in this case, small slide valves might be made to work with dry or slightly superheated steam, but with steam sometimes wet and sometimes dry, and the ordinary oil cup, nothing but trouble could be expected. The company's experience with slide valves working in superheated steam has not been encouraging. Corliss valves appear to work well up to a temperature of 500 degrees Fahrenheit, or thereabouts, but a cautionary point applies; the steam valves, having little lap and little motion are not likely to give trouble, but the exhaust valves, which have practically the same lap and travel as slide valves, may do so in the rare cases in which the steam remains superheated, and the cylinder dry throughout the stroke. For the highest temperatures multiple-beat drop valves appear likely to answer best.

The case is cited of a pair of compound engines of the horizontal type, with cylinders originally 25x50-inch, with 60-inch stroke, with a boiler pressure of 160 pounds per square inch, and a normal speed of 52 revolutions per minute. The smaller cylinder was fitted with a liner and steam-jacketed. The liner had been rebored at the same time to 25¼ inches in diameter. The smaller piston was a simple hollow casting, 25 inches in diameter and 7⅛ inches deep, packed with three cast-iron rings 1⅛ inches broad, and varying at the time of the breakdown from 9/16 inch to ½ inch thick, the thinnest parts being nearest the joints. There was no tailrod to support its weight. Soon after starting one morning, the engineer, hearing an unusual noise in the cylinder, stopped the engine, took off the cylinder cover, and found a piece driven out of the liner about 9 inches from the r end and one of the piston rings brok On gaging the cylinder its diameters w found to be $24\frac{5}{16}$ inches on the fr end, $25\frac{11}{16}$ inches in the middle a 25½ inches at the back. Apparently joint of one of the rings had turn around to the upper part of the pist and the ends had sprung out of groove. One of these ends had beco caught between the piston, and the li had been broken off and been for through the latter. The piston had parently not been examined for a y The plant was shut down a week by trouble.

A dangerous accident was averted the prompt and courageous action of engineer in charge of a horizontal t dem-compound engine, 26 years old, w cylinders 18 and 29 inches, by 30-i stroke, running at 94 revolutions per m ute on 110 pounds per square inch. high-pressure cylinder had Corliss val the two steam-valve boxes on the top be connected to each other by a pipe rectangular cross-section, on the top which was bolted the engine stop valve. flange of this valve casing was 10½ inc outside diameter, and the neck betw the flange and the bulb containing valve seat was 6⅜ inches external 5 inches internal diameter. The u flange of the casing was connected to end of the steam main extending ac the three boilers which supplied steam about 19 feet of 5-inch cast-iron p with three right-angle bends of s radius. The pipe, besides being bo to the stop valve and steam main, re on the wall between the engine house the boiler room, but was not anch anywhere. The engineer was sitting w in 6 feet of the stop valve, when noticed escaping steam and on closer amination found a crack extending ne all around the neck just above the tom flange. With cool and imme action he shut the valve and preve the casing from being blown off the inder. The cause of the fracture probably the deterioration of the m by the vibration of the steam pipe du its long life. Had the pipe been fi anchored in the wall, the vibrat caused by the sudden stoppage of steam flow on the closing of the Co valves would have been lessened.

An accident occurring to an 800-h power engine running on 85 pounds st pressure illustrated the heavy stresses to which bolts and flanges can be subjected when the jointing material is laid entirely within the bolt circle. A few seconds after opening the stop valve to start this engine, and just after the flywheel had begun to move, the bolts and studs securing the cylinder cover gave way, and the cover was blown off and driven up the rod until the gland bolts struck the bottom of the socket of the coupling rod. The bolts were bent and the gland and stuffing box broken. Neither of the cotters in the piston rod or the crosshead was bent, and no water came out of the relief valve. The breakage was due to the [illegible]ual straining of the bolts caused by screwing down the cover upon an asbestos jointing ring, $\frac{7}{8}$ inch wide and [illegible] inch thick, laid inside the bolt circle. There were 22 bolts and studs, $1\frac{1}{8}$ inches in diameter, so that the stress upon them from the steam pressure, if uniformly distributed over the cross-section, would have been 6200 pounds per square inch; but when this stress was concentrated on the small portions of the areas [illegible] the jointing ring, it must have been [illegible] times that intensity, and evidently sufficient to start fractures at the bottoms of the screw threads, which extended until the bolts became too weak to bear the load upon the cover.

A case is cited of a pair of horizontal [illegible] compound engines, operating on [illegible] pressure. The cylinder diameters were $22\frac{1}{2}$ and 42 by 72. The speed was 42 revolutions per minute. The connecting rods had forged eyes at the crank-pin ends, but butts and open straps at the crosshead ends. The brasses at these ends were tightened by a pair of [illegible] cotters, with screws at the ends passing through conical boxes resting on the straps, and secured by nuts on the screwed ends of the cotters. There were no bolts through the ends of the straps and no clips around them to prevent their opening out in the event of the cotters getting slack or breaking, although the risk of neglecting such safeguards had been clearly explained to the owners. Last year the risk matured and one of the cotters broke, while the strap opened and came off. The piston rod was freed and driven backward, carrying the rod [illegible] with it. The high-pressure cylinder and its cover were badly broken up; the low-pressure cylinder was cracked and its cover broken. The guides for the crossheads were broken by the slide blocks, the crosshead was broken, the piston-rod [illegible] badly sheared, the circulating pump [illegible] in pieces, and the engine bedplate fractured. The accident required a shutdown of 46 days through the neglect of precaution which would have cost perhaps $10.

Failure to inspect a cotter caused another breakdown in a horizontal condensing engine with a 25x48-inch cylinder, normal speed 60 revolutions per minute, with a boiler pressure of 90 pounds. The air pump, horizontal and double acting, 8 inches in diameter by 54 inch stroke, was placed behind the cylinder with its piston rod passing through the back cover of the latter, and was coupled inside that cylinder to the end of the main piston rod by a cotter secured by a split pin. The engine came to a standstill one evening and the attendant found the spindle of the rear end exhaust valve twisted off. On opening the cylinder he found the cotter which had fastened the air pump to the piston rod lying in the valve box with one end sheared off. The cotter had evidently fitted badly, become slack, sheared the split pin, jumped out of the rod and fallen into the exhaust port, where it had been caught and sheared by the closing valve. The cotter had not been inspected for more than three years.

### Gas-engine Failures

Two gas-engine failures may be included, on account of the illustration which they afforded of connecting-rod bolt and flywheel-key troubles. The first case was that of a horizontal 20x30 inch engine running at 180 revolutions per minute on producer-gas. The large end of the connecting rod was of the marine type with round-backed gunmetal steps, the cap being held by two steel bolts 2 inches in diameter, Whitworth screw thread. There were no fillets at the junctions of the shanks and heads, nor were the shanks reduced in diameter between the heads and the screw threads. Thus, the smallest diameter of each bolt was the core diameter of the thread. The engine was started in August, 1907. Soon afterward the cylinder end cracked, but was temporarily repaired and kept at work while a new cylinder was being put in shape. This was installed early in 1908, and the engine then ran until February, when both the bolts in the large end of the connecting rod gave way at the junction of the shank to the head. In the one which probably broke first the fracture had evidently begun some time before the final break, and had extended gradually through the metal, for with the exception of a small area the surfaces of the fracture were smooth and black with oil. In the other fracture the break was new; its surfaces were clean and fresh and with large crystals.

The cause of the original crack which led to the first failure was probably the sharp corner at the junction of the head and shank. The stress upon the bolts through the inertia of the moving parts was probably about 3000 pounds per square inch. Previous to the breakdown the engine had made about eleven million revolutions. The cylinder end, piston and bedplate were broken beyond repair, the liner was damaged and the connecting rod bent. After the breakdown the bolts in the large end of the connecting rod of another engine owned by the same plant were examined, and an incipient crack found, with the aid of a magnifying glass, at the junction of the head and shank of one of them. The additional bearing surface gained by omitting the fillets under the heads of connecting rods of the marine type is not sufficient compensation for the risk involved.

The second gas-engine accident was that of a horizontal engine, with $8\frac{1}{2}$x15 inch cylinder, running at 170 revolutions per minute on illuminating gas. The engine had one flywheel, 5 feet 6 inches in diameter, with six curved arms, and a boss $7\frac{3}{8}$ inches in diameter by $7\frac{1}{8}$ inches wide, bored to $3\frac{1}{2}$ inch diameter to receive the crank shaft, to which it was secured by a key $8\frac{1}{2}$ inches long, $\frac{7}{8}$ inch broad and $\frac{5}{8}$ inch thick, with a gib head. The depth of the keyway in both shaft and boss was $\frac{5}{16}$ inch. In 1907 the key broke inside the boss from the head end, and both it and the keybed in the shaft were found to be battered and slightly worn at the edges, indicating that the wheel had been rocking at the key. The owner of the engine was advised by the inspector to have the wheel taken off the shaft and the keyways in both machined to true plane surfaces, but he declined to allow the engine to be shut down longer than was necessary to get a new key driven in.

The new key was made up and driven in tightly, and a tin shield which covered the end of the shaft was renewed. The engine ran for nine months, when the wheel became so loose as to attract attention. When the tin shield was removed the side of the boss which it had covered was found to be cracked radially from the leading corner of the keyway. The side next the engine was still sound. There was also a longitudinal crack in the shaft parallel to the trailing or driving edge of the keyway. The key was loose and easily driven out, but the wheel was fixed and was forced off with difficulty. It was then seen that the crack in the shaft extended the full length of the keyway, parallel to and about $\frac{3}{8}$ inch from it, and that the metal between it and the keyway had risen sufficiently to bind the wheel. The trailing or the driven side of the key had forced back the face which was driving it and sheared the material lying immediately behind. The key and the keyway were worn round and the diameter of that part of the shaft on which the boss of the wheel had been riding was reduced nearly $\frac{1}{32}$ inch, except where the partly sheared material behind the key and between it and the crack had been forced outward by the pressure of the key. The partial shearing of the shaft, the flow of the steel behind the keyway and the longitudinal crack about where the plane of the keybed would cut the circumference of the shaft, differentiated this trouble from the ordinary cases of rocking wheels and consequent split bosses.

# Practical Letters from Practical Me

Don't Bother About the Style, but Write Just What You Think, Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

## Curing an Engine Pound

A certain engine had developed a bad pound on the head end, and I had the pleasure of assisting the engineer in charge of the plant to find the cause by a general overhauling. It had no name plate upon it, but was generally supposed to be a 9x12 Porter engine, 240 revolutions. At first I applied the indicator, with the result that Fig. 1 was obtained, which showed that the valve rod had been lengthened by someone. I corrected this but still the pound was there, so I turned the engine over, making marks on the crosshead guides on each extreme of travel. Then disconnecting the connecting rod, I pushed it hard up against the head end and found that the crosshead only went even to the marks on the guide. This showed that there was no clearance, the piston hitting the head end while the crosshead passed the crank-end mark ¼ inch, showing that the crank end had that amount of clearance and the head end none.

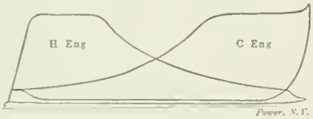


FIG. 1

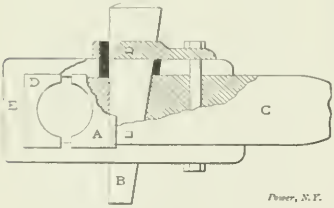


FIG. 2

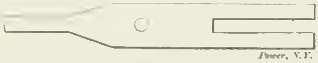


FIG. 3

The piston rod had been screwed into the crosshead up to the last thread by someone to stop this pound. The trouble was due entirely to the fact that previous parties were not familiar with the style of connecting rod end, which is shown in Fig. 2, and had kept putting in shims, making matters worse at every shim. Referring to Fig. 2, I found the shim put in between the end of the key and inner brass box, which of course lengthened the distance between the pins as keying up took place. After removing the shim and placing it between *E* and *D*, Fig. 2, the clearance became equal. The end of the rod does not bear against the brass box, but has an open slot like that in Fig. 3. Fig. 4 shows the imprints of the follower bolts, 1/6 inch deep, which were made by the continuous pounding of the piston against the head end.

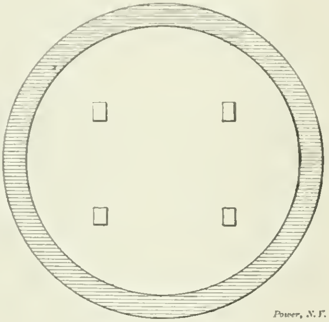


FIG. 4

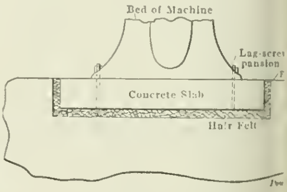
A. C. WALDRON.

Lynn, Mass.

## Vibration

Reading about a church in England having a turbine set on a concrete slab supported by rubber blocks reminded me of a similar job I did in on of the leading hotels of this city. The supporting piers of this building were about 8 feet square. One of them came down in the laundry, and two extractors running at 1600 revolutions per minute were placed at the foot of this pier. The action of these machines caused the piers to vibrate; cracking the plaster throughout the building.

It was suggested that a sheet of rubber be placed under the machines, but as rubber deteriorates rapidly, especially when in contact with oil, this idea was abandoned. After studying the pro tion, this method was tried and pr satisfactory, and as far as I kno so today. A pit about a foot deep, tangular in shape, was dug and concr Then a sheet of hair felt about 1½ in thick was placed in the pit and the end sides turned up flush with the floor. concrete, made strong, about 1 par portland cement to 2 of sharp sand, made on the felt and the machines bolted to it. The machines "floate the hair felt.



TO PREVENT VIBRATION

HAROLD JA

New York City.

## Heating Shaft Couplings

Heat, when properly applied, is the most useful aids an enginee have in his repair work. Take, fo ample, a shaft coupling that has to off; pulling bolts and sledges have to make it move. It is here heat judi ly applied will often do more th the slugging and bull strength.

A piece of sheet iron wired or bl in place will suffice to hold the fire a the coupling. A few wet rags to the shaft cool, and things are rea the blaze. If it were not possi remove the key beforehand, care be taken to see that it starts wi coupling; otherwise, if it is made taper, forcing the coupling will br up harder on the key.

If the coupling is of cast iron or b care will have to be taken that it hammered too hard while hot, oth a fracture may result.

In shrinking on couplings that a heavy to manipulate readily by ha is a good plan to sling them in p near the end of the shaft and heat while hanging, so that, when the speeded enough, it is simply a matter of swinging them on.

Before heating it is a good plan to verify the bore of the coupling to size. It should be a "wee bit" smaller than the shaft, the exact amount depending upon the diameter of the shaft, and is given in engineers' or machinists' handbooks. If the bore proves up all right, take a wire gage, say, of 3/16- or 1/4-inch wire, pointed at each end and of the diameter of the shaft that goes in the coupling, should be made. When the heated coupling shows an easy fit by the gage, it is ready to go on.

Right here it is well to remark that no matter how reliable the machinist or shop that does the work, it is well for the engineer to have good calipers and measuring tools and take measurements himself to check up with, and there will be times when this plan will save trouble in more ways than one.

Just before the coupling is ready to be forced on, it is well to examine the shaft for burs or kinks and verify the keyway. When the coupling is on, the key should first be entered by hand and then driven home until the coupling and shaft are cool. This same method may be applied to pulleys, bands, and so on.

THOMAS H. HEATH.

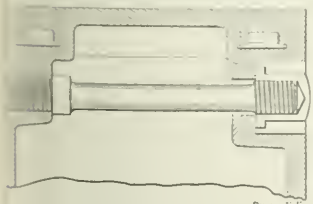
Seattle, Wash.

## Follower Bolts

The follower bolt illustrated and described by N. L. Davey, on page 621 of the October 12 number, interested me, as we have been priding ourselves for fifteen or twenty years at not having a single accident such as he describes, by making the style of piston in which it does not occur.

The thing is fully shown by the accompanying sketch. Riveting in the stud prevents its coming out; turning down the body of the stud makes it elastic, the equivalent to a spring washer; and the dome-cap nut shuts out the steam and prevents corrosion.

As stated above, the long use, without finding one loose or broken, has settled all trouble so far as we, or our customers, are concerned.


Power, N.Y.

FOLLOWER BOLT

JOHN E. SWEET.

Syracuse, N. Y.

## Effect on Economy of a Poorly Constructed Foot Valve

The foot valve shown in Fig. 1 consisted of an upper half tapped to receive the suction pipe, a lower half with apertures to admit water and between them a leather gasket, part of which formed the flap. It is shown by the heavy line in Fig. 2. This valve was screwed to the bottom of the suction pipe of a centrifugal pump; when in operation a vacuum gage in the suction line showed 20 inches of vacuum, which was too high considering that the length of suction pipe was only 6 feet. It was thought the apertures admitting water were throttling the flow and the lower half of the foot valve was left off, but there was no improvement.

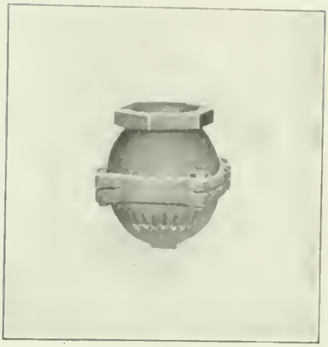


FIG. 1

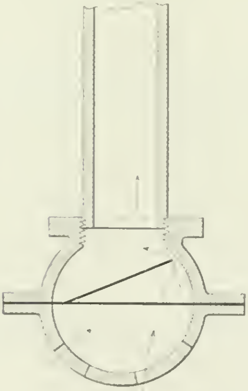

Power, N.Y.

FIG. 2

On further examination it was found that the flap, when open, rested its edge on the surface of the valve, as shown in Fig. 2, and practically shut off the flow. This was corrected by fitting a casting between the two halves, allowing plenty of room for the flap to open. See Fig. 3.

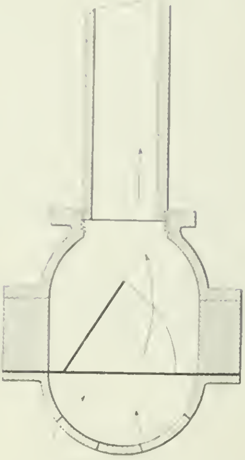

Power, N.Y.

FIG. 3

The vacuum gage now showed only about 2 or 3 inches.

A. H. ANDERSON.

Chicago, Ill.

## Why Dashpots Sometimes Fail to Work

The gland on the steam valves may be screwed down too tight, or the packing needs renewing. The valves may not be properly lubricated, or the seats are cut. The engine may not have enough compression to counterbalance the pressure on the valve. The leather may be worn, or hard and dry. The vacuum pot may get air around the leather, or through the gasket in the bottom of the pot, if any, or the pots may be worn badly in some cases, although seldom is this the fault.

Among some of the remedies that I find satisfactory are the following: Use good packing on the valve stems. Do not tighten any more than is necessary to keep from leaking. Keep the leathers on the plungers moist; this can be done by using a few drops of castor or neatsfoot oil occasionally.

As the dashpot is generally set close in the floor, it will naturally collect dust, especially when sweeping around it. A good remedy to cut loose the dust and gummy oil and to moisten the leather is the following: Take warm water and good soap (white preferred) and make about a pint of soapy water. Take a squirt can, put the water in the can, and then squirt the soapy water so it will r[illegible] the plunger in the vacuum pot. This will remove the old gummy oil and [illegible] and moisten the leather and cause it [illegible] well. The best time to put the water in is when the engine is running; only a small amount is necessary. After the water dries out, put a few drops of castor or neatsfoot oil in the pot.

If the leather is worn badly, take the plunger out, get some good flax thread or shoe thread, and put it under the leather, around the plunger, as if you were using paper liners. Put enough around the plunger to make the leather fit the pot snugly. After you once use thread for spreading the leathers you will not use paper again.

A pot should close properly, if it rises as much as one inch, provided everything is in good order. The pots on all Corliss engines that I have seen will work properly when proper care is taken of them, although there may be some exceptions.

A. L. HOWARD.

Wiggins, Miss.

## Curing a Hot Crank Box

Fig. 1 shows a crank box that always ran hot, a piece of designing found on a high-class engine. There is a wedge coming down on the bearing, or one-half of the crank box, and a simple set screw for letting it down. There is no provision for keeping this wedge from working down too low and clamping the box too tight, causing it to run hot. This crank bearing gave considerable trouble, until we put another set screw beneath the wedge, as shown in Fig. 2. This way we could adjust the wedge between the two screws and hold it where we set it.

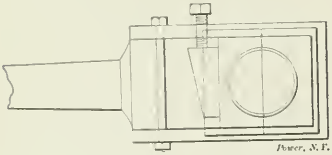


FIG. 1

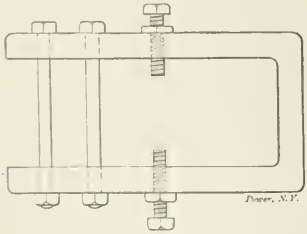


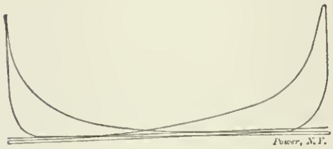
FIG. 2

C. R. McGAHEY.

Richmond, Va.

## Corliss Engine Dashpots

Several persons have recently stated in POWER that Corliss-engine dashpots failed to work properly when the load on the engine was very light. The accompanying diagram from the high pressure cylinder of a tandem-compound Corliss engine shows that the load is unusually light but the engine runs perfectly. The governor is steady and the dashpots work correctly. The diagram shows also that the valves close very sharply.



The diagram is shown to prove what I stated some time ago: That a Corliss-engine dashpot will work perfectly if the valves do not open at all, provided the valve gear is correctly adjusted and the dashpot and connections are correct, also.

HARRY W. BENTON.

Cleveland, O.

## Exciter Trouble

We are having trouble with our exciters and wish that some reader would help us out. The commutator on the exciter runs hot, and the heat is transmitted through the shaft to the bearing, causing a great amount of trouble. The brushes do not spark at all, but the brushes and brush holders run so hot as to be unbearable to the hand. The brushes are equally spaced around the commutator and advanced slightly in the direction of rotation.

The armature has a small amount of end play when running without any load, but bears toward commutator-end bearing when the load is thrown on. The commutator has been turned down only three times. The brushes are graphite, copper-plated. The commutator runs hot with all wires disconnected from the machine. If heating is caused from friction of the brushes, how can this be remedied? If the tension is reduced, sparking occurs. The exciter has new bearings and runs without practically any vibration. The builder of the machine thinks there is a damaged field coil on the alternator, which calls for excessive current from the exciter. How can this be true when the machine even runs hot with all wires disconnected?

JAMES A. WALKER.

Owensville, Ind.

## Receiver Pressure

We have a problem that is rather dif cult to solve and would like assistan in the matter. In our plant we have 14 and 28 by 36-inch cross-compound co densing engine. The high-pressure cy inder exhausts into the usual receiver an thence into the low pressure cylind Now, it is understood that if you wa to put more work on the low-pressu cylinder you must raise the receiver pr sure. In this case, if we raise the r ceiver pressure above 10 pounds it bac up in the high-pressure cylinder a causes it to carry steam full stroke; in other words, raising the receiver pr sure to get more work out of the lo pressure cylinder only puts more w on the high-pressure cylinder, by choki the exhaust. Now, as our feed-wa heater is a closed live-steam heater a we could not turn the exhaust from pumps into it we tapped the end of receiver and piped the exhaust from $5\frac{1}{4}$ and $3\frac{1}{2}$ by 5-inch boiler-feed pu and also the exhaust from an 8 and by 12-inch circulating pump into the ceiver, which would raise the pressure 13 and 14 pounds, releasing the load the high-pressure cylinder, making a m earlier cutoff and at the same time ca ing the low-pressure cylinder to do horsepower more work.

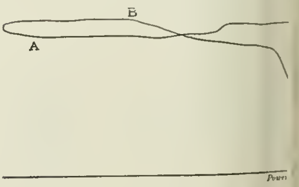
Now, why is it that we cannot b this receiver pressure up to 14 pou with a short cutoff and get same res or, why is it that this exhaust steam f the pumps that is turned into the rece until it builds up to 14 pounds does choke the high-pressure cylinder?

E. A. BALDWI

Great Bend, Kan.

## A Freak Diagram

The accompanying diagram was ta from a 14x36 Slater engine one mor after some repairs had been made by



A FREAK DIAGRAM

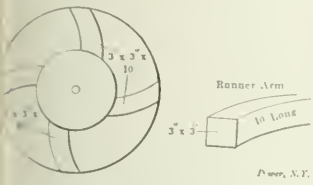
night engineer. The key was out of bell crank of the exhaust valve and steam valve would not unhook and pushed so far up on the seat that it w not entirely close.

WILLIAM R. CAT

Groveton, N. H.

## A Centrifugal Pump Puzzle

Accompanying is a pencil outline of the nning part of a centrifugal pump, sub- ited for the purpose of giving young aders something to figure on. It is mple, yet a puzzle to a beginner in the gine room.



CENTRIFUGAL PUMP PUZZLE

Suppose the "boss" comes in and asks engineers how much water this centrifugal pump will put into a tank in one , and how much horsepower it will t run it. There are four runner s 10 inches long and 3 inches square. shaft hole is 2½ inches in diameter, pump runs at 350 revolutions per min- nd the lift is 24 feet.

How would you "figger" it out to let boss" know you knew how?

A. I. Haight.

Kalamazoo, Mich.

## Centrifugal Pump Peculiarity

centrifugal pumps running at the peripheral speed, no matter how vanes of the runner are curved, have peculiarity that when delivering no r—that is, running with closed dis- ge valve—they create the same pres- r head in the pump chamber. This to the fact that this head is di- y dependent upon the peripheral d of the runner, that is to say it s as the square of this speed. Now discharge valve of the centrifugal be opened to deliver varying quan- of water, keeping the velocity of nstant, and the head correspond- each delivery of the pump deter- d by means of a pressure gage, as- g of course that the discharge is d directly above the outlet of the , so that the water is delivered freely t atmospheric pressure, it will be d that the values of the quantity of r delivered and the corresponding will vary considerably, according the design of the runner vanes. Start- in with the head at no delivery, this l first rise with increasing delivery— t is, as the discharge of the pump is ng throttled less and less—attaining a tain maximum value and then falling as the quantity of water delivered by pump is still more increased until lly the pump has reached its maximum output, when the head will have become = 0, this point, however, being difficult to reach.

The efficiency, that is water horsepower, divided by the actual horsepower expended, will of course vary from 0 for no delivery to a maximum and back to 0 at maximum output against a head = 0.

The power consumed in the case of vanes curved forward or backward will have a definite value at no delivery, gradually falling off until it reaches a certain minimum and then rising more quickly, reaching its highest value at maximum output. For vanes ending radially the power consumption keeps on increasing from the beginning.

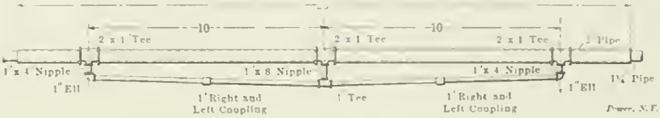
Thus it is quite a common thing to have a pump delivering a certain quantity of water against a corresponding head, consuming a definite amount of power, whereas when working against a smaller head it will not only deliver less water, but also consume more power, due to the reasons stated.

Paul Nettmann.

Aix la-Chapelle, Germany.

## Combined Truss and Steam Pipe

About a year ago, in the plant of which I am in charge, I found it necessary to run a 1¼-inch steam line to a small two-story building in the yard, 24 feet from the main building, for heating purposes. To run underground it could not be drained, as the top of the sewer pipe is flush with the surface of the yard. The space between the buildings is used as a driveway for high-top loaded trucks. It had to go overhead, with an elevation not less than 16 feet. With the tools and material on hand I assembled what I call a good substantial truss and outdoor steam pipe covering combined, as per the accompanying sketch.



COMBINED TRUSS AND STEAM PIPE

Joseph Quinn.

Brooklyn, N. Y.

## Wants a Guard Rail for the Flywheel Pit

Someone should start a method to compel all concerns installing large engines to have a guard rail around the flywheel pit. This should be made a law, as there are too many accidents due to the wheel pit being unguarded. Not only is the person in attendance liable to step into the pit, but a piece of iron or timber may fall into it and do a lot of damage. I remember of a piece of timber falling into a wheel pit, causing the flywheel to go to pieces, and I frequently have seen a wrench or pipe roll off into the pit.

Not long ago, in Ohio, a friend of the writer stepped back into a flywheel pit and no one was left to tell the tale. The poor fellow was torn to pieces by the large wheel. Here in this city a young man was caught by a twenty-foot wheel and turned for a few moments and hurled some twenty feet. It seems that his clothing was caught. Now, there should be some protection against such accidents.

I have witnessed so many of these accidents that it has prompted me to write a few lines on the subject and I should be pleased to hear from others, too.

C. R. McGahey.

Richmond, Va.

## A Peculiar Engine Delay

The accident was to an 11 and 22 by 14-inch cross-compound noncondensing direct-connected Buckeye engine, running at 200 revolutions per minute. The usual practice during summer months was to shut down through the noon hour. As customary, the engine mentioned was started at 12:40 and allowed to come up in speed, but before it reached full speed, there occurred a sharp knocking in the high-pressure cylinder. In the boiler room one of the boilers showed a full glass. After blowing down the boiler, the engine was started a second time. As everything appeared favorable, the speed was increased, but the same knocking was experienced.

At this stage the second engine, which is 11 and 22 by 14 inches, was started. On taking off the cylinder head of the first engine, a small corner was found to be broken off the ring. The piece being larger than the clearance, it appeared to be the cause of the trouble. The head was replaced and the engine slowly started, but the same knocking took place.

Next the cylinder cocks were taken off, and on removing the second one the trouble was solved. A small piece of well worn steel, about the size of a small peanut, was blown out. After replacing the cylinder cocks the engine was started without further delay.

Frank W. Bellinger.

Havre, Mont.

# Subjects Under Discussio

Comment, Criticism and Debate upon Various Articles, Letters and Editorials Which Have Appeared in Previous Issues

BRING OUT YOUR IDEAS

## Heat Transfer and Future Boiler Practice

In Arthur H. Allen's article on this subject in the September 21 number, Doctor Nicolson's formula is probably quoted correctly, but without further explanations than those given the equation does not appear to be correct.

By inserting the names of the various values the equation would read:

$$\frac{\text{B.t.u.}}{\text{hr.} \times \text{ft.}^2} = \left[\frac{\text{temp.}}{200} + \frac{1}{40}\,\text{temp.}^2\left(1 + \frac{1}{\text{inches}}\right)\frac{\text{lb. ft}}{\text{ft.}^4\ \text{sec}}\right](\text{temp.} - \text{temp.}) \qquad (1)$$

$$= \frac{\text{temp}^2}{200} + \frac{1}{40}\,\text{temp.}\left(1 + \frac{1}{\text{inch}}\right)\frac{\text{lb.}}{\text{ft.}^2\ \text{sec.}}. \qquad (2)$$

The equation as it now stands cannot be correct, but if the constant 200 is an expression of $\frac{\text{temp.}^2\ \text{hr.}\ \text{ft.}^2}{\text{B.t.u.}}$, and the constant $\frac{1}{40}$ an expression of $\frac{\text{B.t.u.}}{\text{temp.}^2\ \text{lb.}}$ and the numerator 1 is in inches then equation (2) would become:

$$\frac{\text{B.t.u.}}{\text{hr.} \times \text{ft.}^2} = \frac{\text{temp.}^2}{\text{temp.}^4\ \text{hr.}\ \text{ft.}^4} + \frac{\text{B.t.u. temp.}}{\text{temp. lb.}}\left(1 + \frac{\text{inch}}{\text{inches}}\right)\frac{\text{lb.}}{\text{ft.}^4\ \text{sec.}} \qquad (3)$$

$$= \frac{\text{B.t.u}}{\text{hr. ft.}^2}\quad \frac{\text{B.t.u.}}{\text{ft.}^4\ \text{sec.}'} \qquad (4)$$

and the equation would then be correct.

H. S. Bowen.

Chicago, Ill.

## Will a Centrifugal Pump Do the Work?

I am operating a "central condensing station," condensing the steam from three compound Corliss engines. We have two 6000 gallons per minute, steam-turbine-driven centrifugal pumps, single-stage.

When a pump is [illegible] the gage on the [illegible] a vacuum of 13 inches and [illegible] against a head of [illegible]. The total lift for this pump that is [illegible] is 56 feet, so these pumps are not worked at their full capacity.

As regards reliability, one of the pumps has been running from [illegible] Monday until 5 a.m. the following Sunday, 24 hours daily, week after week, for almost three years, and for the last year has never failed to do its full duty and has not caused one moment's trouble.

The only repair to this unit has been to renew the brass bushings or sleeves that are fitted on the pump shafts when they pass through the packing boxes.

When first started up this pump was a "humbug;" it could not be trusted a half hour at a time, but the cause of the trouble was not in the pump, but was due to keeping the packing in the pump stuffing boxes too tight, thus burning the packing; then the pump got air and the suction was broken. After learning to have the packing free, we have had no trouble whatsoever.

These pumps run at 1270 revolutions per minute and the impeller is about 15 inches in diameter.

Mr. Corwin will find that these pumps will lift by suction just as well as any reciprocating pump, but the suction line must be airtight, as only a very small air leakage will destroy the suction and once it is lost the pump must be stopped and started again to create the vacuum again.

When a centrifugal pump is in operation and discharging against a head, if the vacuum breaks and the pump loses its suction, the water in the discharging line ceases to flow and as long as the pump is left running the impeller will hold this water in the line, and it will be impossible to create a vacuum again in the suction as long as this condition exists.

There are two ways we have used, when our pump loses its suction, to start the water again; one is to stop the pump and as soon as the discharge line is drained out start the pump again, or else we close the gate valve in the discharge line and open the vent or drain line at bottom of the discharge line, next to the pump. This allows the pump to free itself of all air, water or vapor that may pass the impeller without creating any pressure on the discharge side of the impeller, and the pump will pick up the water; as soon as a solid stream appears, the pump is ready for work again. Th second plan does not require the pump be shut down.

Mr. Corwin will find just as we h that a centrifugal pump is as dependa and reliable as any reciprocating pu if not more so, and the attention requir to keep it up is only a very small per c of that required to keep up a reciproc ing pump.

I have started this pump dry (that with no water in it), with the suct valve closed and the delivery line op and the pump has created a vacuum of inches on the suction side. This amo of vacuum will be abundant to fulfil Corwin's requirements.

I believe Mr. Corwin will be perfe satisfied if he installs a centrifugal pu but I think for his work he should h a two-stage unit.

Harry W. Benton

Cleveland, O.

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I have been for several years operat a 14-inch single-stage Worthington c trifugal pump and at all times the v uum gage on the suction line regist 27.5 inches, which would show an equi lent lift of over 29 feet.

John Hurs

Louisville, Ky.

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In the September 21 issue L. Cor asks the above question.

The greatest hight through whic centrifugal pump will draw water is al 27 feet. For this maximum lift spe precautions must be taken to insure suction pipe line being air tight, espec ly so when the suction head exceeds or 17 feet. The less the suction head the shorter the pipe, therefore, the ter; and, except under extraordinary cumstances, 17 feet should not be ceeded.

A two-stage pump would be prefer. for the lift given (115 feet), from point of view of efficiency, the limi economical head for a single stage pu being about 100 feet; but I very m doubt if the two-stager would increase suction head available to any useful gree.

If Mr. Corwin could get his mac nearer the water level the case would pear to be an ideal one for a two-st small diameter pump.

Under existing conditions, my answer to Mr. Corwin's query is: "No."

JOHN S. LEESE.

Manchester, England.

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Mr. Corwin asks in September 21 issue about a proposed centrifugal pump installation.

His main question is in regard to the suction which has to be carried through 300 feet of pipe and to such a hight that the vacuum at the pump may be as great as [illegible] inches of mercury.

Centrifugal-pump salesmen, he says, maintain that the centrifugal pump is the equal of a reciprocating pump for any purpose, that is, will operate as well at a high suction head.

This may be approximately true under ideal conditions, which do not often exist in practice. These conditions include the tight pump and stuffing boxes as well as the character of suction pipe.

A reciprocating pump has a positive displacement, and without any water at all will produce a vacuum depending upon the amount of clearance and slip of the valves. Even though the slip might be considerable, the strokes might be increased and still pump about the same quantity of water.

In a centrifugal pump, the capacity falls off as the total head is increased. But it is a fact that the falling off in capacity is greater if the additional head is added to the suction rather than the discharge side, and cannot operate at all at high suction if there is chance for much air leakage. At low suction heads a considerable air leakage might not interfere with the operation of the pump except only to decrease the amount of water delivered. But at the high suction lifts, even if we neglect the additional amount of air which must leak through, the air is expanded to occupy a much greater volume.

In addition to the air leakage which we may always expect to find in practice, the air which is naturally contained in the water should not be left out of account. The air will displace the water causing a falling off in capacity although the pump may continue to operate if the air passing through the pump is thoroughly mixed with the water. If, however, the leakage is irregular, the pump may get a quantity of air suddenly and [illegible]

The operation at high suction lift is far more uncertain if the pump is being used for a higher lift than that designed. Then there may be a faulty proportioning of the pump passages; this is more common than is generally supposed, even with the reputable pump builders.

The number of stages would make no difference, and a pump of two or twenty stages could make no better suction lift than a single impeller.

The fact that reciprocating-pump repairs can be made in reasonable time is no argument for continuing to do so and to operate most of the time at low efficiency.

There are, no doubt, many pumps doing service at this extreme suction lift, but it is too high to expect permanently quiet and satisfactory results from any pump where the suction line is so long with corresponding opportunity for air leaks.

It would seem like a better proposition to use some of the money thrown away on repairs and in operating the pumps at decreased efficiency after the valves and cylinder are worn, to build a concrete pit to decrease the suction head, or build a shed nearer the source of supply and install centrifugal pumps under more favorable conditions.

Even with gritty water, centrifugal pumps will give months and possibly years of service, with good bronze impellers. They require practically no attention and the confidence of knowing there would be a reliable supply of water at all times without worry of repairs, would soon win over Mr. Corwin to the opinion that under proper conditions the centrifugal pump is the ideal for such a service.

R. PRATT.

Lynn, Mass.

## Cooling the Exhaust of a Gas Engine

S. M. Dunn, in the October 12 issue, evidently overlooked the fact that in the steam-engine example which he cited, the expansion curves are not the same in the two cases.

Whereas the engine may have the same apparent expansion curves, whether operating with or without a condenser, such is not actually the case, for that part of the expansion curve shown at the end of the indicator diagram as an approximately vertical line is longer when the engine operates condensing than when exhausting into atmospheric pressure.

The total adiabatic expansion which takes place within the cylinder is from the pressure of admission to that of exhaust and by decreasing the exhaust pressure (holding the admission pressure as before) the range of temperature within the cylinder is increased.

There is, in fact, the same range in temperature within the engine cylinder whether the expansion gradually follows the stroke of the piston all the way down to the condenser pressure or whether it drops suddenly to this lower pressure on the opening of the exhaust valve at some intermediate point. There is actually the same amount of energy derived from the working fluid in either case, but for the engine with early release, this energy is largely wasted in causing the exhaust steam to have a very high velocity through the exhaust passages, a form of energy, which in the steam engine is not available for the direct production of power. In other words, the range in temperature within the engine is independent of the point of release, depending entirely on the difference in pressure of the source over that of the condenser.

However, this is entirely outside the question at issue, that of increasing the power obtainable from an engine by cooling the exhaust alone and without a vacuum-producing auxiliary.

The statement in the last paragraph of his letter, that there is a vacuum-producing tendency in the exhaust of a gas engine is quite true. However, as to the effect of introducing a cooling means into the exhaust, there is an opening for an interesting discussion.

Consider a gas engine in which the charge expands to 30 pounds per square inch just before release. The exhaust valve opens and the gases escape into the atmosphere. With the drop in pressure from the 30-pound initial to the 15-pound final, an extremely high velocity is given to the exhaust gases. Now, cause this mad, impulsive rush of the gases from the cylinder to be confined within the limits of a long exhaust pipe of suitable cross-section and they will endeavor to carry along with them everything remaining within the cylinder. Therefore, immediately following each discharge puff in the exhaust pipe, there is established a partial vacuum at the exhaust valve.

Suppose that a cooling fluid is mixed with the exhaust gases at this point. The gases will be cooled and therefore deprived of some of the energy which is serving so usefully in trying to produce a vacuum. The gases will decrease in volume on being cooled. With less volume there will necessarily follow less velocity through a given size passage and the momentum of the moving charge—the force which causes the suction—is decreased.

Moreover, the cooling water has to be taken up from rest by the exhaust gases and carried along, so that the resulting velocity of the two is much less than otherwise. It would seem that by cooling the exhaust, one would be decreasing its vacuum-producing power.

H. B. STILZ.

Philadelphia, Penn.

## Condenser and Cooler Installation

In regard to W. E. Turner's "Condenser and Cooler Installation," in the September 28 number, I think his way of tapping the pipe which encircles the pond is a good one, but since he plans to place the condenser at such a hight that he will get enough fall from the hotwell to force the water through the 4-inch header, I suggest that he put the 4-inch pipe about five feet above the surf[illegible] the water in the lake, and have the [illegible] inch pipes tapped so they will point [illegible]wardly (as he shows them in the diagram), and also at an angle of about 45 degrees upward. This will make a much more effective cooling scheme than placing the pipe under the water. Although it is true that the hot water will tend to travel upward, this advantage is more than made up for by the cooling of the water before it comes in contact with the water in the lake; and the water should be taken from the middle and the bottom of the lake for the condenser.

J. H. JACOBUCCI.

Rawlins, Wyo.

## Ash Separator for Suction Ash Conveying System

In a recent issue an admirable article gave the details of a suction ash-conveyer system. To prevent the ash from passing over into the suction blower and scoring the blades, a settling tank was provided. This would be accomplished more effectively by a centrifugal draft producer and ash separator placed as shown in the accompanying sketch.

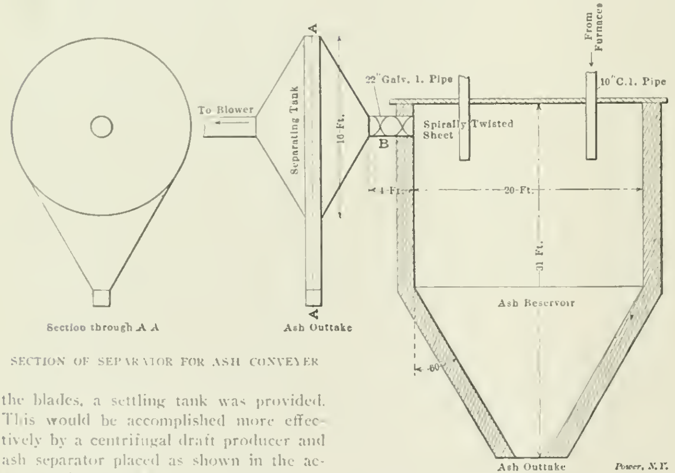
A piece of sheet metal, 22 inches wide is twisted spirally into the shape of a twist drill until it just fits inside the 22-inch pipe at *B*. By means of tongues at the corners of the sheet and four rivets the piece can be fastened to the pipe.

Most of the wet ash settles in the larger tank. The draft containing small particles then passes through the pipe *B* into the torpedo shaped galvanized iron separating tank. The centrifugal whirl attained while passing through *B* throws the ash particles to the outer edges of the tank, and finally lodges them above the outtake. The air passes on through the suction pipe free of ash dust. This is the principle which has worked so well in certain steam separators. If necessary, baffle plates might be used.

The dimensions given are tentative. The 60-degree angle used throughout has been found by experiment to be a safe one for the sliding of ash on most surfaces. Details of the piping and devices for wetting the ashes and producing a draft are omitted, as they are explained in full in the previous article. The fact that there are two ash outtakes could be remedied by placing a chute so that the ashes from the smaller tank would be delivered under the larger one.

W. T. DAMON.

Ithaca, N. Y.



SECTION OF SEPARATOR FOR ASH CONVEYER

## Boiler Room Ecomomy

In the August 3 number, R. Cederblom suggested a method for heating the air for the furnace by means of the heat in the waste gases.

While the intention is good, the design appears to me to be slightly at fault, and the principal objection to it has been pointed out by F. McMahon in the October 12 number, viz., stratification. The hot gases would take the upper passages and the air the lower ones.

Would it not be better to make a box of rectangular cross-section, a square tube sheet at each end, and the box filled with tubes as in a surface condenser? Second-hand boiler tubes would be good enough and would not cost much. The waste gases could flow through the tubes and the air through the space surrounding the tubes. The air could enter the box at one end and leave at the other end at the top. If the gases entered the tubes at that end of the box from which the air left, we would have the benefit of the contraflow principle.

The sketch, which is a plain view, will help to convey the idea. The sides as well as the top of the box could be open at the ends so as to facilitate the entering and the leaving of the air.

A point to be considered in conne with heating of the air by the gases is the effect the reduction of perature of the gases will have or draft. The interposing of this incr resistance would also retard the dr.

There are not many plants in such a scheme would be practicable out assisting the draft by some mech means.

However, there are several tu blowers on the market which are installed.

An inexpensive scheme would run a pipe to the top of the boiler and thus supply the hottest air in room to the furnace. This shoul sult in considerable economy and dentally make the boiler room more fortable.

A common idea is that the eco resulting from heating the air by gases is due to the return of heat to the furnace, whereas there is that it is due to the better combusti sulting from the higher temperatur

In an experiment conducted for th pose of finding the best way to powdered coal, and reported in P May, 1904, the air was heated to 7 grees Fahrenheit, and the increased oration resulting therefrom amount about 19 ounces. The air in this was heated by running the air through the furnace, thus taking th from the furnace.

Someone should construct an air l and report results in POWER so th will all know what to do.

R. McLA

Berlin, Ont.

## Safety Cams and Trip Col

In July 30 number, L. R states that he does not agree wit statement, published in issue of J because, he says, "the remark ref a single-eccentric Corliss engine.

An engine, either single or doub centric, is not correctly adjusted, valves are not disengaged, or tripp the trip collar, when the valve ge reached its full travel, with the go down on the safety rest.

Let us consider Mr. Roundy's re assuming that the engine is perfect justed except for the trip collar safety cams. The trip collars a back so that when the governor is on the safety rest in the positio starting the engine, that is, the p where the engine should receive its mum amount of boiler pressure latest point of cutoff—the valve tripped but is held on by the hoo is closed by the valve gear on its stroke (and not by the dashpot) giving a point of cutoff near the

the piston stroke and, instead of being the sharp cutoff that is characteristic of the Corliss valve gear, it is a slow cutoff giving a rounded, sloping line to a diagram. Now, just as soon as the speed of the engine is sufficient to cause the governor to rise, the trip collar comes into action and causes the valve to be tripped and continues to do so in its true manner, varying the point of cutoff according to the various loads on the engine. Mr. Roundy states that this is the correct adjustment for a single-eccentric Corliss valve gear. I say it is not. While it is an adjustment quite within the limit of such a valve gear, yet I claim it is [illegible] bad practice and one that should not be followed.

When a single-eccentric valve gear is correctly adjusted, excepting the trip collars, and they are set as stated before, the eccentric is set 90 degrees plus the angle of advance ahead of the crank; it can be set exactly 90 degrees ahead of the crank, but this would give a late release and no compression, while a small angle of advance allows the exhaust to be correct and gives a small amount of compression. Assuming, then, the eccentric set 90 degrees plus a slight angle of advance ahead of the crank, when the engine is being started the valve will be closed by the valve gear, and not by the dashpot, because the trip collar does not engage with the toe of the hook; hence the point of cutoff will be near the end of the stroke and because the exhaust valve opens a trifle before the piston reaches its full travel, almost boiler pressure is exhausted to the atmosphere. This condition continues until the governor rises sufficiently to bring the trip collar into duty, then the valve is tripped, and closed by the dashpot; then the valve is closed a little before one-half of the piston stroke and the steam expands for the balance of the stroke, and when the exhaust valve opens, the pressure exhausted to the atmosphere is considerably reduced due to the expansion of the steam.

There are three events in each stroke of each type of engine, that are positive under all variations of speed and load: namely, admission, release and compression. The one point or event in the steam distribution of each stroke that is variable is the point of cutoff, and the only difference between the two types of valve gear, or rather the only difference in the steam distribution between the two types of valve gear, is in the range of the point of cutoff.

The single eccentric is limited to a trifle less than ½ of the piston stroke, while the double eccentric will cut off up [illegible] of the piston stroke.

It is the duty of the governor to vary the point of cutoff to suit the requirements of the engine according to the varying conditions of the load.

In order that the governor may perform its full duty, it must have full control of the point of cutoff at all times, and each and every rise and fall of the governor, no matter how slight, must change the point of cutoff.

If the single-eccentric valve gear (complete) is correctly adjusted, the latest point of cutoff will be about ⅜ of the piston stroke, but may vary a little one way or the other of this point, due to the position of the eccentric, but the governor will unhook the valve each and every stroke, and this latest point of cutoff will be obtained when the governor is down on the safety rest. In this position the trip collar trips off the hook when it has reached its extreme travel in the direction that opens the valve.

Now, if the trip collar is set back from this correct position, and is adjusted as Mr. Roundy states, the governor has no control of the point of cutoff beyond the point just stated, yet the engine gets boiler pressure or the latest point of cutoff is near the end of the piston stroke; this condition then means that the latest point of cutoff is, say, ¾ of the piston stroke while the latest point of cutoff controlled by the governor is ⅜ of the piston stroke.

When an engine running in this condition is loaded so that the governor stands in a position that just trips the valve at its latest travel, opening the valve, the least addition to the load will cause the governor to drop and throw the trip collar out of duty and the latest point of cutoff becomes almost full stroke; this gives a tremendous thrust to the piston for a few strokes and the governor rises much too high, the point of cutoff being too early, down comes the governor too low again. Just as long as the engine has this heavy load on, the governor will hunt, and the speed of the engine will be unsteady. It is because the governor has not full control of the point of cutoff at all times.

With the double-eccentric valve gear, the latest point of cutoff may be ⅞ of the piston stroke, and be under the control of the governor at all times, because the exhaust valves are operated by one eccentric and it is set in the same position as the one eccentric in the single-eccentric valve gear, while the steam valves are operated by a separate eccentric and this eccentric can be set only at an angle of advance ahead of the crank sufficient to remove the lap from the steam valves and open the valve the amount of lead desired. Thus the valve gear for the steam valves reaches its full travel in the direction, opening the valve just a trifle before the end of the piston stroke, and the trip collars are set to unhook the valve when it reaches this position, and the dashpot closes the valve just before the piston reaches full stroke.

I hope I have satisfactorily explained my position in this matter. Mr. Roundy's statement is true, yet it is a bad practice and should not be followed. Mr. Roundy will find that a single-eccentric Corliss engine is not at all inconvenient to handle when adjusted correctly. I have handled both types and indicated and adjusted both types and some very large compound condensing units, too.

The trip collars are set (for both types of valve gear) when the governor is down on the safety rest in position for starting the engine, they are placed so that when the governor is let right down in its extreme position the hook is held off by the safety cam and cannot pick up the valve, and open it; hence, no steam can be admitted to the cylinder, and the engine must stop.

When a Corliss engine is correctly adjusted it is an impossibility for it to run away or race; that is, so long as no mechanical derangement occurs in the valve gear.

In July 27 number, W. E. Crane undertakes to explain how he gets a point of cutoff at ¾ of the piston stroke. Unless the action of the dashpot is retarded, it is impossible to get a point of cutoff at ¾ the piston stroke when the eccentric is set 90 degrees ahead of the crank. If a steam valve eccentric is set 90 degrees ahead of the crank, and the trip collar is adjusted correctly, the valve will positively be tripped, exactly when the piston is on ½ stroke.

Now, how does he expect us to accept the idea that the valve is so slow in closing that the piston has moved another ¼ of its travel before the valve is closed?

Of course, if he retards the action of the dashpot he can secure this result, but not if he has his dashpots working well. We are positive that such a late point of cutoff cannot be obtained when the eccentric is set 90 degrees ahead of the crank, unless some trick is worked on the dashpot.

HARRY W. BENTON

Cleveland, O.

## How Shift Changes Waste Money

I have read J. M. Whitham's article, "How Shift Changes Waste Money," September 21 issue. The remedy given is to permit no fireman to wash and change clothes until his relief has gotten into firing togs and is in position for duty and work. Now, Mr. Whitham admits in his article that the firemen are tired after their long hours of labor and anxious to get away. Consequently, if there is such a great waste of coal during morning and evening changes, why does not Mr. Whitham, instead of increasing the already long hours, give the true remedy as pointed out in an editorial, issue of June 22, and advise his client, accordingly?

ALBERT L. ANDERSON

Douglas, Alaska

## Saving by Throttling Steam

In the October 12 issue, W. E. Crane states that if dry, saturated steam at 100 pounds pressure absolute, is throttled to 80 pounds it will be superheated 10 degrees, then, assuming the steam to have a quality of 98 per cent. at a pressure of 100 pounds absolute, he attempts to show that on throttling to 80 pounds it will not be superheated. Evidently Mr. Crane thinks a degree Fahrenheit and a British thermal unit are one and the same thing for he mixes them indiscriminately and gives a solution that is meaningless.

The total heat in a pound of steam at a pressure of 100 pounds absolute, as given by Reeve, is 1181.4 B.t.u., while at 80 pounds it is 1176.4 B.t.u., which gives 4.7 B.t.u. available for evaporating the 2 per cent. moisture. The latent heat of evaporation at 80 pounds is 895.3 B.t.u. for one pound of steam or 17.9 B.t.u. for 0.02 of one pound, which shows that the amount of heat available is only about 25 per cent. of that necessary. The final result would be an evaporation of 0.0052 pound of water or a quality of 98.52 per cent.

W. L. DURAND.

Brooklyn, N. Y.

## Cylinder Lubrication

The writer has charge of a power plant containing four compound engines, two 18 and 30 by 16 and two 16 and 27 by 16. The engines were equipped with ordinary sight-feed lubricators and a cheap grade of cylinder oil was used. After some time and some strenuous kicking, we got a good grade of cylinder oil and cut the amount down at least one-third. Then after a time we equipped the engines with a force-feed pump and cut the amount down one half.

We operate one 18 and 30 by 16 engine at 220 revolutions per minute, twenty hours per day, one 16 and 27 by 16 at 250 revolutions per minute, twenty-four hours, and the others fourteen hours, and use on an average of 1 quart of cylinder oil in twenty-four hours. We find that our engines are well lubricated; and what oil we can save from the exhaust is filtered and used over again in the crank cases. I find it more economical to use a good quality and less quantity, especially with high-pressure steam, and the difference between a good grade and poor grade can be noticed in the drippings from the exhaust line.

I was at one time compelled to use a cheaper grade of oil (one of the "just as good" kind), and knew that I would have a hard time to convince the management that it was not suitable. I used the oil for some time and noticed the effect, making a few simple tests which gave me good data, which I presented to the management. Since then we have been getting good oil.

C. E. NIGH.

Morgantown, W. Va.

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I think that this is the most important question of the day to operating engineers. I run an 18 and 36 by 42 cross-compound condensing engine at 72 revolutions per minute, and in twelve hours I use just about 1¼ quarts of "Improved" high-pressure cylinder oil made by the Inter-Ocean Oil Company. I have not tried to see just how little I could get along with, but I know that when the engine was erected, over two and a half years ago, the man from the shops centered the piston on the low-pressure cylinder and said: "I will leave this just a trifle high. In about three or four weeks you will have to recenter it, as it will wear so as to get too low."

I did not think the piston was getting low, so I ran the engine day and night for two years, when we had a break in the frame at the crank end. We had the same man from the shop to replace the broken part. We put the low-pressure piston in and I told him to center it and tell me how much wear there had been in two years. He went over it and reported that it still was a trifle high.

Now, should I destroy that record by trying to see how little oil I could get along with, or should I still use the same amount? The cost may be 13 or 14 cents for twelve hours' run. I should like to hear from others on this. Some may think that the men who made this examination are dead, but they are not. They are alive, and ready to testify to these facts.

S. P. EATON.

Kansas City, Mo.

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Two engines in one plant, one a Greene, 20x44, the other a Harris-Corliss, 24x48, both making 100 revolutions per minute, use each 1 pint of cylinder oil per day of 11 hours, or 7 to 8 gallons per month for both engines. With this allowance of oil the cylinders are always found to have a good coating of oil.

Another plant having a pair of 24x48 Corliss engines, coupled together, making 102 revolutions per minute, run on a pint of oil per cylinder per day of 11 hours.

At another plant having a 40x54 tandem-compound engine, Porter-Allen type, making 75 revolutions per minute, running 24 hours a day, the daily consumption for both cylinders is one gallon. These amounts could perhaps have been reduced still further without danger to the engines.

I was much interested in reading Mr. Crane's article in the September 7 issue, and from my own experience I can a with him in what he says in regar the groaning of engine valves, the c and remedy. Trying to overcome troubles by using great quantities o is like giving a patient medicine whe needs a surgical operation.

Engineers sometimes find that their valves run quietly the valve cylinder surfaces, when examined, found to be dry, even when using quantities of oil. This is due to the that the steam is very wet and the inder oil does not contain a large en per cent. of fatty oil. As Mr. Cran plains, it is necessary that the o compounded with some animal or oil, so as to form an emulsion wit moisture in the steam and enable cling to the surfaces. Petroleum itself has no affinity for moisture, a used in the cylinder it would be w right through with the steam, so customary to combine a fatty oil wit petroleum cylinder stock. Tallow usually used for this purpose; this oil that is expressed from the tallo is known in the oil trade as ac tallow oil.

Where the steam is fairly dry, fr to 6 per cent. is usually sufficient t good service, but where the steam is wet a larger per cent. may be nece The writer has known of one instan the case of a large compound e where a compound of 5 per cent. low oil gave excellent results in the pressure cylinder, but the low-pr cylinder was always found to be dry after using an excessive quantity. increasing the content of tallow 10 per cent. overcame the troubl even after using a very moderate a of oil the cylinder and valve surface found to be well coated with oil.

Engineers should learn to make own tests and experiments and th no better place than right on thei engines and pumps. But first they know something about the proper the oils they are using, the g flash test, viscosity, etc. Not th relative lubricating value of two o be determined by them, any mor one can determine by the result calorimeter alone what is the mos able and economical coal to use; b are of assistance in comparing with another, and as these tests are and easily made every engineer have a set of instruments for th pose. A saponification test to det the per cent. of animal oil in a c oil, however, involves some knowl chemistry, and unless one has t paratus at hand and has had some ence in this work it would be bet cheaper to send the samples to a for analysis.

W. A. T

Boston, Mass.

# Philadelphia's Manufactured Coal

By Thomas Wilson

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The statements that Philadelphia is a slow town, that the people are conservative and their methods of doing business belong to the old school, are so often made that a great many people actually believe them and think that the Quaker City is all this, and then some. There may be, perhaps, a basis for the above remarks, but impressions depend largely upon the viewpoint, and in my way of thinking it would appear that most of the critics had opened their mouths and shut their eyes, and missed much of Philadelphia's greatness. At any rate, it is almost a certainty that most of them, and perhaps some more of us are in the same plight, have never heard of the United States Coal Manufacturing Company and the wonderful heat-giving qualities of its coal blockettes. The blocks, 1 inch square by ½ inch thick, are made from ordinary run-of-mine coal crushed and treated with five different chemicals, and, according to William J. Wilson, consulting engineer of the company, will burn twice as long and give twice as much heat as an equal weight of the best hand picked anthracite. The same authority was not willing to agree that pound for pound the blockettes contained twice as many heat units as the anthracite, but backed up his claims by numerous anecdotes which may be of interest.

The first was a test on an Elmira boiler conducted at Reading, Penn. With the best bituminous coal, a steam pressure of 40 pounds and a water pressure of [illegible] pounds, gage, were obtained in [illegible] minutes; but with the fuel made by the United States Coal Manufacturing Company, it only took one-quarter of a [illegible] longer to raise 80 pounds steam pressure and a water pressure of 300 pounds. The test on the blockettes was continued for 25 minutes, and without any additional firing the boiler blew off at 80 pounds pressure the greater part of the time. Besides, the bituminous coal had the advantage of an exhaust blower, while with the blockettes this apparatus was not called into service.

Another test was made with equal weights of manufactured fuel and the best hand picked anthracite in two stoves in which the conditions were identical, that is, the same draft, same make of stove and everything as nearly alike as it was possible to have it. A committee was appointed to conduct the test, and, according to their report, the anthracite burned six hours, leaving 28.5 per cent. ash; the manufactured coal burned 12 hours and 30 minutes, and only 14.2 per cent. of ash remained in the stove. The method of determining the evaporative qualities of the two coals is still more interesting. A kettle filled with water was set on the top of each stove, but unfortunately the committee in charge were a little negligent, and they burned the bottom out of the kettle on the stove using the blockettes, as all the water had been evaporated, and upon examination found that the kettle on the other stove burning the hand picked anthracite was still half full of water. Such circumstantial evidence proved conclusively to the committee and also to Mr. Wilson that the manufactured fuel had double the efficiency of the anthracite.

The superiority of the manufactured coal was also confirmed by a certain citizen of Philadelphia, who started his fire at 7 o'clock in the evening, using only one load of the manufactured coal, and at 6.30 next evening the fire was still burning. Ordinarily, three buckets of coal were required for the same service.

Upon questioning as to how such wonderful results could be obtained, it was at once made evident that the process of manufacture was a secret, and the only information forthcoming was that the coal was "chemically and mechanically treated and mechanically and chemically mixed." No special urging was necessary to bring out the statement that the coal was a far superior fuel for anything. According to the test, it excelled for domestic use, was the best fuel with which to generate power, and in the manufacture of steel had exceptional merits. If the coal were sold at the same price as anthracite, the company would easily make 100 per cent. profit, and furthermore could guarantee that its coal would do twice as much work as the best selected anthracite. Not only this, but the blockettes would not produce smoke, and the death-dealing gases common to anthracite and other fuels would be entirely burned in the furnace.

It appears that the company is now erecting a large plant on the Schuylkill river to manufacture the coal which will be brought from a mine about 100 miles distant through a pipe-line running the entire distance. The coal will be pulverized at the mine, and, with water as a carrying medium, will be conveyed from the mine to the works by a series of pumping stations. According to Mr. Wilson, the plant will be ready for service within a comparatively short time, probably four months at most.

It may be of interest to look back a few years and review some of the company's past history; for, according to the "*Philadelphia Press*," the company was organized in 1903, and its origin is not nearly as recent as might naturally have been expected. In September of 1906, W. P. Taggart, formerly of Reading, reorganized the company, which was chartered under the laws of the District of Columbia, and issued a capital stock of 1,000,000 shares at a par value of $1 each. Of these 600,000 shares were held by Taggart, 200,000 as treasury stock, and the remaining 200,000 were put on the market. Promises were made to erect a great manufacturing plant in Frankford that would turn out 100 tons of coal blockettes a day, and as the coal was to be obtained from the culm pile, its initial cost would be so small that the company could prepare the blockettes for market at a cost of $2.75 per ton. Selling these blockettes at $6.50 per ton, which was a figure 25 cents below the cost of anthracite, would give a profit of $3.75 per ton. With such alluring figures, a number of customers were obtained for the stock and in the summer of 1907 about $70,000 worth had been disposed of. Prospective customers were taken to the office, which was located at 1339 Arch street, and demonstrations, evidently of a convincing character, were given. The same office is in use today, and consists of two very ordinary rooms, one in which the tests are conducted, and the other serving as a private office.

Many of these stockholders, however, became dissatisfied with the slow progress made by the company, and on August 7, 1907, Mr. Taggart was arrested on complaint of Oliver K. Wismer, of Philadelphia, who had invested $1550 in the enterprise. The president was accused of fraud, or, in other words, selling stock under false pretenses. To allay the fears of the stockholders, it appears that Mr. Taggart often referred to a promising offer from a great syndicate of $75,000,000. This had been refused for he confidently expected $100 per share for the same stock that he had been selling for $1 to all who would buy, and even as low as 40 cents.

On August 9, 1907, the company went into the hands of a receiver, and Taggart was sent to Moyamensing prison under $3500 bail, which he was unable to obtain, although president of a company capitalized at $1,000,000. The case was continued for some time, and on May 1, 1908, Judge Barratt directed that a verdict of not guilty be found in favor of Taggart. Witnesses had testified that Taggart notified the shareholders that he had been offered $75,000,000 by a syndicate to sell out, that he had paid $5000 for the secret process of manufacture, that he had obtained a contract with the Philadelphia & Reading railway, and that he was negotiating with the Government. The head of the syndicate turned out to be J. H. Wilson, janitor of a salvation army quarters across the street from the office, and in the opinion of the judge, the whole thing was too absurd to deceive intelligent persons.

However this may be, evidently the company is again on its feet, and doing business in the same old stand, with the same line of talk in regard to the large plant it is going to build, and the enormous profit it will make from the manufacture and sale of the coal.

# High-Pressure Fire-Service Pumps of New York City *

By Prof. R. C. Carpenter

The paper, which is of considerable length, was devoted to a concise description of the high-pressure pumping system installed for fire service in the city of New York, and the results of a test of the pumping machinery.

The system protects the district extending north from the City Hall to Twenty-fifth street and east, approximately, from the North river to Second avenue. It comprises about 55 miles of extra-heavy cast-iron main, from 12 to 24 inches in diameter, with 8-inch hydrant branches, and two pumping stations so located that they never can be in the center of a conflagration. At the present time the pumping stations have a combined capacity of over 30,000 gallons per minute, delivered at a pressure exceeding 300 pounds per square inch.

The two stations, known as the Gansevoort pumping station, located near Gansevoort market on the North river, and the South-street station located on the corner of Oliver and South streets near the East river, are identical in construction and equipment, either station being large enough for eight pumping units. There are now five units installed in each station, consisting of Allis-Chalmers five-stage centrifugal pumps, driven by Allis-Chalmers induction motors, and the necessary auxiliary machinery. The motors and pumps are alike, and their parts are interchangeable. The pumps each have a specified capacity of 3000 gallons per minute of sea water, working with a suction lift of 20 feet and a delivery pressure of 300 pounds per square inch. The actual capacity, as indicated by a 24-hour test, was about 30 per cent. in excess of that specified.

Each pump is direct-connected to its motor by a flexible coupling, which takes care of any variation from alinement. The motors are of the constant speed induction type three phase, 25-cycle, 6300 to 6600 volts, designed to operate at about 740 revolutions per minute. They are of the wound rotor type, and in starting an iron-grid resistance is connected in the secondary circuit and gradually cut out by means of a handwheel on the motor switchboard panel.

The specifications require the motors to have sufficient starting torque to attain full speed between 30 and 45 seconds after starting, with a current not exceeding 150 per cent. of that used when the motor is working under full speed. Each motor was required to develop not less than 800 brake horse-power when using current of 6300 volts, 25-cycle, and under these conditions to have an efficiency of not less than 92 per cent., a power factor not less than 93 per cent., and a motor slip not in excess of 2 per cent.

The pumps are water-balanced by a piston connected to the last impeller, and upon which the water pressure acts, but should any additional end-thrust occur, it would be taken up by the ball bearing provided in the outboard bearing.

The specifications for the pumping system provided for an endurance test of each motor and pump lasting 24 hours without stop, during which time the capacity and efficiency of the pumps and motors were to be determined. The specifications provided for making the test with sea water, but this was later changed to a test with Croton water under the conditions of actual use. With Croton water the efficiency guarantee was 71 per cent.

The original specifications called for a capacity of 3000 gallons of sea water per minute, against a discharge pressure of 300 pounds per square inch and a suction lift not exceeding 20 feet. The total increment of pressure is equivalent to 308.66 pounds from the intake to the delivery side. The Croton pressure varies at the stations in different parts of the day from about 40 to 13 pounds per square inch, and is affected by the amount of water being drawn from the mains. Consequently, to meet the requirements, the delivery pressure would need to be 308.66 pounds in excess of the intake pressure. There was also a further correction from the fact that sea water is heavier than fresh water, and this correction under maximum conditions might amount to 2½ per cent.

The discharge of the pumps was determined by the reading of the Venturi meters, one of which was located in each discharge line. The modified specifications also required that the efficiency of each pump should be not less than 70 per cent. and its capacity not less than 3000 gallons of sea water when lifted to a pressure equivalent to 308.66 pounds. To determine whether the requirement was met, a separate test of each pump was required.

In the test of the South street station the delivery every hour was largely in excess of the contract requirement of 15,000 gallons. The smallest delivery for eight consecutive hours occurred at the last part of the test, when the average capacity was 18,447 gallons per minute, and the average efficiency was 72.2 per cent. During this time the average pressure pumped against was 314.5 pounds, or an excess of about 6 pounds over the contract requirement. There was considerable variation in the efficiency. During the first hour the efficiency was less than 70 per cent., whereas during the third, fourth and fifth hours it exceeded 75 per cent.

The horsepower delivered by the mc rs
during the test averaged for the 24 h rs
about 920, or about 15 per cent. a
rating without excessive heating. It
thus be noted that the average result
the 24-hour tests of the South street a
tion exceeded the contract require
in capacity, pressure head and effici

For the Gansevoort station, in w
the same method of testing was app
the efficiency average for 24 hours a
72.9 per cent., with a variation, excep
the first hour, of less than one hal
one per cent. The efficiency fell b
70 per cent. during the first hour, w
was due to the opening of an auton
relief valve on pump No. 2, which
charged some of the water into the
tion before it had been metered.
least average capacity during eight
secutive hours, when all the water pu
was passed through the meters, was
419 gallons, or about 16.5 per cent. a
that guaranteed. The average net
sure in pounds was 324.3, which is r
16 pounds in excess of the contrac
quirement. The average efficiency fo
period of least capacity was 72.9
cent., which is nearly 2 per cent. r
cess of the efficiency guarantee. The
age capacity for the entire test was
gallons, which was obtained with an
age speed of 753.6 revolutions per m

Immediately after the close of th
duration tests of 24 hours' duration, a
test was run on each motor separ
which was continued long enough
uniform results were shown to obta
to 15 readings. These tests were ru
the purpose of ascertaining whether
were deficiences in any of the indi
motors.

At the South street station th
dividual pump tests showed a variat
efficiency of from 70 to 77 per cent
at the Gansevoort station of from
79 per cent. This variation may
been due to the structure of the
hut according to Professor Carper
was more probably due to variable l
past the balancing piston, or throu
relief valves.

It will thus be noted that the
operated singly showed an efficier
from 4 to 6 per cent. in excess
average when operated together.
Professor Carpenter's opinion thi
due probably to less loss in eddy c
and friction head, etc.

## DISCUSSION

On October 12 the Amercian
of Mechanical Engineers devote
evening to a discussion of cent
pumps in general and in particula Pro-
fessor Carpenter's paper. The first ake
of the evening was Prof. Geo F
Sever, who spoke of the electric fe
tures of the Manhattan statio and
primarily on the reasons for select th
system which is now in operation. After

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*Abstract of paper presented before the American Society of Mechanical Engineers.

analyzing the situation, it was decided to use alternating current in preference to gas, or building a municipal plant for which it was thought that the city was not quite ready. The reasons for choosing alternating current rather than direct current were: First, simplicity, second, absence of commutators and brushes to be taken care of; third, quick starting when necessary to operate in an emergency, fourth, less cost of copper in the distribution system to insure continuity of service; fifth, lower first cost of motors, sixth, with induction motors there are no exposed live circuits in the station, as there might be with direct-current machines.

To insure continuity of service to each station, independent feeders were brought to the New York Edison Waterside stations, one from the No. 2 station, and one from No. 1 station; also independent feeders from the nearest substations. In all four independent sources of power were provided for each pumping station.

An interesting stipulation in the contract provided that if the New York Edison Company should fail to deliver a continuous and uninterrupted service, it would be forced to pay to the city $500 per minute for each minute of interruption or delay after the power supply had been interrupted or delayed for three consecutive minutes.

William M. White, chief engineer of the I. P. Morris Company, of Philadelphia, spoke of efficiencies of centrifugal pumps and thought that there were no more accurate methods than those employed by the author of the paper; but questioned a particular paragraph in Professor Carpenter's paper, in which it was stated that the results of tests showed that the centrifugal pump operated singly had an efficiency of from 4 to 6 per cent. in excess of the average when operated in multiple. Mr. White could not see any good reason for such performance.

Mr. Bibbins was then called on to give a comparison of the two systems, the electric and the gas-driven station. Mr. Bibbins used the high-pressure system of Philadelphia as an example of the latter type of station, and first raised the question of security of supply.

In Philadelphia the Delaware station receives its supply directly from a 30-inch gas trunk line running between two large gas holders. The pipe line is roughly [illegible] miles long and the capacity of this pipe line even if both the holders were unavailable, would constitute a considerable reserve in itself. Again no intermediate apparatus whatever, except main valves, existed between the pipe line and the engines. The Philadelphia plant can draw directly on the two large holders for several million cubic feet of gas, and this constitutes a very safe and reliable source of motive power which can be only paralleled by the situation as it exists in New York, where there are so many stations to draw from. During 30 day preliminary trial of the Philadelphia station, in which time 100 alarms were given and 100 starts made, only four misses occurred in a single unit, that is, four misses on the eleven units constituting the station. There was not a single instant of which he was aware that the station had failed to respond to service. Mr. Bibbins thought it would be possible for a modified type of gas engine to be adopted which would permit of direct connection to centrifugal pumps. The cost of service in Philadelphia was about 6 cents per thousand gallons, and according to Professor Carpenter, the cost in New York was about 8 cents; but on the other hand, cost in either the gas or electrical station is relatively unimportant. The main point is reliability and the readiness to respond.

J. J. Brown, of the Wheeler Condensing and Engineering Company, with reference to Mr. White's question about the difference in efficiency of centrifugal pumps working in multiple and as separate units said that they had noticed this same thing, and thought it was due to difference in capacity of the pumps. His company had found trouble in getting one pump in on a line, and he had seen from 15 to 20 minutes wasted in cutting in a centrifugal pump when one was on the line. The second pump at first refused to deliver any water, but after it had once got to working, and a velocity through it obtained, it would run for hours without trouble.

George A. Orrok, mechanical engineer of the New York Edison Company, spoke of the guarantees and the manner in which the machinery met them. Seventy-one per cent. appeared to be very high, and many doubts were expressed regarding fulfillment of the guarantee. That the extreme figure of 79 per cent. should be obtained was in his opinion probably the result of careful design and extra good shop work. That this figure came as a surprise was explained by the fact that most centrifugal pumps are not especially designed for the work they have to do. Pump manufacturers have been more concerned in getting a line of patterns which would suit standard conditions than in developing a system of patterns for a line of pumps capable of doing the best work

Frederick Ray, of the Alberger Condenser Company, said he had noticed a difference in the efficiency of the independent unit and pumps running in multiple. It appeared to him that part of the difference might be due to the fact that when running the whole station, there appeared to be on one side of the station, two units discharging through the Venturi meters while on the other side there were three. Under such conditions, the losses through the meter would show a difference in the mercury column. It had not been his experience that there would be a difference in efficiency of running a number of pumps together as compared with running one alone The efficiency should be the same, and in this case, as the pressures were taken at each pump, any losses would have to be external to those pressures If the pressure had been taken at the discharge of the whole system, then those losses would naturally come in.

Richard H. Rice complimented the design of the station and the choice of the centrifugal pump and alternating current as the motive power; but in view of the fact that it is an emergency installation pure and simple, he thought the plant could be still further simplified. For instance, the speeds chosen for operating the pumps are too low, and the pumps contain too many stages. In his experience in operating centrifugal pumps, at turbine speed, he had found that a smaller number of stages would give an efficiency comparable with the results obtained in the New York plants. It was his opinion that the pumps could have been designed with two or three stages at most, and a higher speed employed. This additional simplicity would be of value.

C. A. Hague agreed with Professor Carpenter on the question of efficiency shown by centrifugal pumps operating singly and in multiple. He thought that the difference was probably due to disturbance in the water. In the New York stations the inlet and discharge pipe were coupled too close together, and it was his opinion that the inlet pipe was not large enough. He had found that a large body of water next to the pumps would materially ease the machines in their operation, and if connected a little farther apart, the efficiency would probably be a little nearer together and higher for the group.

Charles B. Rearick, in a written discussion, suggested that new fire pumping stations might be located adjacent to some large power plant having considerable boiler capacity, and the pumps driven by turbines, eliminating the necessity of large overload capacities in electric-generating units for the central station, and also the liability of derangement of lines between the power station and the pumping station. The charge for steam service per annum should be less than for similar electric service Steam turbines would have the advantage that they could operate at any speed, and therefore maintain in the discharge mains any pressure desired. Furthermore, automatic regulating valves could be used in connection with the turbine to maintain the pressure constant irrespective of the demand or flow It is probable that the cost of installation would be less than for electric driven units The turbines could run noncondensing, as the question of steam consumption would be of small moment for fire service.

POWER
AND THE ENGINEER

DEVOTED TO THE GENERATION AND
TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

John A. Hill, Pres. and Treas. Robert McKean, Sec'y.

505 Pearl Street, New York
355 Dearborn Street, Chicago.
6 Bouverie Street, London, E. C

Correspondence suitable for the columns of Power solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "Powpub." N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During* 1908 *we printed and circulated* 1,836,000 *copies of* Power.

*Our circulation for October,* 1909, *was (weekly and monthly)* 135,000.

*November* 2............ 42,000

*This paper reaches* 42,000 *separate readers each month and* 30,000 *each week.*

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*

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## Boiler Domes

The third recommendation of the Massachusetts Board of Boiler Rules as given in the latest issue of these rules, which has just been published, is as follows: "This Board does not recommend a steam dome on a boiler, but does recommend the use of a deflecting plate, or a dry pipe located at the highest point of the steam space, and having closed ends and small slotted or drilled openings on its upper part, a total area of openings not less than twice the area of the outlet, and an ample drain opening at the lowest point."

The object of the law is, to place such restrictions on the methods of construction and the materials to be used, and also on the conditions of operation, as will likely reduce the possibility of explosion to a minimum. It must be admitted that the usual methods of attaching a dome to the shell of a boiler, add materially to the possibility of weakening the structure, and while this can be avoided by careful design, the additional cost of such construction is an item and the manufacturer to meet competition uses the cheapest form of construction that appears to be satisfactory. Doubtless a very large percentage of the boilers constructed with butt-straped joints and equipped with domes, if tested to destruction, would develop the first evidences of real weakness at the dome connection.

If the dome was an essential feature of boiler operation, the details of construction, particularly as regards the connection with the shell, should be covered by the rules; but since it is regarded by a large majority of well informed engineers as a useless appendage, the Board does well to discourage its use.

## The Crude Oil Gas Producer

If crude oil is burned in a suitable furnace with a deficit of air, a fixed gas will be produced, consisting largely of carbon monoxide. It is based on this fundamental principle that two concerns on the Pacific coast are now developing continuous producers of high thermal efficiency for the generation from crude oil of a fixed gas, said to be ideal for power purposes. Until recently gas engines of small size have been operating on a rather expensive distillate, vaporization being accomplished by the heat of the gas-engine exhaust. A few years ago a plant of four 5000-horsepower gas engines was installed near San Francisco, using a water gas generated from crude oil by the Lowe intermittent process, which yields a comparatively rich gas with an objectionably large hydrogen content; this gas is generated primarily, however, for illuminating purposes, where high hydrogen is advantageous. The thermal
ficiency of the system is low—from for
to fifty per cent. According to a test
ported by Prof. W. F. Durand, one
the new processes, which we recently
scribed, has already attained an efficier
of about 70 per cent.

Owing to the possibility of working
new type of crude-oil gas producer
varying rates of production, the size
gas holders should be capable of
terial reduction, if, indeed, the holder
not eliminated entirely in power plants

Owing to the simplicity of the fun
mental principles involved, it is proba
that within a few years there will
numerous types of crude-oil gas produc
on the market. One thing seems cert
and that is, that for variable load w
that system which has the best method
automatic control for producing gas
uniform quality at various rates of
ning, bids fair to lead in the race
favor.

## Engineers' Wages

Taking into account the responsibil
which he carries, the training which
must go through to prepare himself
his position, the wide range of subj
of which he must have expert knowle
the number of hours which he works
the fact that he must be continually
call, the steam engineer receives the
return for what he does and is of
of the wage-earning class.

We have in mind now not the
fessional but the operative engineer;
"running engineer," as he calls him
To fill his place in a modern plan
moderate size, the engineer must
good deal of a machinist, something
steamfitter and plumber, quite an
trician, as well as a specialist upon
ers and engines and their accessory
paratus. As a matter of fact, they
dinarily get less wages than either
chinists, plumbers or electricians, a
New York City often less than the
men who stoke their boilers.

Why is this? The average emp
is not a grind, and if he were, how
it happen that the engineer should
especial butt of his parsimony?

The ordinary business man doe
pay any more for a thing than he h
and hates to be open to a char
extravagance or remark among hi
sociates. It would hurt his feelings
to be twitted as being a "good
because he paid his engineer three
half dollars a day, when his neighbo
but two and a half, than it would
an order the profit upon which wou
the entire salary. And yet the sam
will uncomplainingly pay a man
eleven dollars a day to paste brick
row with mortar, and will without
tion pay his firemen three dollars
half for an eight-hour day becaus

is organized, and demand it, and he knows that practically everybody is paying the same price

The engineer has organized, too, but along different lines. Instead of combining to coerce the employer into paying higher wages, they have thought that they could improve their condition pecuniarily and raise the status of their vocation by improving their knowledge of their business. They took as their motto, "To Earn More Learn More," and they have been pegging away at it for twenty years They have evolved some good men. They have been an important factor in the production of that quasi-professional man who administers the large central-station, mill and office-building plant. They have raised the average salary of the steam engineer by helping to make a comparatively few high-salaried ones, but they have done nothing for the rank and file, for the man whom the employer does not expect to know much anyhow and upon whom he is accustomed to look much as he does upon the man who runs his elevators and sweeps the halls—a necessary part of the mechanical outfit.

If employers could be made to understand how inadequately they are paying their engineers in proportion to the pay in other lines, if they could be made to appreciate how much a good engineer can save them, not alone in fuel and supplies but in wear and tear of apparatus and interrupted service, they would voluntarily straighten the matter out. If they let it go on as it is going the engineers will be simply forced, as the increased cost of living makes their pittance less and less adequate, to combine for the forcing of better pay and better hours in the way the other trades have done.

## A Marine Turbine Reducing Gear

In the September 14 issue of POWER AND THE ENGINEER, mention was made of an experimental marine-turbine spur gear patented by Admiral Melville and J. H. Macalpine. In the use of steam turbines for marine propulsion, the chief result sought is to secure simultaneously the economical speed rate of the turbine and that of the propeller, and the desirability of inserting some form of reducing gear between the turbine and the propeller driven by it in order to enable both turbine and screw to operate at high efficiency has long been recognized. Hydraulic and electric reduction gears, though practical, are inefficient, while the loss in the transmission of power by correctly designed spur gearing is remarkably low. The solution of the speed-reduction problem for marine turbines of large power by means of spur gearing, however, though often discussed, has been dismissed almost immediately as being impracticable simply on account of the size involved.

The problem to which Messrs. Melville and Macalpine applied their talents was the design of a practical reducing gear for the transmission of large powers. In the De Laval turbine transmission no more than three hundred horsepower had ever been attempted and in motor-car drive, although pressures exceeding 2000 pounds per inch of gear face had been successfully utilized, it was not certain that powers ranging from 4000 to 6000 horsepower could be as successfully transmitted as the 75 to 90 horsepower reached with the motor car.

At a pitch-line speed of approximately 6000 feet per minute and a pressure of about 450 pounds per lineal inch of tooth, a small pitch was deemed necessary if comparative quietness of operation was to be secured. A narrow pitch meant a broad face, and it was decided to use a pitch diameter of 14 inches for the pinion, 70 inches for the gear and 22 inches face There are 35 teeth on the pinion and 176 on the gear, giving a reduction ratio closely approximately five, with what is known as a "hunting" tooth interpolated for the purpose of equalizing the wear. The pitch is 1¼ inches and the teeth are inclined 30 degrees with respect to the axis.

In order to secure the proper working of such broad teeth, Messrs. Melville and Macalpine adopted the plan of mounting the pinion shaft in a device which they have called a floating frame, the object of which is to cause the alinement and position of this shaft to be controlled wholly by the pressure of the teeth which are in contact and not by the exercise of skill, or the lack of it, by the workmen who fit the bearings.

Consideration of the reduction of weight attainable by the use of this gear in a well known merchant ship gives the following figures: At 1000 revolutions per minute of the pinion and 283 pounds pressure per inch of tooth contact this gear would transmit 2500 horsepower. In the vessel selected, the engine, a triple expansion, is of about this power. The main engines without shafting, propellers, stern tube and fittings weigh in all 221 tons. Deducting from this condenser pipes, steam valves, air pumps, circulating pumps and so forth, the weight left for the engine proper would be approximately 150 tons. A marine turbine of 3000 brake horsepower at 1000 revolutions per minute will weigh 27 tons, and the reducing gear will weigh 25 tons, making a total of 52 tons. Deducting this from the 150 tons of engines now in the vessel leaves 98 tons, which means a saving of about 65 per cent in power-plant weight. If this gear will transmit 2500 horsepower it is claimed that similar gears could be applied with a great saving of weight and space to all steamships having a speed up to 18 knots per hour which comprise a large per cent of all the ships afloat. By the law of comparison for simpler machines the dimensions and power of the present design from 6000 horsepower to a size suitable for the "Mauretania," with three screws of the same total horsepower as the present four-screw ship, the weight of the turbines would be halved, as would also the engine-room length, and the number of boilers would be very materially reduced.

## The Master Mechanics' and Chief Engineers' Association

There has recently come into being in Fall River, Mass., an organization which is to be known as the Master Mechanics' and Chief Engineers' Association. The objects of this association are several fold. It is to be a sort of employment bureau, intended to serve both the mill owner and the members of the society, in the supplying of mills with suitable expert mechanical help for the positions of master mechanic and chief engineer, and the member who desires to change with a new job There are also the social features, which are characteristic of most organizations. Present-day tendencies are toward all sorts of organization, with some particular object specified in the preamble to the constitution, to which attention is directed when an excuse for the existence of the organization is needed

It is very generally believed that the mill employment agencies, knowing which side of the bread carries the most butter, have served and do serve the mill owners better than they have and do serve the workers. And in this organization an attempt will be made to place men without the intervention of the mill-employment agency, whose influence is frequently, to use a mild term, regarded as sinister.

In some way it is expected that a fraternal spirit will develop, which will enable a member whose long suit may happen to be an exceptional ability to handle mechanical problems to draw upon the experience of another member who may chance to be equally well equipped with attainments in the electrical field. In fact, a sort of steam, mechanical and electrical clearing house, which will put at the service of the mill owner employing a member of the association, not only his own particular master mechanic and chief engineer, but the knowledge and experience of the entire association in a consulting capacity, thus making members of the organization more desirable men to employ as the resources of the entire organization may be drawn upon in cases of emergency

If the idea can be made to work out successfully, membership in the organization will be most desirable, for the mill owner certainly will employ a man who can draw upon the collective wisdom of the organization in preference to one who is limited to his own narrow experience

# Power Plant Machinery and Appliance

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

## New Hydraulic Governor

The illustration shows a pelton water wheel, fitted with a patent hydraulic relay governor. The speed of the wheel is governed by moving deflectors into the path of the jets from the nozzles, thus diverting more or less of the total discharge direct into the tailrace. Both deflectors are operated simultaneously, being coupled to the crosshead of an hydraulic relay as shown. The coupling rod between the two jets is provided with a screw union, having right- and left-hand threads, thus enabling the two deflectors to be accurately adjusted to act in unison. A plan of these deflectors is shown separately to an enlarged scale at *A*. Details of the hydraulic governor are shown separately, Fig. 1. The hydraulic cylinder rests on planed seatings, cast solid with the slide, over which the crosshead travels. The coupling rods between the latter and the deflectors are always in tension, so that the crosshead is always pressed downward when the deflectors are in the path of the jet. The hydraulic cylinder derives its supply of pressure water direct from the pipe line through the valve chest shown in position at *F*, Fig. 2. The inlet to this chest is at *A*, the water entering passing first through a strainer and then through a small nozzle, intended to insure smoothness and regularity in the motion of the relay ton. The exhaust port is at *B*, and fr *D* and *C* pipes lead, as shown, to posite ends of the relay cylinder. admission of the pressure water to cylinder is controlled by a small pis valve of phosphor bronze, marked *E*.

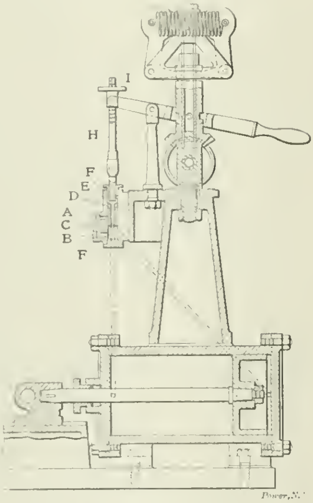


FIG. 2. ENLARGED SCALE OF DEFLECTORS

The position of the valve relatively the governor-balls is adjustable by m of a screwed link and the locknut sh at *I*. The governor is operated by a drive and bevel gearing as indicated.

At normal speed, water is shut off f both ends of the relay cylinder, bu change of speed in one direction or other is followed by admitting wate the corresponding end of the relay inder, and thus moving the deflecto or out of the path of the jet. Under sonable conditions of work, the gove will maintain the speed constant with limiting variation of 3 per cent., said, and the mean speed can be adju by hand through a considerable limi lengthening or shortening the link *H*. very close speed regulation, as in dri alternators, etc., with heavy load cha a compensating or "overtailing" devi fitted, either mechanical or electrical. governor is suitable for operating n nozzles, rectangular nozzles and the of turbines, etc., and is manufacture Percy Pitman, 3 Willcott road, A London, W., England.

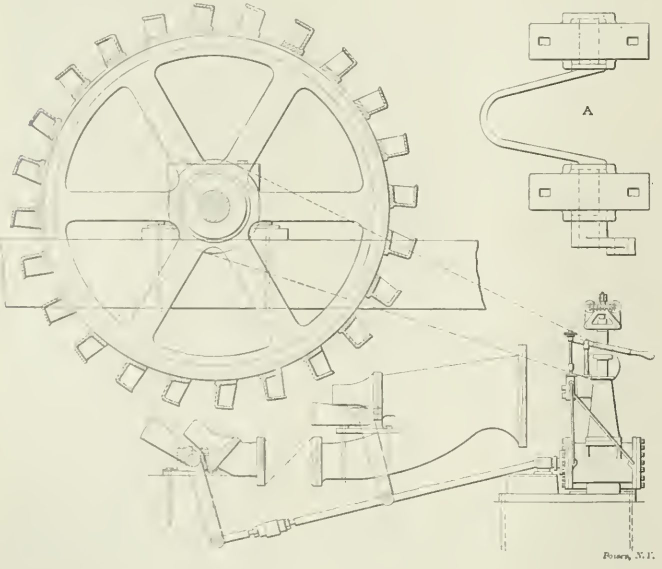
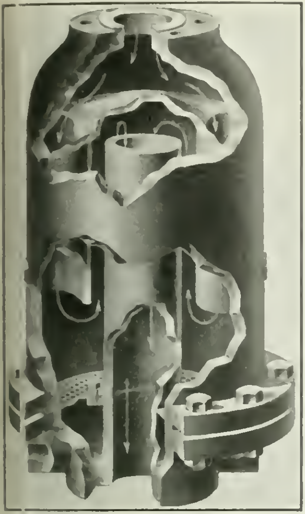


FIG. 1. PITMAN GOVERNOR APPLIED TO A PELTON WATER WHEEL

## Utility Steam Separator

The accompanying illustration is o new Utility steam separator, whic is said, gives a storage of steam a throttle valve greatly in excess o displacement of the piston.

The steam and entrained water, ing the separator at high velocity, ar verted in a direction over the dom through the two interior side cha the combined area of which is more double the area of the inlet port. claimed that the sudden expansio the steam, due to the change in vo precipitates the entrained water t bottom of the separator, through th forated drain board; preventing the rent of incoming steam from agi its flow through the drip to the a trap, from which it is discharged. dry steam is drawn off to the through the interior pipe from the ten space at the top and sides of the separator far removed from the current of incoming entrained water and steam. is separator is made as shown for vertical position, also horizontal and



UTILITY STEAM SEPARATOR

a[illegible]r; and is constructed for 150 [illegible] working pressure. It has the [illegible] ends faced and drilled for extra-[illegible] a standard flange fitting, and is provided with gage and drip tappings. This separator is manufactured by the Standard Steam Specialty Company, 544 West Broadway, New York City.

## "Volcano" and "Comet" Flue Cleaners and Telescope Automatic Balanced Valve

The designs of steam-boiler tube cleaners and a telescope automatic balanced

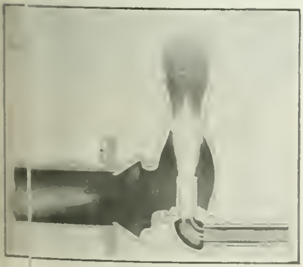


FIG. 1

valve for use with them have recently been put on the market by Charles A. Clark & Co., 60 High street, Boston, Mass., which are claimed to be superior to anything heretofore offered. They are the "Volcano" and "Comet," patent steam tube cleaners. From the illustration of the "Volcano" cleaner, Fig. 1, it will be seen that it is so devised that a jet of steam creates a partial vacuum in the tube, the amount of which depends upon the steam pressure. Actual tests of the "Volcano" cleaner show 8 inches of vacuum with 80 pounds steam pressure in the boiler. It sucks the soot from the tubes and discharges it up the flue, where it is carried away by the chimney, no steam whatever entering the tubes. It is of light, strong construction, consisting of only three parts, each feature of which

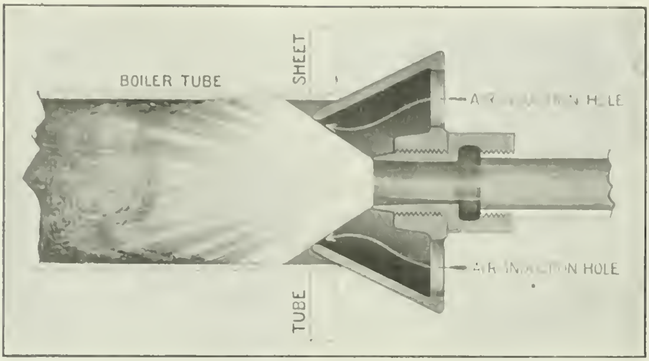


FIG. 2

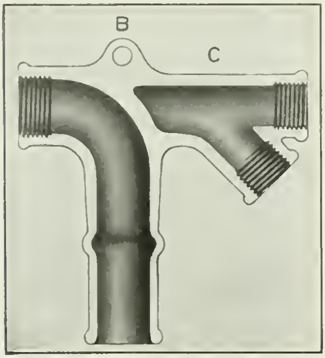
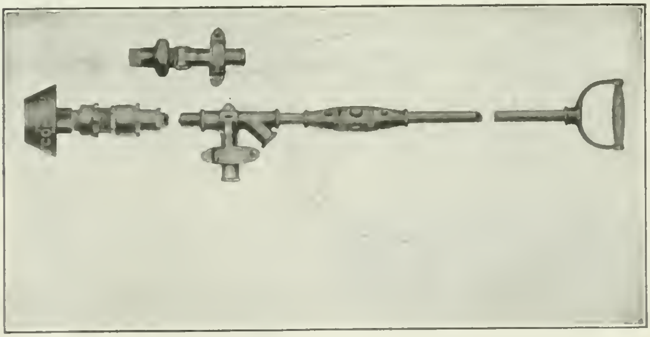


FIG. 3

was adopted after exhaustive experiments had shown that it was the best that could be designed for the purpose.

It will be observed in the "Comet" tube cleaner, Fig. 2, that the head is simply constructed, consisting of two parts only, a conical hollow body with a single-jet steam nozzle passing into its center through the back or larger end wall. In this wall a series of air-induction holes are arranged to surround the nozzle, forming a direct annular air passage open at both ends of the head. When the cleaner is in operation a partial vacuum is formed behind the nozzle by the rapid longitudinal expansion of the steam passing through the tube. The air is thus induced through the air holes in large volume, which not only relieves the vacuum but combines materially to augment the mass and accelerate the velocity of the current throughout the tube, consequently producing a most effective tube-cleaning force in proportion to the amount



COMET TUBE CLEANER

[illegible] It has been demonstrated by several conclusive tests of the "Comet" tube cleaner, in connection with boiler tubes 3¼ inches in diameter and 18 feet long, that the passage of the air and

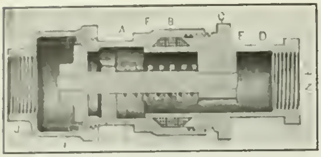


FIG. 4

steam mixture through the tube exceeded 4500 feet per minute, while with the air holes closed the steam passed through the tube only with an average velocity of about 2000 feet per minute. In Fig. 3 is shown a special handle fitting, in section, showing how the steam passage is separated from the handle connection; also, a loop *B*, by which the cleaner may be

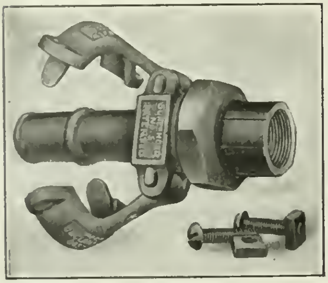


FIG. 5

suspended when not in use. This cleaner is adapted to either vertical or horizontal boilers.

In the use of steam tube-cleaning apparatus, whether of the blowing or sucking type, it has been often noticed that the quantity of steam wasted while changing from tube to tube, and that also wasted during the time of opening and closing the main stop valve, was a large percentage of the total steam used. That this waste, which until recently has been regarded as a necessary annoyance con-

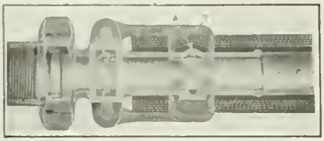


FIG. 6

nected with the steam flue-cleaning operation may be avoided, has been amply demonstrated by the invention of the telescope balanced valve, which was designed to be used in connection with the "Comet" steam tube cleaner and the "Volcano" vacuum tube cleaner.

In construction, as may be seen from Fig. 4, this balanced valve is simple, durable and, above all, practical. Referring to the sectional diagram of the valve, it will be seen that *A* is a cylinder, *B* a packing chamber at one end, *C* the packing nut, and *D* a plunger adapted to slide within the cylinder *A* and having a three arm spider *E* rigidly attached to the valve stem *G*, which is guided by passing through the three-arm guiding spider *H*. The valve *I* is attached to the valve stem *G*, and moves in the valve chamber *J* in the same proportion as *D* slides within *A*. The spiral spring surrounding the valve stem *G* merely overcomes the friction of the packing on the plunger *D*, and tends to hold the valve *I* yieldingly against its seat. At *F* is an annular surface on the inner end of the plunger *D* of sufficient area slightly to overbalance the area of the valve *I*.

A slight push on tube-cleaner handle causes the plunger to telescope in the cylinder and lift the valve wide open, thus giving a quick and powerful blow at full boiler pressure. The valve automatically closes and opens as the cleaner is changed from tube to tube. The advantage of this having steam at full boiler pressure and confined within a few inches of the end of the tube is obvious. The dotted lines shown in connection with the valve *I* and the valve chamber *J* represent wings on valve and corresponding guides in the valve chamber to prevent rotation of the valve when used in connection with the "Volcano" vacuum tube-cleaner head. The valves and seat are so designed that they are easily accessible and may be reground at any time.

The "Volcano" cleaner, like the "Comet," is intended for use in connection with the telescope automatic balanced valve; also, with the patented tubular handle which is regularly furnished, as is also the "Sure Hold" patent hose fitting which is intended to hold any so-called rubber, steam or water hose to which it can be attached; and under any pressure whatever the hose will burst rather than leave the "Sure Hold" fitting. From Figs. 5 and 6 it will be seen that *A* represents a circumferential enlargement forming an outwardly projecting convex rib, the purpose of which is to bulge that part of the hose immediately circling the rib.

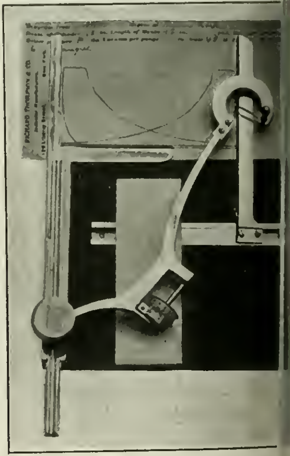
At *B* is represented a concave recess formed on the inner surface of the clamp. When these clamps are brought together by means of bolts these recesses not only surround the hose but the bulge caused by the rib, thus producing an absolutely sure hold; hence its name. It will be seen that within the grasp of the clamps there is a knoblike mass of hose of greater diameter than that at either side. This together with the fact that the clamps are securely fastened to the hose ni makes it impossible for the hose to l off. These fittings are furnished union ends, either male or female as be desired.

---

## Improvements in the Thomps Standard Planimeter

The illustration, appearing herev shows the improvement that has made in the Thompson Standard pla eter, such as was used by A. B. Ca twenty years ago.

The improvement is in the locatio the tracing point, the guiding handle being placed on one side, thus leavin unobstructed view of the tracing point diagram lines without having to ch the position of the board or hand. feature is an advantage that will b preciated by its many users.



SHOWING IMPROVED TRACING POI

This instrument correctly give mean effective pressure of an ind diagram without any figuring. It is by Richard Thompson, 123 Liberty New York City.

---

## New Type of Jet Conden

During the last few years grea provement has been made in the face condenser. Where formerly transmission of 200 or 300 B.t. square foot of surface per hour p gree average difference of temp was formerly considered good p recent designs have raised this fig 900 B.t.u., and even more. Such im men in design has resulted in s condensers, or with the same size c denser has permitted the use of less

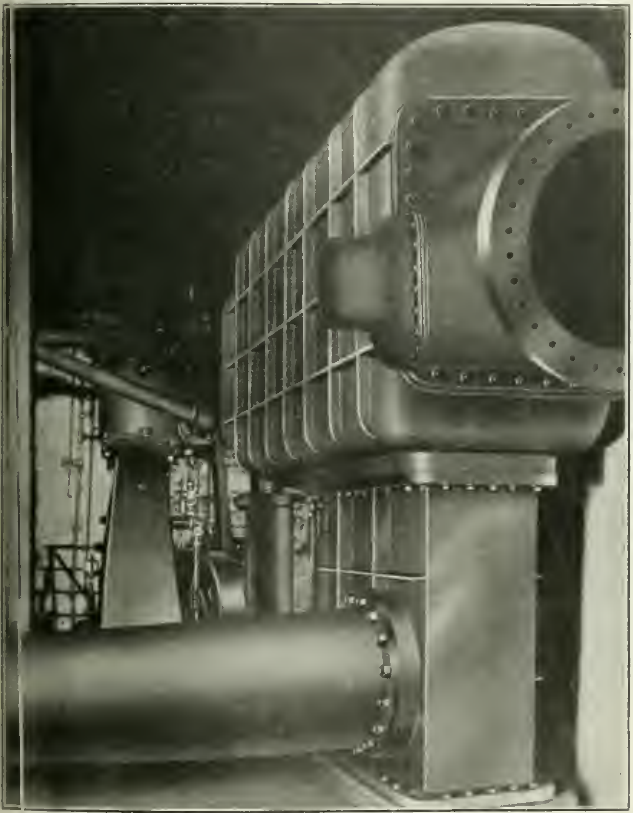


FIG. 1. AN INSTALLATION OF THE WHEELER RAIN TYPE CONDENSER

perhaps warmer circulating water to ntain the same vacuum.

the jet condenser, economy is effected, not so much by increasing the of heat transmission as by insuring ughness of intermixture; that is, king up the water into small drops bringing each particle into intimate act with the steam passing through h condenser, thus realizing to the fulls extent the heat-absorbing power of h water. This would naturally reduce amount of water to be pumped and minimize the power required to run the

Besides the water in the hotwell be more suitable for boiler feeding, r its temperature would be higher, d steam would be required for the t or less coal under the boilers if later be used. The importance of high temperature in the hotwell will be realized when it is considered that the coal consumption is increased at the rate of [illegible] per cent. for each 10 degrees Fahrenheit that the final temperature of the circulating water falls below the temperature corresponding to the vacuum.

Where cooling towers are employed, it is also important to utilize to the fullest extent the heat-absorbing capacity of the water between the temperature at which it is delivered to the condenser by the circulating pump and the temperature corresponding to the vacuum, in order that a high vacuum may be realized from comparatively warm circulating water and further that the water may be delivered to the tower as hot as possible, so that the largest possible amount of heat may be dissipated from a given amount of surface. Using a condenser in connection with the cooling tower means two temperature steps before the heat of the steam is transmitted to the atmosphere, and if the condenser requires a high temperature head to perform its work, the range of temperature for the tower will be less. This will necessitate a larger surface in the tower to transmit the given amount of heat, or if the cooling plant has already been installed, it may be necessary to provide the required temperature gradient by carrying hotter steam in the condenser, and as a consequence a lower vacuum.

Even though plenty of cold water be available it is of importance to reduce the amount supplied to the condenser in order to lessen the amount of air pumped in along with the water. In many plants employing jet condensers it has been found that the vacuum cannot be improved beyond a certain point by increasing the amount of circulating water, the reason being that much of the additional water does not come into contact with the steam, and the air introduced with the extra water more than counterbalances any benefit gained by the lower average temperature of the water.

On general principles, it would appear much easier to secure high temperature in the water leaving a jet condenser than that from a surface condenser, for the reason that the water and steam in the former come into direct contact, with no intermediate wall of iron, and in view of the fact that open heaters, which are practically the same thing as a jet condenser, are able to heat water to within one or two degrees of the temperature of the steam. Notwithstanding all this, the fact remains that the discharge from most jet condensers lacks from 10 to 20 degrees Fahrenheit of the temperature of the steam.

The lack of economy which the above figures imply may be laid to several causes, such as improper design of the condenser head permitting masses of water to pass through the condenser without coming in contact with the steam. Some jet and ejector condensers are designed so that the steam will project itself against the water at high velocity, resulting in back pressure on the engine or turbine, or perhaps adequate provision has not been made for withdrawing the air. The air may not be sufficiently cool before it is passed to the air pump, or improper arrangement of parts may permit steam rather than air to pass from the condenser to the pump. These are the faults common to the jet condenser, and it will be of interest to note how they are eliminated and better economy obtained by the type of condenser illustrated herewith.

The apparatus presented in Figs. 1 and 2 is a new form of jet condenser recently gotten out by the Wheeler Condenser and Engineering Company, of Carteret, N. J. The outfit is installed in a basement beneath a Westinghouse Parsons turbine of 1000 kilowatts capacity. Injection water is taken from a creek nearby, and the warm water is pumped from the hotwell by a 10-inch high-lift centrifugal pump driven by a 10x10-inch vertical engine. Air is withdrawn from the top of the condenser shell by a 9 and 22 by 12-inch rotative dry-vacuum pump, while an 18-inch horizontal release valve provides outlet to the atmosphere in case of stoppage of circulating water, all of this apparatus being that of the Wheeler Company.

From the sectional view, Fig. 2, the

salient features of the condenser may be noted. The condenser head is exactly the same as that installed and illustrated in Fig. 1, but the hotwell arrangement is slightly different, provision in this case being made for direct connection to the pump. Reference to the drawing will indicate that water is introduced at the upper right hand corner into a pan extending nearly the full length of the condenser. From here it overflows through numerous tubes, and also over the edge of the extreme left of the pan, to a similar pan below provided with similar overflow pipes and weir discharging the water to the lower part of the shell, from which it is discharged into a barometric column or, as in the present case, to the pump.

Steam enters through the large opening at the left of the condenser, passing through the lower shower of water, then through the upper shower in reverse direction, and finally all that is left of the vapor, together with the air and other gases, passes around the left end of the upper pan and over the coldest water to the dry-vacuum pump suction opening in the uppermost part of the shell. From the drawing it will be evident that the cross-sectional area of the passageway for the steam decreases as the amount of vapor is lessened by condensation, so that a uniform velocity is maintained, and no dead pockets are left in which air might accumulate. As air is nearly twice as heavy as steam at the same temperature, it would naturally settle to the lower part of the condenser, unless swept along positively by the steam. In surface condensers it would be permissible to place the air-pump suction at a low point, but in the jet condenser this would be impracticable, due to the possibility of water being carried over with the air. As in the surface condenser, it is also important to have the air as cool as possible at the outlet, in order to lessen the size and work of the air pump.

From the construction of the condenser in question, it will be evident that it would be impossible for the steam to pass to the air-pump suction without having passed through all the sprays produced by the small baffles placed below the tubes, as indicated in the drawing. At the right is a float controlling a vacuum-breaking valve. The circulating water is siphoned up to the condenser head from a lower level, and if the vacuum is broken for any reason, will cease to flow. Thus, in case the water level should rise abnormally in the shell, due possibly to the stoppage of the circulating pump, the valve would break the vacuum, stop the inflow of water, and the steam would escape through the release valve to atmosphere.

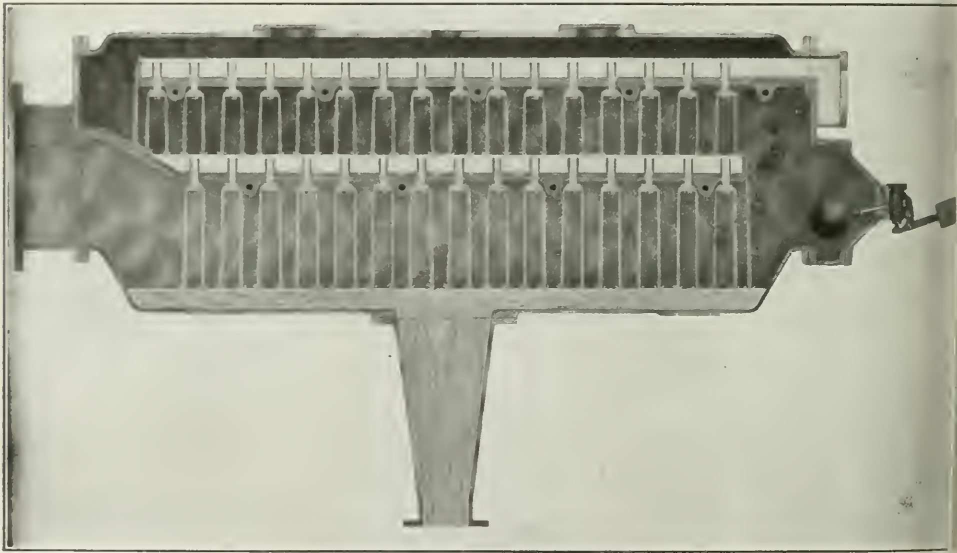


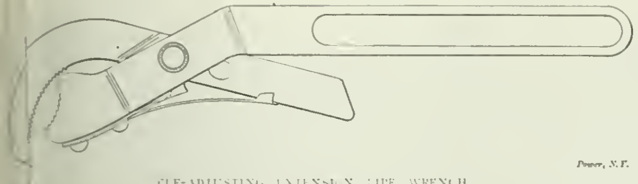
FIG. 2. PRINCIPLE OF OPERATION OF THE NEW JET CONDENSER

In the accompanying table are given results of tests conducted at the plant. On the day the tests were made the street-railway load on the turbine varied from full load to 10 per cent. overload. Temperature readings were taken by thermometers placed in the exhaust pipe and in the hotwell, while the vacuum readings were taken from a mercury column connected to the condenser. The barometer stood at 29.9 inches. Due to the varying load on the turbine, it was necessary to set the injection valve to care for maximum load likely to be carried. withstanding, the temperature of the water was kept close to the tempera of the exhaust steam, although the in temperature of the injection water quite large, and only a comparati small amount of water was required, conditions being unfavorable to close justment.

In judging the performance of a denser, the ratio of steam condense circulating water is always an intere feature. For example, take the ei set of readings in the table, in whi vacuum of 28.55 inches of mercur given. Subtracting this reading fro barometric reading 29.9 would lea steam pressure of 1.35 inches of mer which according to Peabody's tables responds to a temperature of 88.5 d Fahrenheit. At a temperature of 8 latent heat of steam is 1042 B.t. cool the condensate from 88.5 d Fahrenheit to 87 degrees, the temp of the outgoing condensate, will g heat units, or 1043.5 in all. The e temperature of the circulating w given as 44 degrees Fahrenheit, a final temperature as 87 degrees. B these limits each pound of wat absorb 43 heat units, and dividing by 43 will give 24.3 as the num pounds of circulating water requi condense one pound of steam. As the exhaust is not steam when it at the condenser, some of it hav ready condensed in the turbine the exhaust pipe, due to work per med and to radiation, the amount of oling w r would be somewhat less than this tg c If 10 per cent of the steam was w r, then there would be only 930 heat ; adding 1.5 would make 940.5, and c ng by 43 would give 21.9 as the r of the circulating water to steam. ature of the test is the small difference between the temperature of the steam c nding to the vacuum and the temperature of the circulating water at the t

## elf-Adjusting Extension Pipe Wrench

T self adjusting extension pipe and t wrench illustrated herewith is made f rop forge steel and conforms it- y size or shape, round, square r. It has a quick and positive istantly releases by back pressure it is unnecessary to remove it new bite, as it operates as a


Power, N.Y.

SELF-ADJUSTING EXTENSION PIPE WRENCH

two concave jaws which give it greater bearing and make it less crush a weak pipe. The locking jaws are so constructed that n drop out, and all parts are r geable.

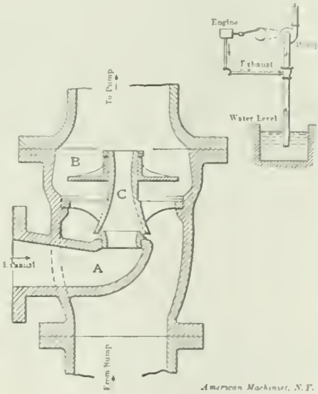
wrench is manufactured by the d versal Tool Company, 75 West- street, Providence, R. I., and is sizes to fit pipes from ⅛ inch t 3 inches in diameter.

## Automatic Suction Pipe Condenser or Steam Driven Pumps

M tempts have been made to dispos the exhaust steam from a steam- ri mp by blowing it into the suction p of the pump. Some devices for such p are on the market, notably for k n pumps and mine pumps, and they opera with some degree of success.

The devices have not proved entirely satisf ry for the reason that they fail ha le the air which is always con- n with the steam. If air is blown i t suction pipe of a pump its suc- on is apt to be lost, and the speed of the ump will be increased to a dangerous xtent unless the steam supply is immediately cut off. In some of the coal mines in Pennsylvania automatic stopping devices are provided with old type suction-pipe condensers, so that when the suction is lost by reason of air in the pipe the pump is automatically stopped. But the pump cannot be automatically started, it requires manual operation for priming the pump and for starting it again, and this is troublesome, for the pump is generally located some distance away, and anyhow a mine operator always dislikes to have pumps stop on odd occasions.

The accompanying illustration shows an automatic condenser of the type in question so designed that advantage is taken of the kinetic energy of the exhaust steam to effect a compression of the air within the suction pipe so that the air is driven through the pump and into the delivery pipe. The pump is thus automatically reprimed whenever the suction is about to be lost, and all danger of the pump racing is obviated. This condenser is installed as a part of the suction pipe, and the steam exhaust is connected to the nozzle *A*. The valve *B*, which acts like a foot valve following the motion of the water, is arranged as shown with an injector tube *C* extending through the valve seat. The steam entering into the suction pipe becomes condensed by the water handled by the pump. The valve remains open as long as the suction is unimpaired, and no injector action takes place. As soon, however, as the suction is about to be lost by reason of an accumulation of air at the top of the suction pipe the valve will close. Injector action will then occur, so that water from the sump will be drawn by the steam through the injector tube, causing compression of the air so that it is driven through the pump and its delivery pipe. The suction is then restored to the pump, so that the foot valve opens and remains open until a certain amount of air is again collected at the upper end of the suction pipe, when the same performance is repeated.



American Machinist, N.Y.

AUTOMATIC SUCTION PIPE CONDENSER FOR STEAM-DRIVEN PUMP

This device is thus entirely automatic, and it is operative up to a considerable hight of lift, depending, of course, on the temperature of the water and the ratio between the amount of steam used and the amount of water delivered by the pump. If the condenser is located higher than the level of the sump a vacuum is given for the exhaust, the degree of vacuum being in direct proportion to the hight of the steam nozzle above the surface of the sump. While such a vacuum is, of course, desirable, the main object is to dispose of the exhaust together with the air contained therein, and this object is accomplished nicely by utilizing a part of the energy of the steam for compressing the air.

It is not customary or practicable to install for all pumps high-priced condensers giving a high vacuum because, aside from the question of price, such condensers are complicated and require more attendance than can be given to them. It is more customary to exhaust the steam below the surface of the sump, sometimes as deep as 8 feet. This causes a corresponding back pressure, which, however, is a small drawback compared with other disadvantages, such as vitiating of the atmosphere and rotting of timbers.

It would, therefore, appear that this automatic suction-pipe condenser for pumps—although it cannot give a high vacuum—will by reason of its simplicity and low cost fill a long-felt want.

## Big Boiler Explosion at Pabst Brewery

Just as we are going to press, news arrives of an explosion of three Munoz boilers in the Pabst brewery at Milwaukee. The explosion appears to have been very violent, shaking the city within a radius of a half mile and breaking many windows. The front of the power house was blown out, an elevator located close by was jarred three feet off its foundation and a portion of one of the boilers was hurled across the street onto the roof of a three-story storeroom. Two men were killed, several seriously injured and a property loss of over a quarter of a million entailed.

## Engineering Societies

### AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., Jesse M. Smith, New York, N. Y.; sec., Calvin W. Rice, Engineering building, 29 West 39th St., New York. Next meeting, New York, December 7-10, 1909.

### NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Wm. C. L. Eglin, Philadelphia, Pa.; sec. and treas., John F. Gilchrist, 139 Adams St., Chicago, Ill. Association headquarters, 29 W. Thirty-ninth St., New York.

### ENGINEERS' CLUB OF PHILADELPHIA

Pres., W. P. Dallett; sec., W. P. Taylor, 1317 Spruce St. Regular meetings 1st and 3d Saturdays.

### AMERICAN SOCIETY OF NAVAL ENGINEERS

Navy Dept., Washington, D. C. Pres., Rear Admiral John K. Barton (retired) U. S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N.

### AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, Cleveland, O.

### WESTERN SOCIETY OF ENGINEERS

Pres., Andrews Allen; sec., J. H. Warder, 1737 Monadnock Block, Chicago, Ill.

### ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., George T. Barnsley; sec., E. K. Hiles, 803 Fulton building, Pittsburg, Pa. Meetings 1st and 3d Tuesdays.

### AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., Louis A. Ferguson; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly, excepting July and August.

### ENGINE BUILDERS' ASSOCIATION OF THE UNITED STATES

Pres., A. L. Merriam, Oswego, N. Y.; sec., C. H. Sembower, Reading, Pa.

### UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, W. S. Cadwell, Chicago, Ill.; sec., Thomas H. Jones, 244 Eighth street, N. E., Washington, D. C. Next convention, Buffalo, N. Y., August, 1910.

### NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., William J. Reynolds, Hoboken, N. J.; sec., F. W. Raven, 325 Manhattan building, Chicago, Ill. Next convention, Rochester, N. Y., September 1910.

### AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next convention, Philadelphia, Pa., June, 1910.

### OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS

Pres., F. W. Ballard; sec., David Gaehr, 1135 Schofield Bldg., Cleveland, O.

### MASTER STEAM BOILER MAKERS' ASSOCIATION

Pres., J. H. Smyth; sec., Geo. M. Clark, 1337 N. Maplewood Ave., Chicago, Ill.

### INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., Robert A. McKee, Peoria, Ill. Next convention, Denver, Colo., September, 1910.

## Society Notes

The fifth annual entertainment and reception of the Universal Craftsmen Council of Engineers of the Metropolitan district was held at Lexington Opera House, New York City, on Saturday evening, October 23. Notwithstanding the inclemency of the weather the event was well attended, there being present large delegations from nearby cities. The hall looked very pretty with its decoration of flags, bunting and floral designs. A most enjoyable vaudeville program was followed by dancing. Good mornings were said after a most enjoyable occasion.

On November 10, George A. Orrok, secretary of the Gas Power Section of the American Society of Mechanical Engineers, will lecture on the subject of gas-engines and blast-furnace practice before the Society of Engineers of Eastern New York, at the Teneycke hotel, Albany, N. Y.

## Business Items

The Parker Boiler Company, Philadelphia, has recently received the third order from the Astoria Veneer Mills, Long Island, City, N. Y., calling for two 346-horsepower boilers.

The Dearborn Drug and Chemical Company, Chicago, Ill., has just issued a souvenir booklet which takes up the question of water treatment interestingly and thoroughly. They send it free to parties interested in water treatment.

The Locke Regulator Company, Salem, Mass., reports that manufacturers all over the country are taking advantage of the protection offered by their automatic stop and report among recent sales of quick closing valves and engine stops the following: Jones & Laughlin Steel Company, Pittsburg, Penn.; Revere Rubber Company, Chelsea, Mass.; National Tube Company, Pittsburg, Penn., and many others.

## New Equipment

Chandler & Price, Cleveland, Ohio, will build a new power house.

The Interstate Packing Company, Winona, Minn., will erect a duplicate plant.

The Dubuque (Iowa) Packing Company will erect a $50,000 addition to its plant.

Butterfield & Co., Derby Line, Vt., is installing a new power plant, consisting of two suction gas-producer engines of 150-horsepower capacity.

The Mechanicsburg (Ohio) Light and Power Company is considering the installation of water-works system and would like to hear from manufacturers.

## Help Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

AN ENGINEER to operate a 200-horsepower gas plant near New York. Box 53, POWER.

WANTED—Good mechanical designers
detail draftsmen for machinery manufac
located in Wisconsin. Box 98, POWER.

WANTED—Thoroughly competent s
specialty salesman; one that can sell h
grade goods. Address "M. M. Co.," Pow

AN ENGINEER in each town to sell
best rocking grate for steam boilers. W
Martin Grate Co., 281 Dearborn St., Chic

AGENTS WANTED to sell Burgmann
brated engine packings in territories not
covered. See our advertisement on page

WANTED—Man to invest $1500 in
tric-light plant and take management,
of 2000; Middle West; new plant. Box
POWER.

WANTED—First-class draftsman as
sistant in drafting department; must be
oughly familiar with engine and boiler w
Address P. O. Box 512, Erie, Penn.

WANTED—Night engineer to take ch
of boilers, engines, ice machines, pumps,
with proper assistance; give reference, sa
wanted and notice required. Box 55, Po

WANTED—First-class draftsman and
mator for high-class steam power and
ing work. Address, giving full partic
references and salary wanted, Box 828,
lotte, N. C.

## Situations Wanted

*Advertisements under this head are
serted for 25 cents per line. About six
make a line.*

PRACTICAL ENGINEER, age 26, all-r
mechanic, desires permanent position
good firm anywhere that needs a man f
sults; steam, electric, hydraulic or ice
chinery; New York license and best
ences. Box 57, POWER.

TECHNICAL GRADUATE, 30 years,
for member A. S. M. E., six years in
mills and on road, desires position as
representative for one or more concerns
ing specialties; location, New York City.
dress "F.," Box 61, POWER.

POSITION WANTED—As master mec
or chief engineer; experienced in the
tenance and repair of all mechanical
electrical apparatus and buildings in
facturing plant; have had experience in
tric power station, machine shop and
facturing plant, and in designing and
ing special machinery. Box 62, POWER.

## Miscellaneous

*Advertisements under this head a
serted for 25 cents per line. About six
make a line.*

PATENTS secured. C. L. Parker, So
of Patents, 4 McGill Bldg., Washington,

IF YOU DESIRE to learn the late
provements in steam boilers, correspond
the Detroit Water Tube Boiler Co., D

ENGINES AND BOILERS, ¼ to
engine castings in sets. Models and
machine work. Sipp Electric and M
Co., Paterson, N. J. Catalog 4c.

PATENTS—H. W. T. Jenner, pate
torney and mechanical expert, 608
Washington, D. C. I make an invest
and report if patent can be had and exa

WANTED—A hardware or mill supp
cialty to sell on royalty, or manufactu
sell on royalty, or purchase outright
dress with particulars, "Specialty." B
POWER.

ENGINEERS AND FIREMEN—Se
cents in stamps for a 40-page pamphl
taining a list of questions asked by an
ining board of engineers. Stromberg
lishing Co., 2703 Cass Avenue, St. Lou

ANY FIRM or engineer in charge
steam plant that is troubled with scale
boilers can get absolutely free, the be
cator and reducing wheel made, with
lined mahogany case. For particula
dress Great Lakes Chemical Works,
woc, Wis.

## For Sale

*Advertisements under this head
serted for 25 cents per line. About si
make a line.*

FOR SALE—20x48 Wheelock engi
two 72"x18' high pressure tubular bo
good condition cheap. Address "En
Box 2, Station A, Cincinnati, Ohio.

FOR SALE—500-horsepower tande
pound Fleming single valve, automat
two small engines, cheap for cash.
Manufacturing Co., 1801 Third Nation
Bldg., St. Louis, Mo.

FOR SALE—250-horsepower Lane Bod
ley Corliss engine, 18x42 cylinder; en

# estructive Boiler Explosion at Milwaukee

## Pabst's Brewery Plant Damaged to the Extent of $250,000 by the Explosion of Four Water-tube Boilers. One Dead, One Seriously Injured

### BY OSBORN MONNETT

e most disastrous boiler explosion the history of Milwaukee occurred at a.m., Monday, October 25, at the t of the Pabst Brewing Company. ppening so early in the morning, two men were the only persons in the t at the time, one of whom, severely

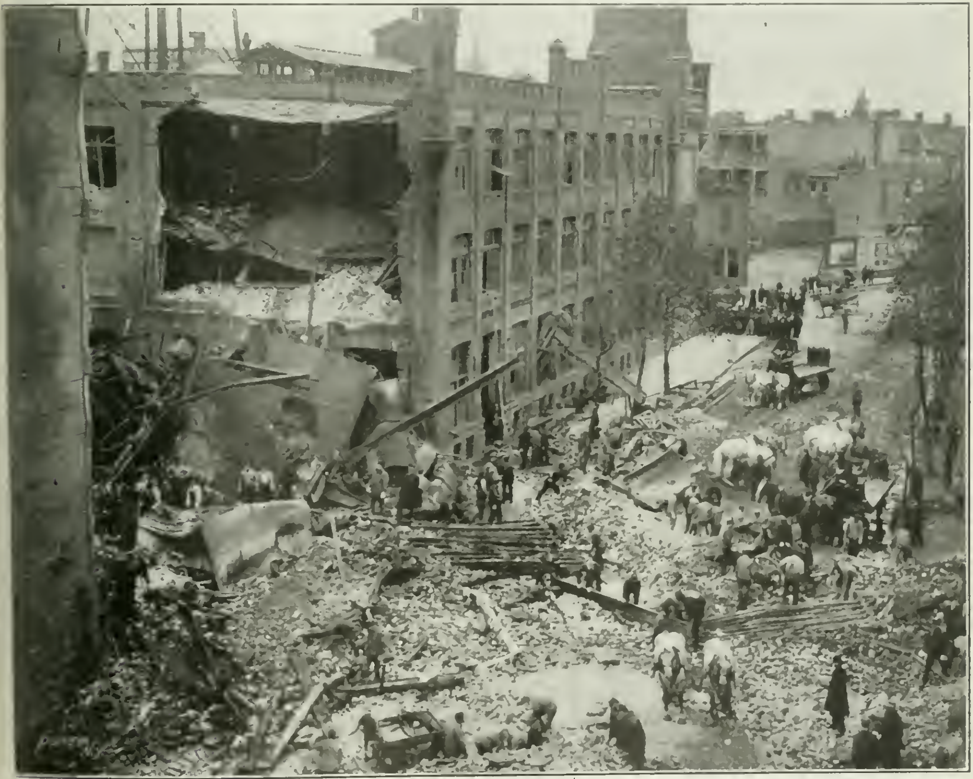


FIG. 1 GENERAL VIEW OF WRECKAGE

injured, was taken from the ruins shortly r the explosion and removed to a hospital, where his chances for recovery are reported favorable. The body of the r fireman was found later buried he débris.

he wrecked boiler house had a frontage of 49½ feet on Tenth street, and was 100 feet deep. The building was the newest addition to the mammoth plant of Pabst's brewery, and the exploded boilers had been in use less than two years. On October 9 they had been subjected to an inspection by the Hartford Company and were apparently in the best of condition. Eight boilers composed the plant, of which six were Munoz boilers of 400 horsepower rated capacity each, and two Edge Moor boilers. The latter had just been put in and had not as yet been under steam.

It is estimated that the property damage will be between $250,000 and $300,000. Insurance on the Pabst plant to the extent of $150,000 was carried by the Hartford Steam Boiler Inspection and Insurance Company, covering damage to property and loss of life resulting from explosions. However, according to the local representative, the policy was written to cover a series of losses, and as the damage wrought constitutes what is known as a "first loss," the amount recoverable is said to be limited to $50,000. A 220-foot brick stack divided the boiler room into two parts and it was the four boilers on the east side of the stack that let go. All of the six Munoz boilers

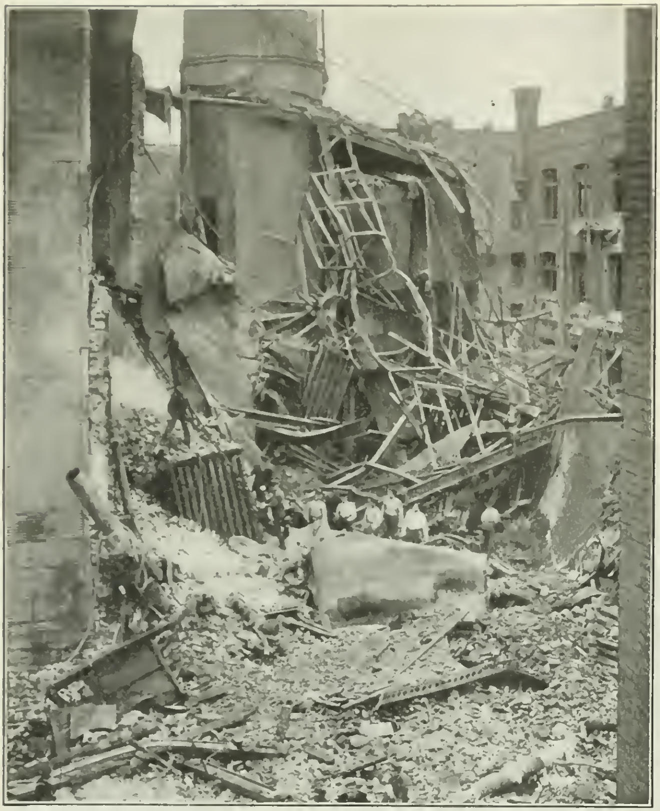


FIG. 2. LOOKING DIRECTLY DOWN ON SCENE OF DISASTER

were, according to Chief Engineer Classman, under steam and connected to the header at the time of the explosion, and the four on the east, or Tenth street side of the stack were totally wrecked; but on examination it was found that the two Munoz and the two Edge Moor boilers on the west side of the stack, although covered with an immense amount of wreckage, were practically uninjured. The stack itself stood in the midst of the wreckage apparently undamaged.

A section of the big malt elevator adjoining the boiler plant to the south and partly filled with grain, was moved 47 inches on its foundation and racked and twisted so that it may be a total loss. The south wall of the three-story building to the north used as a machine shop was torn out and masses of débris poured through the great jagged opening. A portion of one of the boiler drums weighing many hundreds of pounds was hurled across Tenth street and imbedded so firmly in the room of the cold-storage warehouse opposite that the efforts of twenty firemen failed to dislodge it. Tenth street from Chestnut to Cold Spring avenue was buried under tons of broken machinery, twisted steel and great piles of brick from the crumbling walls, while masses of boiler tubes, steam pipes, and fittings were scattered in indescribable confusion.

Although the force of the explosion was evidently directed mostly against that portion of the building in which were located the four east boilers, by one of the freaks of fortune a delicate set of antennæ of the United States Wireless Telegraph Company hanging directly over

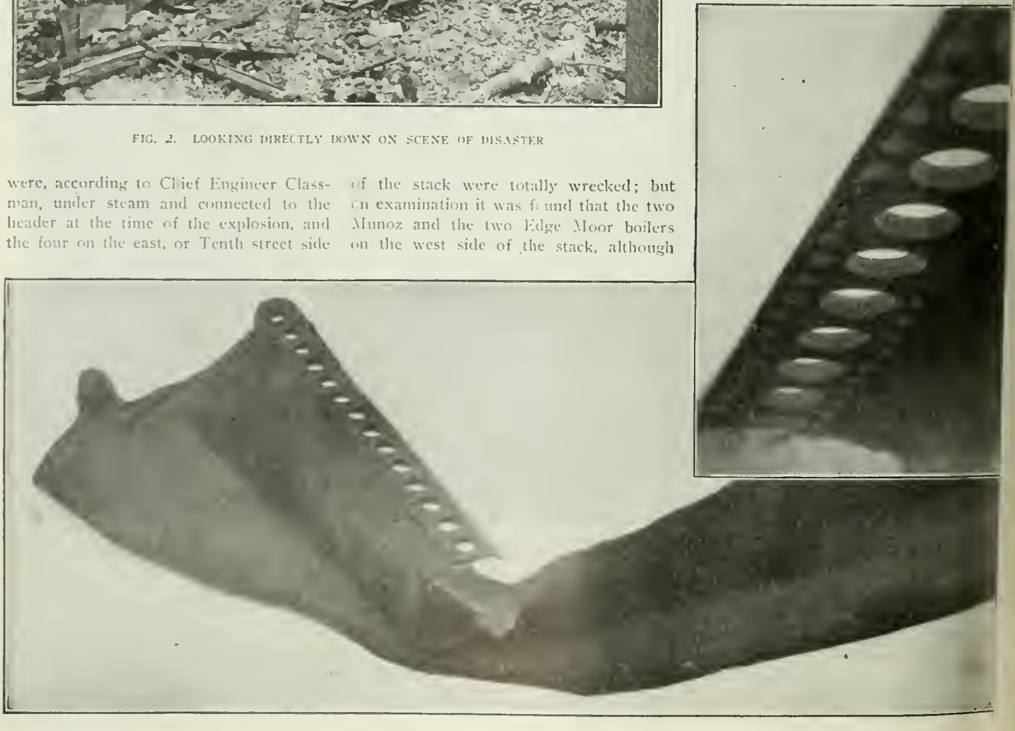


FIG. 3. REINFORCING STRIP, SHOWING SHEARING OF PLATE AT RIVET HOLES

the spot and supported 150 feet in the air between the power-house stack and the chimney on the northern corner of the old boiler house, was not damaged, and wireless communication was not interrupted in the slightest.

The first words in explanation of the disaster came from Gottlieb Jehnert, the injured fireman, who made a statement at the hospital in which he said that an 18-inch steam main leading to the engine room exploded, and was the primary cause of the accident; and that all condi- ns in the boiler room were normal at time.

f this was the case the broken steam er, excessively large for the size of t, would have given excellent op- rtunity for the rapid escape of the m, the shock of which might have n too great for the boilers to with- nd. This explanation, however, was redited generally by engineers and cers of the company as the statement a man dazed by the appalling disaster l not in a condition to make accurate ervations. Later, Jehnert, whose es- pe from instant death is considered raculous, revised his statement, saying t he did not believe the steam pipe let first, but insisted that all gages in the ler room registered properly and that re was plenty of water in the boilers.

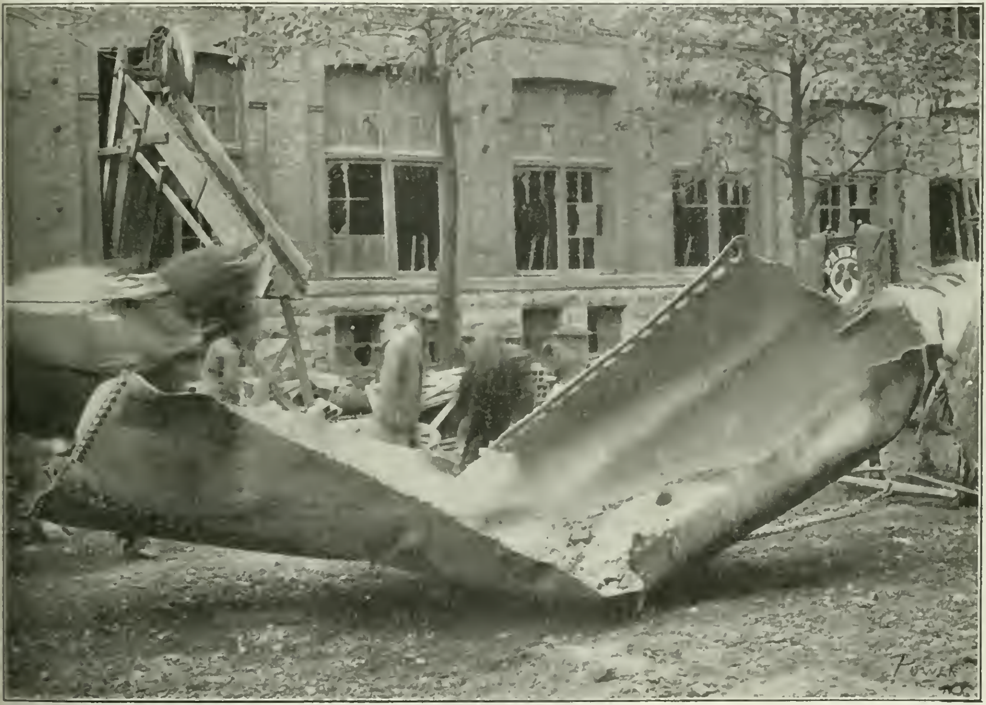


FIG. 4. CLOSE VIEW OF BOILER DRUM

The low water theory is more generally held as being responsible for the explosion. In this make of boiler the horizontal drums have a row of vertical tubes expanded into them for the full length of the drum. Where these tubes are attached, the sheet is reinforced by an outside plate, put on with a single row of rivets at each side, and calked. The exploded boilers have drums 36 inches in diameter, made of ⅜-inch steel plates, with double-strapped butt-joint longitudinal seams, the reinforcing sheet being put on with ¾-inch rivets pitched 3 inches apart. In the event of low water it is held that the portion of the drum at the point where the vertical tubes are connected would be peculiarly susceptible to the deleterious action of the hot gases.

It is a peculiar fact that the drums which have so far been examined, are all found to have given way in exactly the same manner in the reinforcing seam, indicating that this part of the drum, pierced by the opening for tubes and containing the holes for two rows of ¾-inch rivets, was in no case as strong as the double-strapped butt joints, all of the latter so far found being intact.

To refute the theory of low water, however, careful inspection has failed to reveal the slightest burring of the metal in any of the drums available for examination up to the present writing, and until the wreckage is entirely cleared away it will not be possible to arrive at a more definite conclusion as to the cause of the accident.

Power from the Milwaukee Electric Railway and Lighting Company was immediately supplied, through three 180-kilowatt transformers temporarily installed, and operations at the plant were resumed in all departments not requiring steam. It is proposed to erect, as soon as possible, a temporary structure over the remaining boilers and resume operations in the bottling and pasteurizing departments.

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The Canadian Light and Power Company, of Montreal, has contracted with J. G. White & Co., New York, for the construction of a hydroelectric plant on the St. Lawrence river, near St. Timothee, Que. The plant will utilize the Beauharnois canal water, giving an available and constant head of 50 feet. The power station will contain three 7200-horsepower turbine units coupled to 4000-kilowatt generators and have space for a fourth unit; also two 400-horsepower exciter units and switchgear; the 27-mile transmission line to Montreal, and substation and distributing system at that city, will also be included in the contract, which is estimated to cost about $4,000,000.

## Experimental Marine Turbine Gear

For some time past the marine turbine gear which is the joint invention of George W. Melville and John H. Macalpine, has been under test at the shops of the Westinghouse Electric and Machine Company, Pittsburg, Penn., where it was constructed. This gear which has for its object the translation of the high relative speed of the efficient turbine into the more moderate speed which is imperative in the use of the screw propeller, is illustrated in Fig. 1.

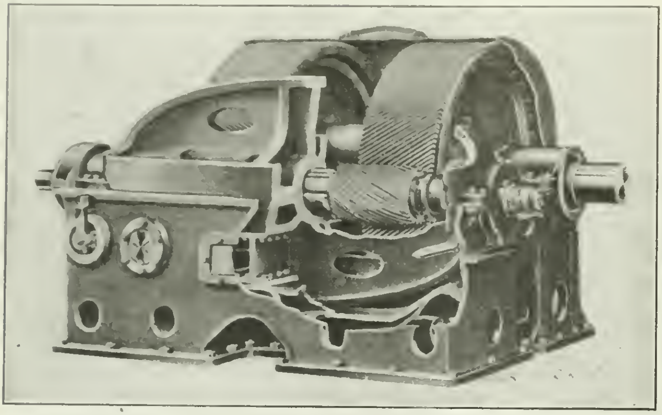

FIG. 1. REDUCING GEAR WITH FRAME BROKEN AWAY TO SHOW PINION AND FLOATING FRAME

It will be seen that in a general way the gear resembles the De Laval arrangement of a divided helical gear one-half of which is right- and the other half left-handed. The smaller gear or pinion is supported in three bearings in the heavy steel "floating frame," which is supported at the middle of its length by a heavy I-beam resting upon a raised portion of the base of the inclosing and supporting gear case.

In Figs. 2, 3 and 4, the device is shown in section, plan and elevation where the relation of the supporting I-beam to the pinion shaft is clearly shown.

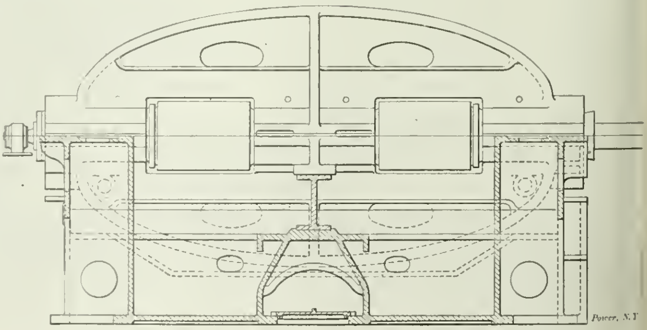

FIG. 2. PARTLY SECTIONAL ELEVATION, SHOWING I-BEAM SUPPORTING FLOATING FRAME

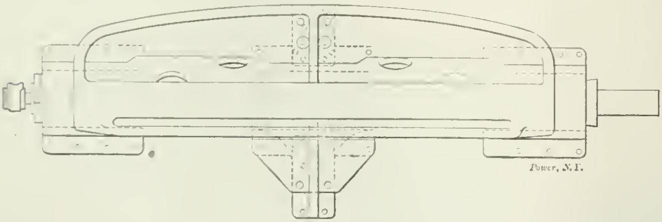

FIG. 3. PLAN VIEW OF PINION SHAFT AND SUPPORT

The floating frame is a heavy steel casting flexibly mounted in the gear box and supporting in rigid bearings the pinion shaft but in such a way that it will allow this shaft to have a slight longitudinal freedom so that it can slide axially to and fro within the frame. In the elevation of the floating frame will be seen the flexible I-beam which is supported by the bed plate. The pinion, it will be seen, is supported in three bearings, the center bearing dividing the two pinion faces, one of which is right-handed and the other left-handed, the gear being much larger and stiffer than the pinion requiring only two bearings. The floating frame is made deep vertically so as to be stiff enough to withstand deflection by the vertical forces at the bea ing. It is also stiffened in the horizont plane to obviate deflection from the hor zontal forces. The floating frame plan shown in Fig. 4. Fig. 5 shows the pinic shaft in section and the flexible sha by which it is driven. At the end of tl shaft is the coupling driven by the turbi shaft while the other end of the flexil shaft is coupled to the extreme end the pinion shaft on the inside by mea of keys and bolts. This interior shaft so flexible that it imposes practically constraint on the pinion and floati frame and it is evident that both as its longitudinal position in the floati frame and in the angular position of t axis, the pinion is solely under the co trol of the forces transmitted through t teeth of the gears and it is evident th the pressure on the faces of the tee would tend to keep the pinion and ge in alinement. But, if for any cause, su as wear, or heating of bearings, or a other disturbing influence, the alineme is affected, the I-beam on which t floating frame is supported acts as hinge allowing the frame to yield to t extent necessary to correct the deflecti

Fig. 5 shows the hollow pinion sh with its internal driving shaft connect to the far end of the pinion shaft, wh its other end is connected to the turl shaft by the flexible coupling shown plan and elevation. This coupling c sists of two flanges, one of which keyed to each shaft and connected each other by links which allow consi able longitudinal freedom.

The gears, Fig. 6, were cut and ha ened by Shuchardt & Schütte, Chen Germany, from steel forgings of 90 pounds tensile strength furnished Messrs. Krupp, of Essen. A very g idea of their size and proportion be had from Fig. 6, which is a reproc tion of a photograph taken just prev to their shipment to this country.

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A Philadelphia paper announces the jury by scalding of a fireman on a loco tive by the falling "off" of the crown sh

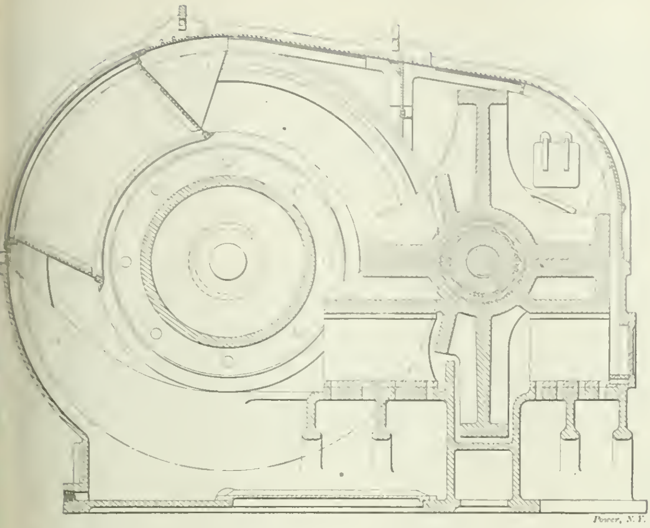

FIG. 4. CROSS-SECTION THROUGH FLOATING FRAME

The combined associations of the Nal Association of Stationary Engineers of Philadelphia, numbering about hundred members, will give a con- dinner and dance on December 3, at Lulu Temple, Broad and Spring n streets. The committee are hard work completing arrangements and a s occasion is assured.

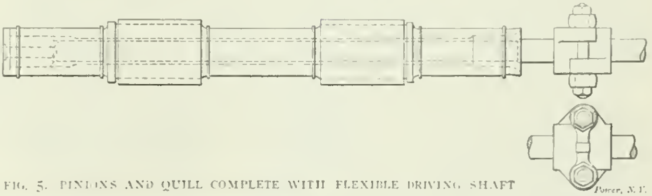

FIG. 5. PINIONS AND QUILL COMPLETE WITH FLEXIBLE DRIVING SHAFT

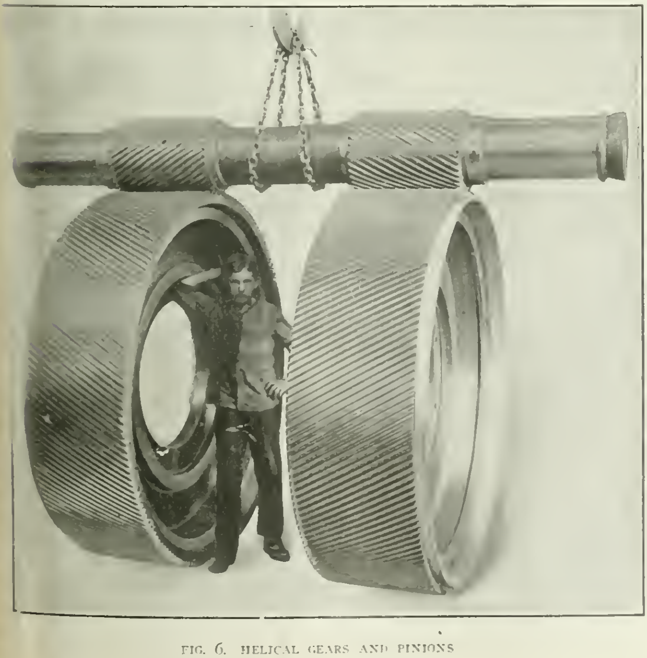

FIG. 6. HELICAL GEARS AND PINIONS

## Superheat Increases Efficiency of High Duty Pumping Engines

Recent official tests of four 30,000,000-gallon pumping engines for the city of Cincinnati, which were described by John Primrose in the *Engineering Record*, showed that the economy of the most economical of all reciprocating engines can be increased considerably by the use of a moderate superheat. The station contains four three cylinder triple expansion vertical pumping engines of the crank and flywheel type, each having a capacity of 30,000,000 gallons in 24 hours. The diameters of the steam cylinders are 29, 54 and 82 inches, the plungers 37½ inches in diameter, and the stroke 96 inches. All cylinders are steam jacketed and reheaters are provided between the cylinders. Each engine is provided with its own surface condenser. The boilers are of the Stirling type, having 2016 square feet of heating surface each, and are equipped with American stokers, having 42 square feet of grate surface. There are also two direct-fired Foster superheaters, each containing 1160 square feet of heating surface and 8 square feet of grate area, and in addition several Green economizers.

There is a considerable reduction in the steam used in jackets and receivers, which indicates that cylinder condensation is less with superheated steam. It is further interesting to note that the temperature of the exhaust steam leaving the low-pressure cylinders is much less when using superheated steam, and this is undoubtedly due to less heat being absorbed by the steam from the cylinder walls during the exhaust stroke in the low-pressure cylinders. Another advantage of using superheated steam is found in reducing the leakage of valves and pistons.

With 95 degrees superheat at the throttle, the duty was found to be 194,403,500 foot-pounds per 1000 pounds of dry steam; with 99 degrees superheat, the duty was 189,624,000 foot-pounds, and 169,250,000 and 171,700,000 foot-pounds were obtained without superheating. During the test the superheater was operated at only about one-third of its capacity, and it is only fair to assume that the superheater would give better efficiency when operating more nearly at its full capacity. The amount of steam used by the auxiliaries is small, but the benefit of using superheated steam on these auxiliaries was very marked.

# Rigid Drives for Electric Elevators

## Method of Transmitting Power from the Motor to the Machine. Back Gearing for Lifting Extra Heavy Loads at Reduced Speeds

## BY WILLIAM BAXTER, JR.

### Transmission Gearing

The way in which the motion of the motor is transmitted to the hoisting drum is illustrated in the lower part of Fig. 49, where the front of the casing is broken away so as to show the worm and gear. The gear *W'* is fastened to the hoisting drum. The worm is made integral with the worm shaft and runs in bearings arranged to take the thrust of the screw in both directions. The bearing *K* can be adjusted endwise of the shaft by the screw *G*, and in like manner the sleeve *K'* can be adjusted by the set screws *G'*. There are three of these screws set between three bolts *H* that hold the tightening gland of the stuffing box, and by means of the screws *G* and *G'* the position of the worm *S* can be adjusted as may be necessary. The disks *L L'* at the ends of the worm *S* form the thrust bearings. A stuffing box is placed at the brake end of the worm shaft so as to prevent the escape of oil from the worm chamber. For the purpose of reducing the friction as much as practicable and also to prevent cutting the thread of the worm or the teeth of the worm gear, the chamber in which the worm runs is filled with oil deep enough to keep the latter thoroughly covered with the oil, and the stuffing box is necessary to prevent the oil from leaking out through the shaft bearing.

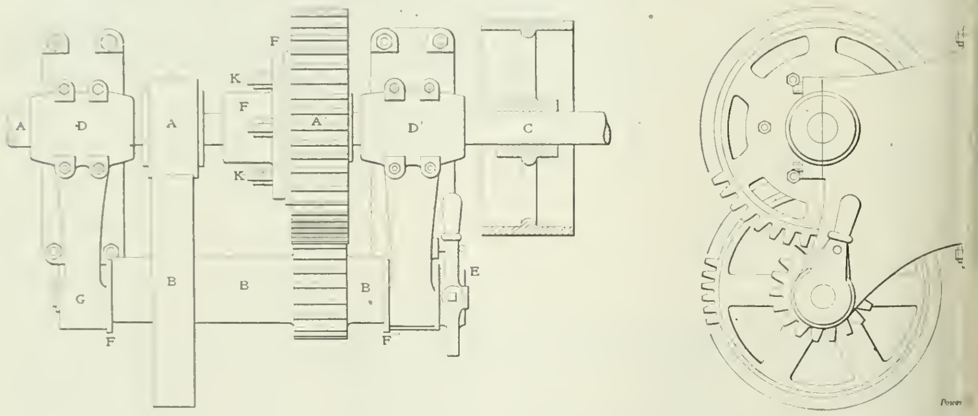

FIG. 50

The ends of the worm chamber are closed with heads that close openings of a diameter slightly larger than that of the screw, so that the latter may be readily inserted or removed whenever required. This can never be done, however, unless the elevator car and the counterbalance are first properly secured so that they cannot drop, and the pressure taken off the worm mechanism. The bearings at both ends of the worm shaft are solid, so that there is no way of taking them up for wear, but experience shows that the wear is very slight; therefore it is better to make them solid, so that the worm shaft may not be able gradually to get out of line, as it surely would if split bearings were provided with which the wear could be taken up. With solid sleeves, if they become too badly worn to run well they can be replaced, and thus the alinement of the shaft is at once restored.

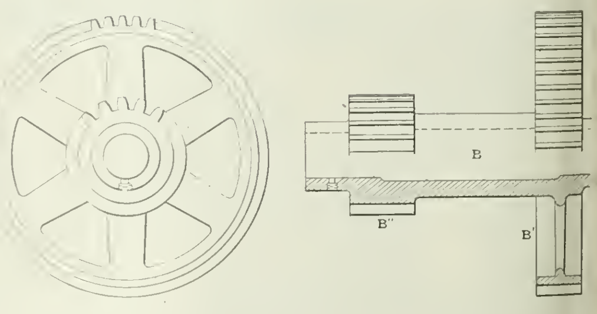

FIG. 51

### Slow-speed Gearing

The construction and operation o back gearing shown on the machine, 32, can be fully understood by the a Fig. 50, which gives a top view an end view of the gearing. The sha the motor armature is shown at *A*, the pinion *A'* is mounted on this between the bearing *D* and the cou *F*. This pinion meshes with a ge that is cast on a sleeve *B* whicl opposite end has a pinion *B''*. Thi meshes with the gear *A''* that for half of the coupling *F*, and it is nted upon the end of the worm shaf on which is also mounted the brake wheel. This shaft runs in the bearing and also in the bearings at both ends of the worm chamber, as shown in Fig. The sleeve *B* runs on a shaft that is made with end sections turned eccentric with respect to that portion upon which the sleeve runs. These ends are held in extensions *G'* of the frames that hold the main bearings *D* and *D'*. On one of the ends of this shaft a handle *E* is mounted, and when the elevator is running under normal conditions this handle is turned so as to throw the gears *A'*, *B'* and *A"*, *B"* out of mesh. Whenever it is desired to take an extra-heavy load the bolts are removed from the coupling *F* and the handle *E* is turned to the position in which it is shown in the drawing; then the gears mesh with each other and the motion of the armature shaft *A* is transmitted through the gearing, with the result that the velocity of the worm shaft is reduced to about to one-sixth of the normal full speed, and the lifting capacity is correspondingly increased. The operation and construction of this gearing can be more fully understood by the aid of the detail drawings shown in Figs. 51 to 55.

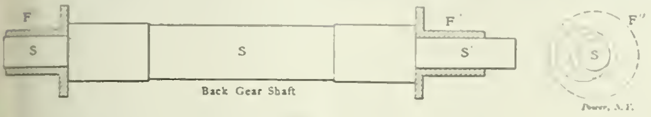

FIG. 52

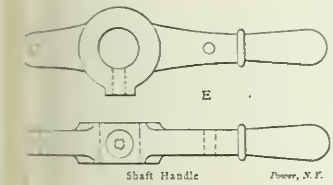

FIG. 53

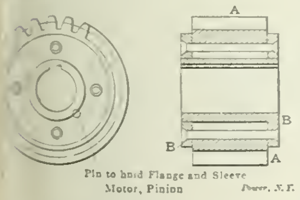

FIG. 55

Fig. 51 shows the construction of the sleeve *B* and the pinion and gear *B"* and *A'*, the three parts being cast together. The shaft *S* upon which the sleeve *B* runs when it is thrown into action, is shown in Fig. 52. The end view shows very clearly the eccentric relation of the end sections *S'* with respect to the body of the shaft. Two views of the operating handle *E* are given in Fig. 53. Fig. 54 shows the gear *A"*, giving a side view and a section parallel with the axis. In Fig. 55 are given two views of the pinion *A'*.

FRAME INSULATION

It is customary in the construction of electric-elevator machines to insulate the motor as a whole from the remainder of the machine. This is done in order that a breakdown of any portion of the insulation proper of the motor, that is, the insulation of the field or armature coils, or of the commutator or brushes, will not cause the circuit to be "grounded" to the machine. In machines that are not provided with a back gear the insulating is easily done by placing sheets of insulating material under the parts of the motor that rest upon the bedplate, also around the holding-down bolts, and between the two parts of the shaft coupling. With the back-gear construction the insulating is more difficult because there are several other points at which insulation must be provided. Looking at Fig. 50 it can be seen that the armature shaft *A* must be insulated from the base of the machine, and this is accomplished by placing insulation between the bedplate and the stands that hold the bearings *D* and *G*. It is also necessary to provide insulation between the pinion *A'* and the gear *B'*, because the pinion is mounted on the armature shaft. This latter insulation is provided by making the teeth of the pinion of insulating material such as hard fiber or rawhide. The pinion, it will be noticed from Fig. 55, is constructed with side flanges *B B'* made of metal, one being formed with a sleeve upon which are placed fiber washers which are clamped together between the flanges *B* and *B'*. As the frame that carries the bearings *D* and *G* is not insulated from the armature shaft, it is necessary to insulate *B* from it, and this is done in the way shown in Fig. 52, in which it will be seen that the ends *S'* of the shaft are provided with fiber bushings *F"*, these being made with a flange so as to prevent contact by end movement.

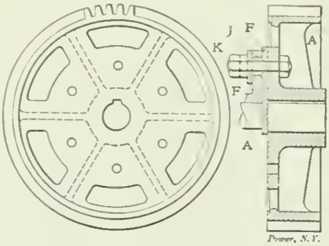

FIG. 54

# Primer of Electricity

COMBINATION CIRCUITS

Besides the simple series circuit and the more complex parallel system, there are two combinations of these that are frequently used on a small scale. One is the series-parallel or series-multiple and the other the multiple-series arrangement of circuits. Reduced to its simplest form, a series-parallel circuit consists of two devices in parallel, connected in series with two other devices in parallel.

Fig. 8 illustrates this arrangement. The circles represent incandescent lamps taking ½ ampere each when an e.m.f. of 110 volts is applied to their terminals. Each pair of lamps, therefore, requires a pressure of 110 volts between the junction points indicated in the diagram, and when this pressure is supplied, there will flow a current of ½ ampere in each lamp or 1 ampere in the pair. The two pairs connected in series require 110 volts each; consequently, 220 volts will be required for both pairs.

The foregoing statements can be proved by Ohm's law. If each lamp takes ½ ampere when subjected to 110 volts pressure, its resistance must be

$$\frac{110 \text{ volts}}{\frac{1}{2} \text{ ampere}} = 220 \text{ ohms.}$$

Now, when several lamps or other devices, all having exactly the same resistance, are connected in parallel, the joint resistance of all of them is equal to the resistance of one of them divided by the number of them.

In the case of a pair of lamps, each having a resistance of 220 ohms, the joint resistance of the two is

$$\frac{220}{2} = 110 \text{ ohms.}$$

Consequently, with 110 volts at the terminals of the pair, the total current flowing through them will be

$$\frac{110 \text{ volts}}{110 \text{ ohms}} = 1 \text{ ampere.}$$

The total resistance of a number of lamps or other devices connected in series is equal to the sum of the individual resistances.

In Fig. 8 there are two pairs of lamps in series with each other, and the resistance of each pair is 110 ohms; the total resistance, therefore, is

$$110 + 110 = 220$$

ohms, and with 220 volts at the main terminals of the whole group, the total current through the two pairs will be 1 ampere.

Fig. 9 illustrates a more complex arrangement of lamps in series-parallel. Here there are six groups of lamps in series and each group consists of four lamps connected in parallel. Suppose these lamps have a resistance of 200 ohms each.

Then each group of four will have a resistance of

$$\frac{200 \text{ ohms}}{4 \text{ lamps}} = 50 \text{ ohms},$$

and the total resistance of the six groups in series will be

$$50 \times 6 = 300 \text{ ohms}$$

The six groups are connected to a circuit giving 600 volts at their terminals; consequently, the current passing through the six groups will be

$$\frac{600 \text{ volts}}{300 \text{ ohms}} = 2 \text{ amperes}.$$

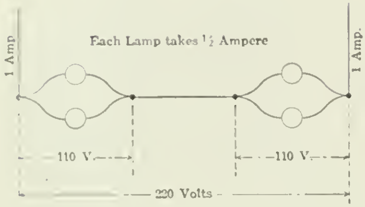

FIG. 8

Now take up the resistances and currents of the lamps separately. The resistance of one lamp is 200 ohms; consequently, with 100 volts at its terminals the current passing through it will be

$$\frac{100 \text{ volts}}{200 \text{ ohms}} = \tfrac{1}{2} \text{ ampere}.$$

Since there are four lamps in parallel, the current through the whole group will be four times the current in one lamp, or

$$4 \times \tfrac{1}{2} = 2$$

amperes. This agrees with the result of the first calculation, for the six groups.

Fig. 10 is a diagram of a common example of parallel-series connection. There are four groups of lamps, each group consisting of five lamps in series. The four groups are connected in parallel with each other. Since each lamp takes ½ ampere at 110 volts, its resistance must be

$$\frac{110 \text{ volts}}{\tfrac{1}{2} \text{ ampere}} = 220 \text{ ohms}.$$

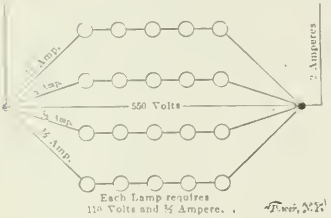

FIG. 10

The resistance of each group, therefore, is

$$5 \times 220 = 1100$$

ohms. With 550 volts at the terminals of each group, the current through one group will be the correct current for one lamp, for

$$\frac{550 \text{ volts}}{1100 \text{ ohms}} = \tfrac{1}{2} \text{ ampere}.$$

Since the resistance of one series group is 1100 ohms, the resistance of the four groups in parallel will be one-fourth of that:

$$\frac{1100}{4} = 275$$

ohms. And with 550 volts at the terminals, the total current will be

$$\frac{550 \text{ volts}}{275 \text{ ohms}} = 2 \text{ amperes}.$$

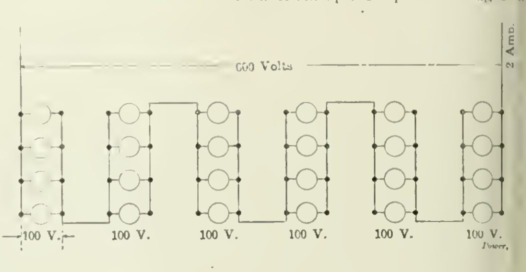

FIG. 9

This checks up with the calculation for a single group, for if the groups are of equal resistance the current will divide up equally between them, and each group will get

$$\tfrac{2}{4} = \tfrac{1}{2}$$

ampere.

So far, only groups of devices having equal resistance have been considered. Fig. 11 illustrates what happens when devices of different resistances are connected in series-parallel and Fig. 12 gives a similar idea of different resistances in parallel-series.

In Fig. 11, a resistance *A* of 4 ohms is connected in parallel with a resistance *B* of 8 ohms; a resistance *C*, of 10 ohms is connected in parallel with a resistance *D*, of 14 ohms; the parallel pair *A* and *B* are connected in series with the parallel pair *C* and *D*, and the whole supplied at a net pressure of 102 volts. The total resistance of the two pairs is 8½ ohms, and the total current, therefore, is

$$\frac{102 \text{ volts}}{8\tfrac{1}{2} \text{ ohms}} = 12 \text{ amperes}.$$

This result is obtained as follows: The joint resistance of two or more unequal resistances in parallel is found by dividing 1 by each resistance, adding the results, and then dividing 1 by the sum of the first results. The joint resistance of *A* and *B*, therefore, is

$$\frac{1}{\frac{1}{4} + \frac{1}{8}} = 2.667$$

ohms, and the joint resistance of *C* and *D* is

$$\frac{1}{\frac{1}{10} + \frac{1}{14}} = 5.833$$

ohms.

The two pairs of coils are in ser so their resistances add; the sum of two is

$$5.833 + 2.667 = 8\tfrac{1}{2}$$

ohms, as previously stated.

Now check up the separate voltages currents. Since the joint resistance and *B* is 2.667 ohms and the total cu is 12 amperes, the voltage drop in pair of coils must be

$$2.667 \text{ ohms} \times 12 \text{ amperes} = 32 \text{ vol}$$

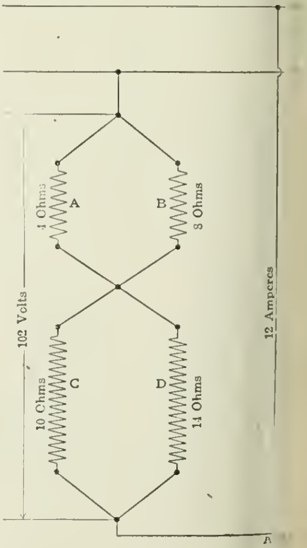

FIG. 11

With 32 volts at its terminals, th rent in *A* must be

$$\frac{32 \text{ volts}}{4 \text{ ohms}} = 8 \text{ amperes};$$

and the current in *B* must be

$$\frac{32 \text{ volts}}{8 \text{ ohms}} = 4 \text{ amperes}.$$

If *A* and *B* take up 32 volts the

total voltage (102), that leaves 70 volts for C and D. With 70 volts, the current in C will be

$$\frac{70 \text{ volts}}{10 \text{ ohms}} = 7 \text{ ampere};$$

nd the current in D will be

$$\frac{70 \text{ volts}}{14 \text{ ohms}} = 5 \text{ amperes}$$

The sum of the two currents is 12 amres, which agrees with the result first tained.

ig. 12 shows the same coils *A*, *B*, *C* *D*, connected in parallel series and lied at the same pressure of 102 s. It would naturally be supposed at thought that the total resistance of whole group would not be changed merely removing the cross-connection ween *A* and *D* and *B* and *C*, but it is.

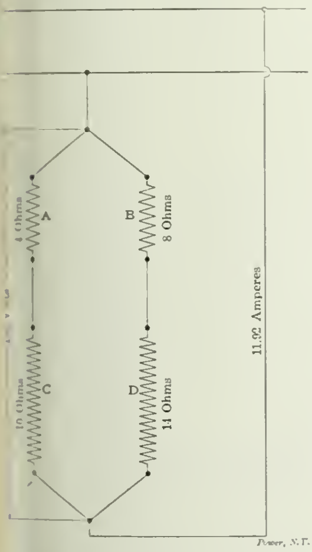

FIG. 12

resistance of *A* and *C* in series is 14 and the resistance of *B* and *D* in is 22 ohms. The joint resistance two series paths is

$$\frac{1}{\frac{1}{14}+\frac{1}{22}} = 8.5555$$

ms, instead of 8½, as in Fig. 11.

An easy way to remember the distinc- between series-parallel and parallel- connections is to extend the two ssions so that they describe the ar-gement of circuits; thus, a series-par- circuit is *a series group of parallel cuits*, and a parallel-series circuit is *a rallel group of series circuits.*

From the foregoing and the two preding primer lessons it should be clear the reader that

1 *In a simple series circuit the curt is the same in oll parts of the circuit.*

2. *In a simple series circuit, the voltages at the terminals of the different devices in the circuit are directly proportional to the resistances of the devices.*

3. *In a simple parallel circuit the voltage is the same at the terminals of all branches of the circuit.*

4. *In a simple parallel circuit the currents in the different branches of the circuit are inversely proportional to the resistances of the branches.*

5. *In a series-parallel circuit each parallel group should be considered as a single device in series with the others.*

6. *In a parallel-series circuit each series group should be considered as a single device in parallel with the others.*

# Proper Area for Boiler Breechings

By J. E. Terman

Considerable variation in the amount of area provided in boiler breechings and connections for the same capacity is often found, and such variations are not only noted between breechings designed by different manufacturers, but also between those made by a single firm. This is partly due to the variable conditions met with in each installation, but it is more often due to the lack of ability on the part of the manufacturer to design such connections uniformly, the areas used in many cases being arrived at along lines that practically amount to guesswork.

The boiler manufacturer frequently bases the area of the uptake connection to his boiler on the cross-sectional area of the tubes, if it is a tubular boiler, and the maker of the breeching bases his flue area on that of the uptakes or the tubes. It is readily seen by a moment's reflection that the cross-sectional area of the tubes does not vary directly with the capacity of the boiler, and therefore with the amount of gas to be handled, for the capacity of a horizontal or vertical tubular boiler varies almost directly with the length of the tubes for any fixed diameter of boiler; therefore, with varying lengths of boiler there could be a number of different capacities with one area for the cross-section of the tubes. It is thus seen that the cross-sectional area of the tubes should not be used in arriving at the proper area for the breeching, and the only correct way is to base the area of such connections on the volume and velocity of the gases to be handled, or, what is the same thing, the amount of coal to be burned, making of course due allowance for unusual length of connections or for bends in the connections, where surrounding conditions make frequent turns necessary. Prof. William Kent's table for chimney sizes, which is probably the most widely used for design of boiler chimneys, is based on a formula in which the effective area of the chimney varies directly as the capacity for any fixed hight, and he recommends that the area through the flues and gas passages be 20 per cent. in excess of the area of the chimney as given by his table.

If the flue designer knows the capacity of the chimney to which the flue is to be connected, he can base the size of the flue required on this. However, the writer's experience would indicate that the 20 per cent. over the chimney area recommended by Professor Kent for flues is somewhat in excess of the average met with in plants which can be said to represent good practice, and 10 per cent. would probably represent conditions as they are actually found in good practice.

As stated above, if the chimney size and capacity were known the flue areas could be designed accordingly, but it very frequently happens that these data are not available, and in many cases where the chimney dimensions are known they would not be correct for designing the breeching, on account of not being correct for the boiler capacity served; and in cases where the chimney area was deficient it would be making a bad matter worse to use this area in designing the breeching, for it would result in a contracted breeching attached to a chimney of insufficient capacity.

In the accompanying table, the flue or breeching area is given as 10 per cent. in excess of the chimney area obtained by Professor Kent's formula, assuming that a boiler capacity of 25 horsepower would be supplied with a stack 50 feet high, 300 boiler horsepower with a stack 100 feet high and 5000 boiler horsepower with a stack 250 feet high, and that the hight of stack for any intermediate capacity between these arbitrary points would vary the same as the capacity. Thus, 2650 boiler horsepower, which would be the capacity midway between 300 horsepower and 5000 horsepower, would be assumed to be supplied with a stack 175 feet high, which hight is midway between 100 and 250 feet. The areas for flues or breeching given in this table may be safely used for all ordinary conditions.

| Boiler H.P. | Breeching Area, Square Feet. | Boiler H.P. | Breeching Area, Square Feet. |
|---|---|---|---|
| 25 | 1.9 | 1600 | 48.6 |
| 50 | 3 3 | 1800 | 53.2 |
| 100 | 6 0 | 2000 | 57.7 |
| 150 | 7 3 | 2200 | 61 9 |
| 200 | 8 8 | 2400 | 66 1 |
| 250 | 10 5 | 2600 | 70.1 |
| 300 | 11 9 | 2800 | 71 0 |
| 400 | 15 2 | 3000 | 78 9 |
| 500 | 18 5 | 3250 | 82 5 |
| 600 | 21 7 | 3500 | 86 8 |
| 700 | 24 7 | 3750 | 91 0 |
| 800 | 27 6 | 4000 | 95 4 |
| 900 | 30 5 | 4250 | 99 5 |
| 1000 | 33 2 | 4500 | 107 6 |
| 1200 | 38 7 | 4750 | 111 3 |
| 1400 | 43 7 | 5000 | 115 1 |

On October 18, a boiler exploded at the plant of the Griffin sawmill company, near El Dorado, Ark., killing seven employees and injuring three other persons severely.

# Boiler Explosion at Amoskeag Mill

## The First Manning Boiler to Fail Disastrously. Blown 50 Feet through Roof. Lower Tube Sheet Lets Go. Are Beaded Tube Ends Necessary ?

Twenty-seven years ago, Capt. Charles H. Manning, general superintendent of the Amoskeag Manufacturing Company, Manchester, N. H., offset the external shell of a vertical firebox boiler to introduce, as he explains, some elasticity into the shell to meet differences in expansion between that shell and the firebox and tubes. Of this, which came to be known as the Manning boiler, many have been made, and of the type we have now to record the first disastrous failure. It occurred with a comparatively new boiler at the Amoskeag mills.

Shortly after the mill was started on Tuesday morning, October 12, a 150-horse-power unit which stood about in the center of a line of twelve, went out through the boiler-house roof like a rocket and landed upon the railroad track about 50 feet from its foundation. A stoker who was just filling the hopper of the Jones stoker with which the boiler was equipped, was blown across the room and killed. Another boiler-room hand was fatally and several less seriously injured.

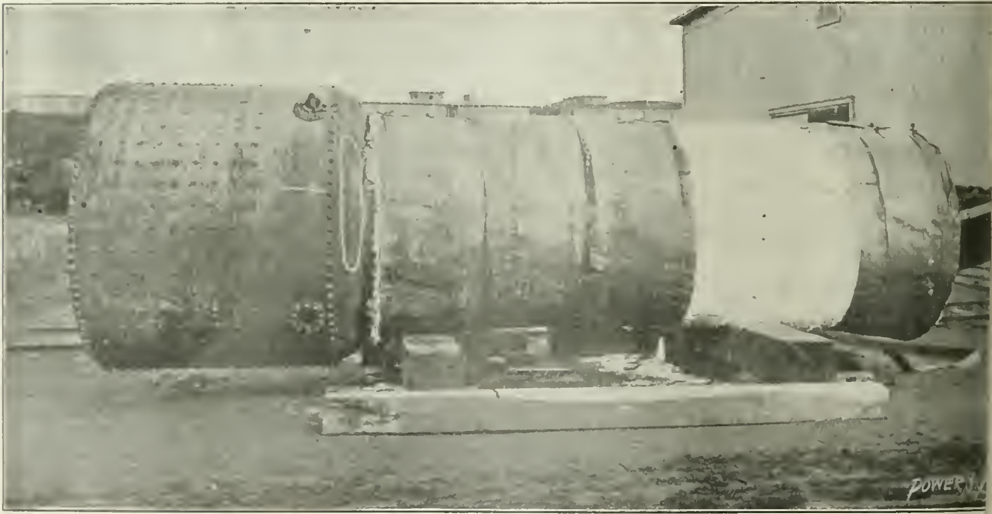

FIG. 1

The twelve boilers which constituted this battery are all of the same size and stood in a line as closely as they could be set to one another. The boiler to the right of that which failed was moved on its foundation a couple of inches but none of the others was disturbed.

The exploded boiler was 60 inches in diameter in the shell with a 72-inch firebox, an 80-inch outside water leg. The firebox was 57 3/32 inches high and there were 182 tubes 2[illegible] inches in diameter and 15 feet long, in ½-inch tube sheets. The water-leg sheets were 3/8-inch inside and 5/8-inch out, as was also the O G offset; the rest of the shell was 9/16 inch. The joints were triple-riveted butt-strapped and the staybolts of the water leg 1⅛-inch, spaced 5 inches.

Fig. 1 is a side-on view showing the dent in the O G, which is the only injury which the boiler sustained from its rough passage, aside from the distortion of the tube sheets and the usual bending of the tubes.

The boiler failed by the tubes drawing out of the crown sheet, every tube coming out clean, allowing the sheet to come down in a symmetrical saucer shape, the center being about on a line with the bottom of the flange, which is about 6 inches deep, as shown in Figs. 2 and 4.

The releasing of the tube ends allowed the pressure to force the upper tube sheet outward, bulging it a couple of inches, most of the tubes remaining in this sheet as shown in Fig. 3. The tubes were simply expanded in and not flared nor beaded over. The boiler was designed to carry 200 pounds, ran at 190 habituall
and was built at the company's sho
some two years ago.

The record of the Mosscrop record
attached to the McIntosh & Seymour e
gine, to which this battery furnish
steam, showed that the speed of the e
gine had been down and had nearly
just about recovered when the explosi
took place. Mr. Manning believes th
the feed had been shut off in the effort
recover pressure and that without the i
coming water in the central column t
contents of the boiler lifted under t
vigorous firing, allowing the sheet to ove
heat sufficiently to pull away from t
tubes. The feed valve had not been fo
at the time of our visit. The crown sh
and tubes were perfectly clean on
water side.

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The State Educational Committee
the N. A. S. E. of Massachusetts
submitted to the subordinate associati
a list of 40 lecturers who are availa
for the coming season, with their subj
and addresses. This is a bit of work
the right direction. With such a list
this to select from there should be
profitless meetings in Massachusetts d-
ing the coming winter.

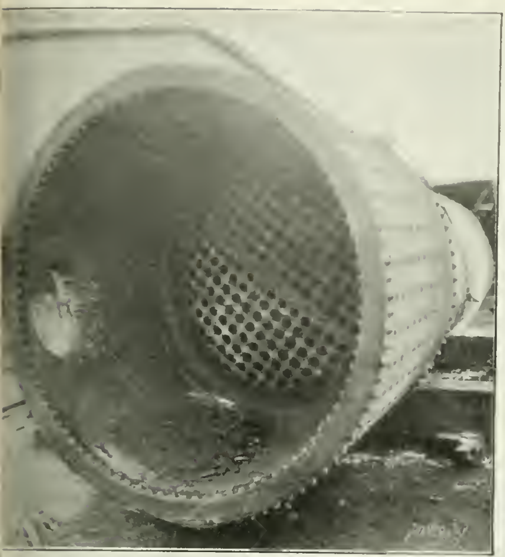


FIG. 2

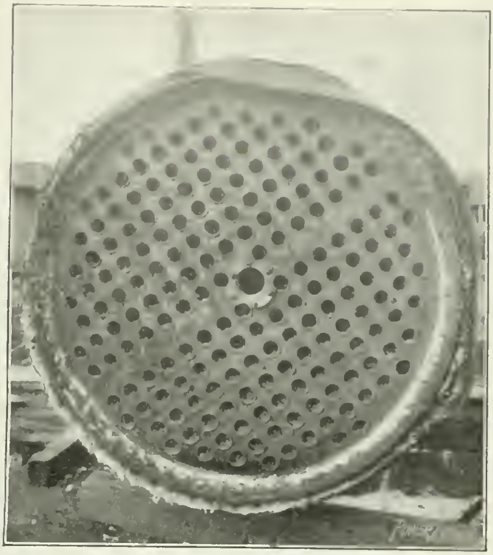


FIG. 3

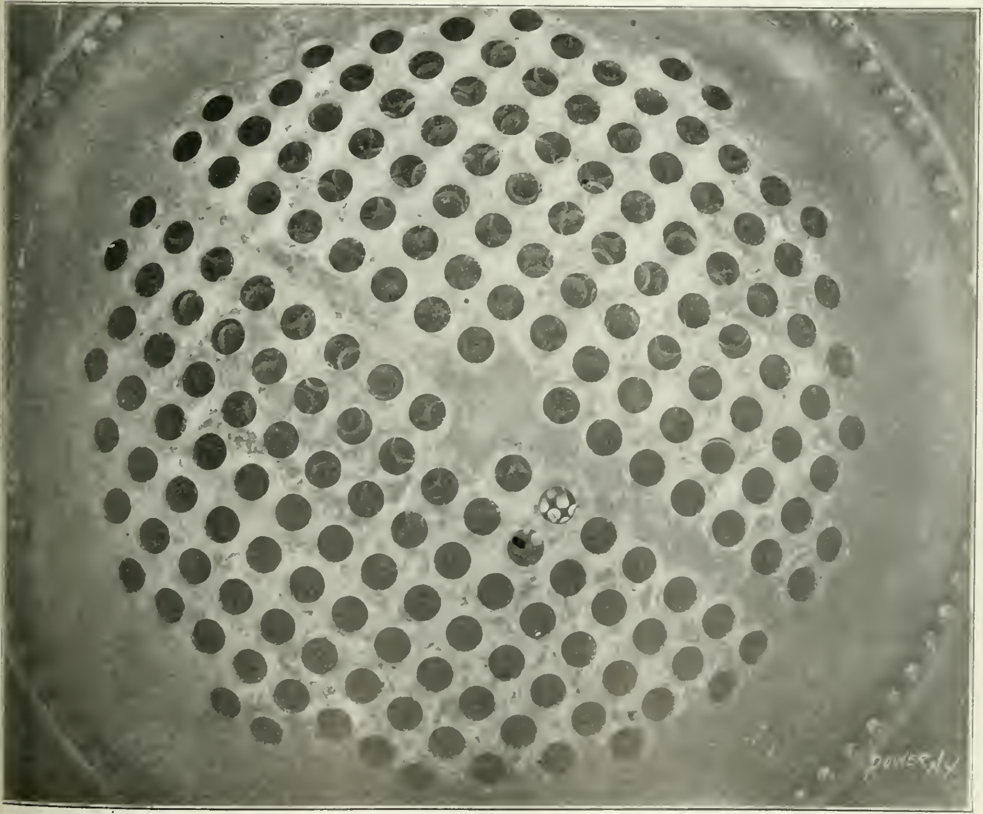


FIG. 4

# Some Tests of Grease Lubrication

Under what conditions is grease a better lubricant than oil? This question is of practical interest to every user of machinery, yet it is probable that not more than [illegible] per cent. of machinery users could give a clear and correct answer. The usual assumption is that, owing to its greater viscosity, grease acts as a drag on the bearings and is, therefore, to be avoided if possible. Consequently oil is tried first, unless the machine is arranged for grease lubrication. If the bearings do not heat with oil the investigation ends there. If trouble is experienced, grease of one kind or another is tried, and by skill or good luck a *modus vivendi* is found.

The accompanying diagrams and tables are taken from a report of tests of various lubricants recently carried out at Cornell University by Professors Sawdon and Diederichs under the supervision of Prof. R. C. Carpenter. To many readers they will, no doubt, come as a surprise, owing to the rather remarkable ability shown in certain cases to endure bearing pressures of 400 pounds per square inch and upward. Incidentally, the tests are rather upsetting to the common theory that grease necessarily has a higher coefficient of friction than oil.

The tests mentioned were made for the Keystone Lubricating Company, and Keystone Grease was used in two of the eight tests. The full schedule of the tests is as follows: 1, heavy mineral grease; 2, a standard animal grease; 3, graphite grease; 4, mineral grease, softer than No. 1, and of another make; 5, engine oil (lubricating oil); 6, engine oil, another make; 7, Keystone Grease, No. 2, density; 8, Keystone Grease, No. 1 density.

## Object of the Tests

The primary object of the tests was to determine the ability to endure extreme bearing pressures. Nevertheless, they were begun at ordinary pressures (86 pounds per square inch), and the loads were increased by steps, so that valuable data were obtained regarding the history of the curves of coefficient of friction and temperature.

The apparatus used was an Olsen testing machine having a journal diameter of 3¾ inches, and length 3½ inches. In order to obtain the desired pressures per square inch the bearing area was somewhat reduced, and the bearing took the form of a babbitt-metal segment or shoe having a projected area of 5.8 square inches. This was subjected successively to total loads of 500, 1000, 1500, 2000, 2500 and 3000 pounds, provided the lubricant showed itself able to carry such loads. If the bearing gave evidence of seizing the test was discontinued. Except in such cases each test was continued for one hour, the journal speed being approximately 240 revolutions per minute, or 236 feet per minute. Observations were taken at 10-minute intervals of the bearing temperature, temperature of the room, the speed and bearing friction. From the total friction were calculated the friction in pounds per square inch and the coefficient of friction.

The grease was fed in the same manner in all of the grease tests. An oil groove was cut near and paralleling the front edge of the bearing, and its ends were turned and carried across the ends of the bearing to the leaving edge. A hand compression cup supplied grease to the center of the bearing on the entering edge. This cup was given a one-eighth turn every half minute for low pressure and more for added loads. The weigl of the lubricant supplied to the bearii during each run was obtained, also tl weight dropped from the bearing. In tl two oil tests the journal ran in an c bath.

The results of the tests as regards ten perature and coefficient of friction a plotted graphically in Figs. 1 to 9 (i clusively). Special features of the sever tests were as follows:

## Features of the Tests

1. Friction coefficient lowest at abo 220 pounds per square inch. During tl test there was a considerable tendency f the grease to work off the journal. Und a load of 345 pounds per square inch tl grease was so fluid as to pass readily c the end of the journal, leaving almo none at the front edge of the bearing. A attempt to run under 431 pounds p square inch led to smoking after 20 mi utes, and the test was discontinued.

2. Coefficient of friction higher th with mineral grease, owing to heat r quired to soften the animal fats. Und all but the lowest pressure the grea melted, ran off and dripped like oil. T run under 431 pounds pressure was co tinued to the end of the hour, but t grease turned black and the temperatu was considerably above normal.

3. This test could not be extended pressures higher than 172 pounds p square inch. The greasy compone softened and ran like oil, while the grap ite filled the oil groove till it had to removed with a piece of metal. The c efficient of friction was higher than shov by the tests of other lubricants. This t appeared to show that graphite grease

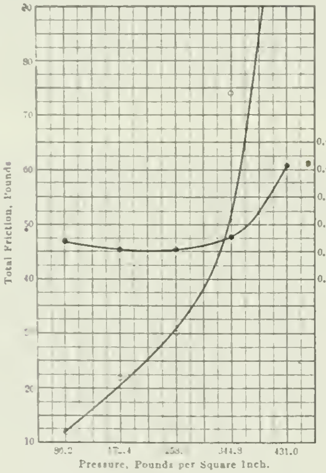


FIG. 1 CURVES FROM TEST 1 OF A HEAVY MINERAL GREASE

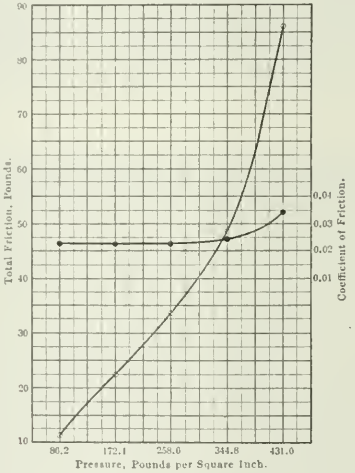
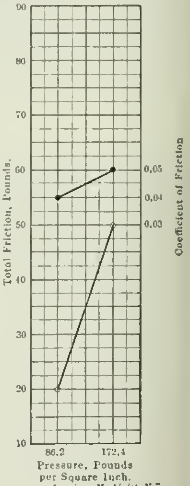


FIG. 2. CURVES FROM TEST 2 OF A STANDARD ANIMAL GREASE



American Machinist, N.Y.

FIG. 3. CURVES FROM TEST 3 OF A GRAPHITE GREASE

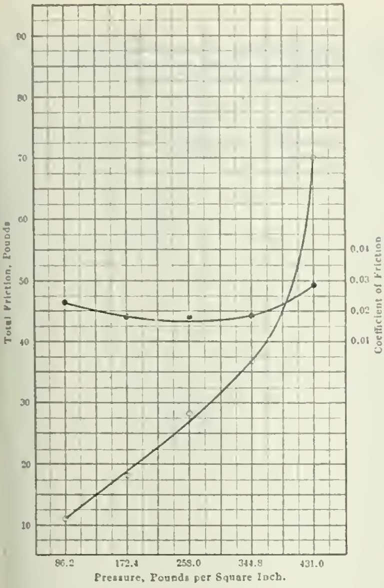


FIG. 4. CURVES OF TEST 4 OF A MINERAL GREASE SOFTER THAN NO. 1.

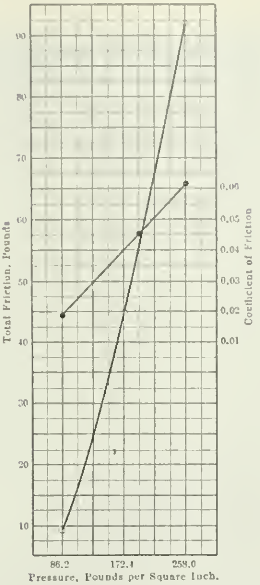


FIG. 5. CURVES OF TEST 5 OF AN ENGINE OIL

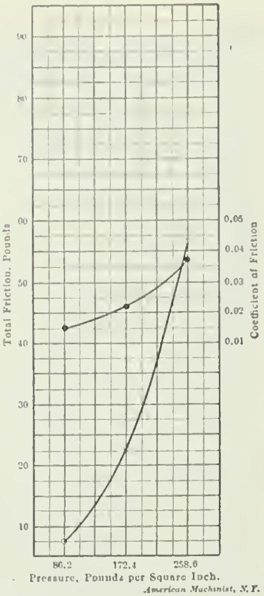


FIG. 6. CURVES OF TEST 6 OF ANOTHER ENGINE OIL

perly used as "dope" for gears and der similar conditions where subjected t churning, but is not adapted to bearing l rication.

This test showed a low coefficient friction for loads between 150 pounds a 350 pounds per square inch. The ring failed to carry a load of 431 nds, as it filled immediately with a k, gritty substance preventing the y of further grease, and was scored.

First oil test. A low coefficient was wn under moderate loads, but it rose very rapidly under higher loads. After running 30 minutes under 258 pounds the bearing smoked and it was found on stopping the test to be badly cut.

6. This oil showed a better test than 5, beginning with a lower coefficient of friction and enduring an hour's run under 258 pounds. It turned black, however, under the latter load.

7. Under loads from 150 to 300 pounds per square inch this grease (Keystone Grease, No. 2 density) showed a coefficient of friction lower than the best test of oil (6), and under loads up to about 360 pounds a smaller coefficient of friction than any of the other greases. The run under 431 pounds load came to an end after 58 minutes owing to the grease cup being empty and the bearing heating up in consequence. In that time 3.23 ounces of grease had been supplied. The grease showed signs of disintegration under heavy loads, but did not turn black until the grease ran out.

(*Continued on page* 791)

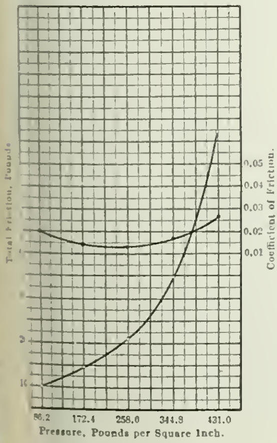


FIG. 7. CURVES OF TEST 7 OF KEYSTONE GREASE NO. 2 DENSITY

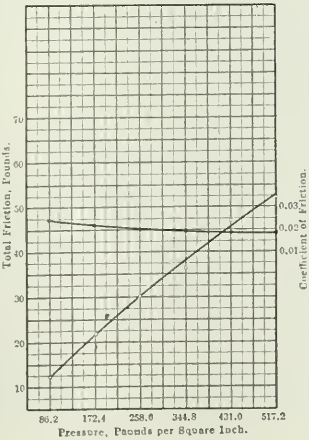


FIG. 8. CURVES OF TEST 8 OF KEYSTONE GREASE NO. 1 DENSITY

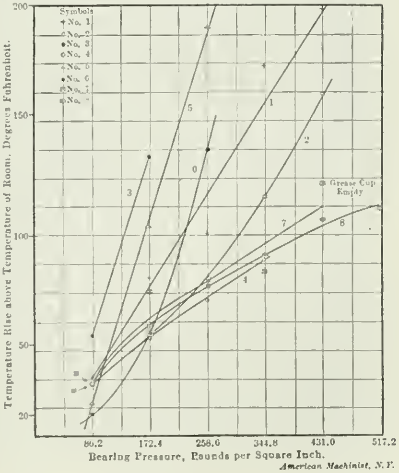


FIG. 9. RELATIONS BETWEEN BEARING PRESSURE AND RISE OF TEMPERATURE FOR THE EIGHT LUBRICANTS OF FIGS. 1 TO 8 INCLUSIVE

# What 14,000 Kilowatts Mean

## A Mountain of Coal and a River of Condensing Water Required to Run a Unit Which Would Light from New York to Chicago

The General Electric Company is making some Curtis turbine-driven units of 14,000 kilowatts capacity. It will be interesting to see what this means in terms which appeal to the comprehension.

The fifth stage rotating element shown in Fig. 1 is 152 inches, or 12 feet 8 inches, in outside diameter and runs at 750 revolutions per minute. If it ran along the ground at this rate it would go 5.66 miles in a minute, or nearly 8140 miles a day, and would run from New York to San Francisco in about 9½ hours. This and the other four wheels which constitute the moving part of the turbine, together with the shaft and rotating fields of the generator, weigh some 180,000 pounds, and yet so freely are they carried upon the cushion of oil that supports the step that this enormous weight can be revolved by one finger.

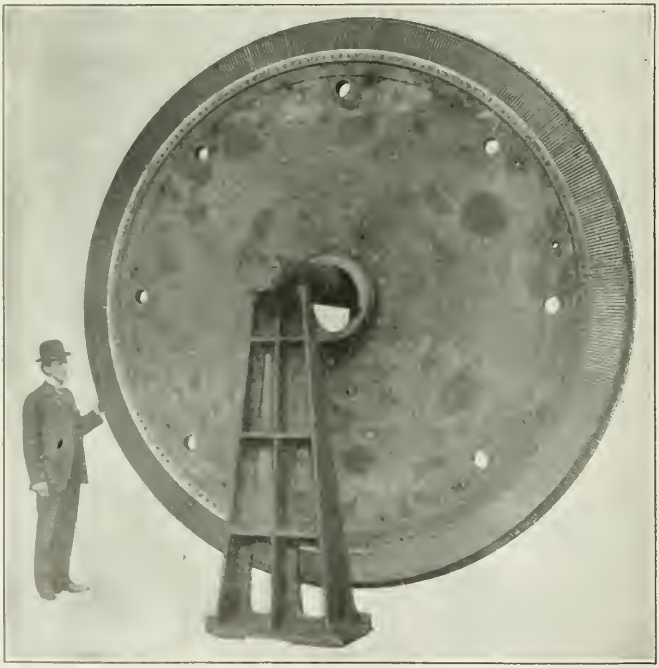


FIG. 1. FIFTH STAGE ROTATING ELEMENT OF 14,000-KILOWATT CURTIS TURBINE

Even at the low rate of 13 pounds of steam per hour per kilowatt this unit would require 182,000 pounds of water evaporated into steam each hour to supply it when running at its rated capacity, which would make a 14.3 foot cube. The day's supply would fill a pond 28x50 feet to a depth of over 5 feet, and at the usual rate of $1.50 per thousand cubic feet would cost over $105 per day. At the 75 pounds of condensing water often furnished per pound of steam condensed, it would require 3640 cubic feet per minute, or as much water as would issue in a jet one foot in diameter, with a velocity that would carry it to a hight of over 90 feet; or as much water as would flow naturally over a weir or dam in a sheet a foot thick and over 18 feet long.

### Coal

It would take to make the steam to run this turbine, supposing one pound of coal to evaporate and superheat 84 pounds of water, 520,000 pounds, or 260 tons of coal per day. This would make a cone 45 feet in diameter on the base an 20 feet in hight, and would take a trai of nine 30-ton cars for its transport. tion. Its cost delivered would be for tl ordinary case somewhat around $1000.

### Capacity

If all applied to lighting, the 14,0 kilowatts which this unit will genera would maintain about 350,000 16-candl power incandescent lamps, which, if hu in a straight line, would supply am illumination to 600 miles of hallways feet wide; or would supply 31,000 a lamps, which, if spaced 150 feet apa would illuminate 900 miles of ordina streets. Using the output of this unit fan-motor service, 150,000 of these lit machines could be kept going. The ener delivered at the terminals of the g erator during a day's run at full l would be sufficient to melt a cone of c per 21 feet in diameter at the base 100 feet high, or 400 miles of copper one inch in diameter.

The floor space required for the proper, including the condenser, wh is inclosed in the base, is only about square feet, or approximately 32 kilow per square foot of floor space. It take two men to operate it and all auxiliaries, not including the boiler-r equipment.

# Quick Action of Heating Surf

Prof. W. E. Dalby in a remark paper upon heat transmission, prese to the Institution of Mechanical E neers, says: "We can all appreciate formidable difficulties which surround kind of investigation when we thin the enormous rate at which hot gases up their heat. As an example, in some experiments were made on Orlean railway with a locomotive b The temperature in the fire box was degrees Fahrenheit, and in the smoke 752 degrees, corresponding to a dro temperature of 2160 degrees alon length of 16.4 feet. The velocity o gases was 164 feet per second, so the gases traversed the tubes in 0.1 second, and the heating surface, t fore, was sufficiently efficient to this large drop of temperature, na ly 2160 degrees in that time.

The third annual meeting of the A ri- can Society of Agricultural Engi ers will be held December 28-29, 190 at Ames, Iowa.

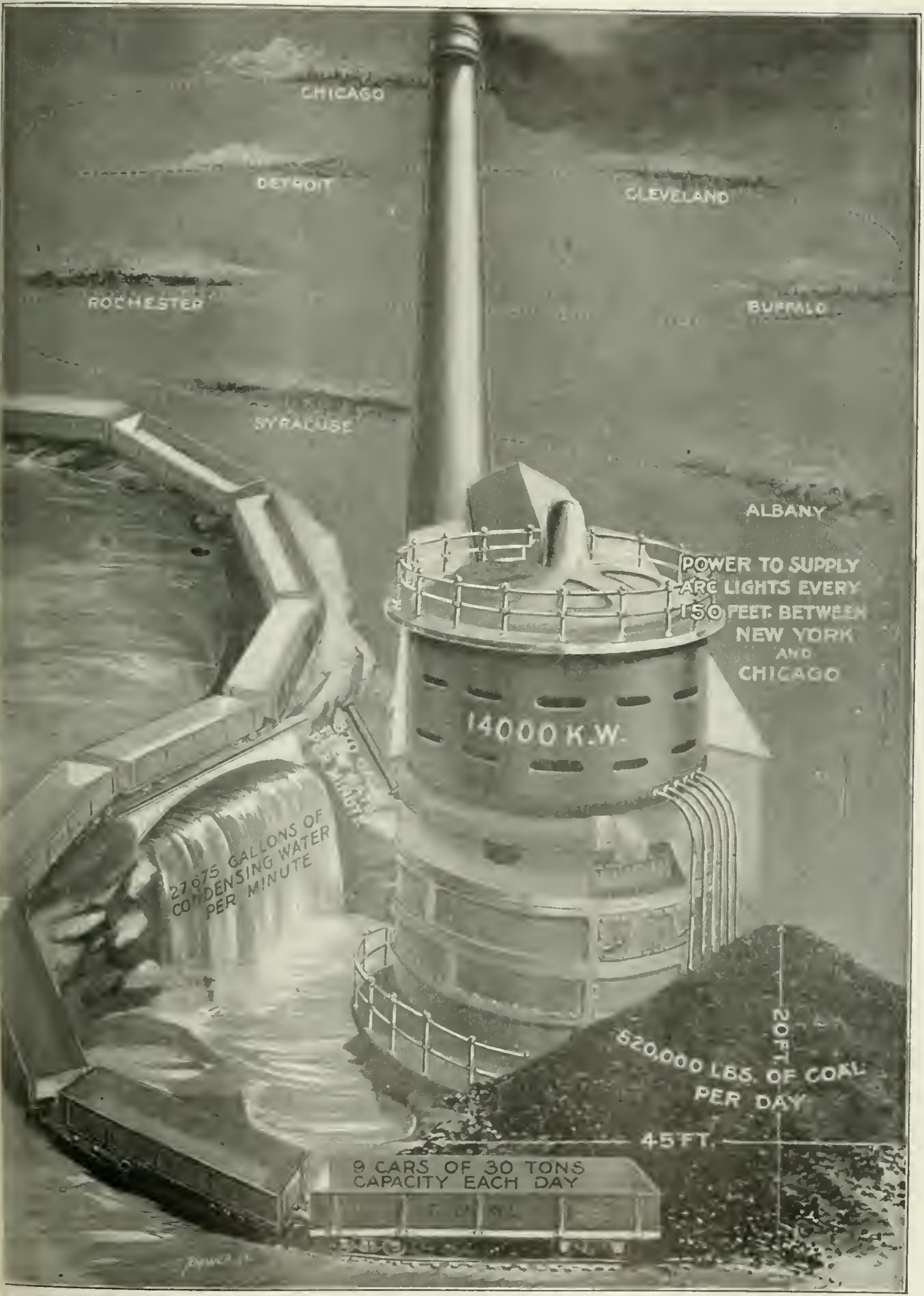

CHICAGO
DETROIT
CLEVELAND
ROCHESTER
BUFFALO
SYRACUSE
ALBANY
POWER TO SUPPLY ARC LIGHTS EVERY 150 FEET BETWEEN NEW YORK AND CHICAGO
14000 K.W.
27,675 GALLONS OF CONDENSING WATER PER MINUTE
520,000 LBS. OF COAL PER DAY
20 FT.
45 FT.
9 CARS OF 30 TONS CAPACITY EACH DAY

FIG. 2. WHAT 14,000 KILOWATTS MEANS

# Tanbark as an Economic Fuel for Boilers*

It is the object of this paper to give the fuel characteristics of wet spent tan as a boiler fuel. It is believed that tanbark contains a larger percentage of moisture than any of the other moist fuels, and it is perhaps safe, therefore, to assume that its correct treatment as a fuel may indicate to a certain extent the most efficient means of dealing with other moist fuels.

The nature of tanbark is too well known to require minute description but it may be stated, as relating directly to its use as a fuel, that its condition in the fire room varies with the method of its preparation for leaching, and its treatment in the leaches. Bark which has been finely disintegrated and has been blown a long distance through a pipe or flue will reach the furnaces almost in a state of a wet powder difficult to burn. On the other hand, with less thorough disintegration and a shorter tan drive the tan will be in larger pieces which allow a freer passage to the draft. The tan in the fire room varies in temperature according to its final treatment in the leach house and according to the distance it is conveyed from the leach to the furnaces. Under good conditions it often reaches the fire room at a temperature of 110 degrees Fahrenheit. The amount of moisture in the tan varies with the leaching process and usually runs from 62 to 70 per cent. Oak tan is easier to burn than hemlock, because it is harder and does not become soggy and pack on the grate, and admits the draft more freely than the hemlock.

Calorific tests conducted on samples of tan which were dried before burning showed an average heat content of 9504 B.t.u. per pound. In the same test it was also shown that the degree of leaching to which the tanbark is subjected does not affect its fuel value except inasmuch as actual weight is subtracted by the leaching process, so that a smaller quantity of fuel reaches the fire room. As regards the loss of weight due to leaching, 100 pounds of air-dry bark ground at the mill will result in about 213 pounds of spent tan, containing 65 per cent. moisture, in the fire room. That is, the weight of the spent tan is 2.13 times the weight of the bark ground.

Since a pound of fuel contains 65 per cent. moisture, 0.35 pound, or the dry amount, must evaporate 0.65 pound of moisture. The calorific value of 0.35 pound of dry tan is

$$0.35 \times 9500 = 3325 \text{ B.t.u.},$$

which is the total B.t.u. in a pound of moist fuel. Subtracting the moisture loss would give

$$3325 - 660 = 2665 \text{ B.t.u.}$$

as the available heat in a pound of fuel as fired.

As previously deduced, the weight of the bark as ground multiplied by 2.13 will equal the weight of the spent tan. Therefore the available heat for boiler purposes obtained from a pound of average air-dry hemlock bark is

$$2.13 \times 2665 = 5676 \text{ B.t.u.}$$

As compared to coal of 13,500 B.t.u., one ton of hemlock bark ground at the mill would equal 0.42 ton of coal. The chemical composition of the dry tan is as follows:

Table 1 Chemical Composition of Dry Tan

| | Per cent. |
|---|---|
| Mineral Ash | 1.42 |
| Hydrogen | 6.04 |
| Carbon | 51.80 |
| Oxygen | 40.74 |
| Total | 100.00 |

The sample in Table 1 was hemlock tan containing 6 per cent. oak tan. When dried at 110 degrees Centigrade, it lost 66.77 moisture.

## Evaporative Tests

The actual evaporative power of tan was taken from the results of 22 complete boiler tests burning tan alone. Eight of these were thermal-efficiency tests. The tests were conducted in accordance with the American Society of Mechanical Engineers' code. The type of boiler in every case was the horizontal tubular. The furnaces varied considerably in design and economic results, but they were all of the dutch-oven type set in front of the boiler, and all were fired from the top through feed holes. All of the tests were made under natural draft, and the results shown in Table 2 were obtained in one of the 24-hour boiler- and furnace-efficiency tests, which was selected to show what may be considered ordinary conditions and results in tan burning.

In a special furnace designed and constructed by the author, a thermal efficiency of furnace and boiler of 71.1 per cent., burning hemlock tan, was obtained, the efficiency being based on the available heat of the fuel. The principal features of this furnace, which was subsequently installed in a number of plants, were: Large combustion space over the burning fuel, automatic stoking with rotating comb shafts, oppositely inclined grate surfaces converging downward to a set of shaking and dumping grates, drying on dead plates over which fuel passed before receiving the air supply, concentrated draft from opposing grate surfaces to a focus of combustion caused by parallel spacing of longitudinal flat grate bars with beveled edges, reverberating draft action resulting from concentrated draft currents and the curvature of the arch, thus directing flames back upon the dead plates. The results obtained from this furnace a given in Table 3.

## Effect of Pressing and Burning Mixed with Coal

To learn the exact economic effect burning coal with pressed tan and al the result of pressing the tan to elimina some of the moisture, three thermal-e ciency tests were conducted, all on t same boiler and furnace, the conditio as far as possible being the same in tests and the furnace operated by t same firemen. The furnace and boi were of the same general type already ferred to. The firing was heavy, the c of tan nearly reaching the arch each ti after firing. The furnace had a gr surface of 11 feet 4 inches by 7 feet, 79.3 square feet, and the perpendicu distance from the grate surface to highest point of the arch inside was inches. The boiler was 6x18 feet contained 2089 square feet of heating s face, the ratio of heating surface grate surface being 26.3 to 1.

The result of this series of tests sh that the burning of coal with pressed increased the thermal efficiency from to 63.4 per cent., and also increased boiler output from 92 per cent. of rated capacity to 135.5.

Since the thermal efficiency was p tically the same with both pressed and pressed tan, the principal advantage pressed over unpressed tan in this ticular case lies in the intrinsically gre calorific value of the pressed tan o to its reduced moisture. In this partic case in which the unpressed tan conta 63.6 per cent. and the pressed 59.6 per cent. moisture, the a gain in available heat units was per cent. over the unpressed tan, or per cent. gained in heat value for per cent. increase in moisture. In a practice, however, a total gain of ab per cent. can be obtained, but against must be charged the power to run press, maintenance, repairs and the advantage of noise and vibration i fire room. The principal point t member in changing from wet to tan, is to reduce the grate surface portionately. Failure to observe this caution has resulted in the throwin of commission of more than one pr

## Effect of Small Combustion Sp over the Fire

A special test on a low arch fu was made to obtain comparison with arches. A furnace containing nine holes and having a hight from ar grate of 26 inches, was tested wit the miserable result shown in Table 5.

## Burning a Mixture of Tan and Coal

Among other methods of burnin the two fuels, the ordinary coal-burnin setting has been tried. The grates are u ally of the shaking variety and are set directly under the boiler and generally only 24 to 30 inches beneath the shell of the boiler. The coal and tan are fired alternately by and. Owing to the large volume of an as compared to its heating value spent tan weighs about 33 pounds per ibic foot), the fire doors have to be pened very often, thus admitting a great ccess of cold air to the fire. The fire ed has a strong tendency to burn through n spots and from blowholes. The temerature-retaining effect of the dutch-oven ch is lost, and instead the fuel gases me in direct contact with the shell of e boiler, which cools them before comustion is thoroughly under way. The relt in every such case the author obrved, was dull, smoky fire of greatly rying temperature and never good comtion. In a certain plant where this ethod was thoroughly tried out it proved unsuccessful that it was discontinued d the grates were replaced by dutch vens in which a mixture of tan and coal as burned, the fuel being mixed before g.

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*Abstract of paper presented before the American Society of Mechanical Engineers

The above illustration affords a good rison of combustion with and witht a brick arch over the fire bed with l iring, and it goes to show that a k or refractory arch is a necessity r good combustion when the two fuels e so related in quantity that their heat es are about equal.

As a further demonstration, experits with automatic stoking were cited. e mixed fuel was fed into a chainate stoker operating on induced draft. s was done under the most favorable ditions possible and under the supern of an engineer representing the in-grate company with the assistance of athor. The steam pressure and the rnace temperature dropped rapidly and as soon necessary to eliminate the tan feed coal alone to prevent the fire going out. Experiments with differt methods of mixing and feeding the fuels all resulted in killing the fire.

Like experiments were conducted on a r t stoker set in front of the boiler l having a brick arch completely over re. No scientific tests were coned, but the mixed fuel easily carried t ad formerly carried by the coal, it g necessary only to increase the feed he stoker. The steam pressure was rased, and as far as the eye could t there was not the slightest decrease rnace temperature, the combustion ng clear and to all appearances exent.

rom these experiments it seems enly safe to state, that for efficient comion of a mixture of tan and coal in r by weight of 5.2 to 1 a refractory ah over the greater part of the fire, and pferably over the entire fire bed, is not s advisable but necessary. It follows tl tan bark of the usual moisture and heat content cannot be burned without the application of a refractory arch, or some device of similar function, such as a large combustion chamber lined with refractory material.

Wood is sometimes burned in combination with tan in the same furnace. Good results are obtained when the wood is ground to about the same fineness of the tan, when it is known in the sawmill district as "hog feed." When wood in slab or log form is burned in the same furnace with tan the results are usually very poor, owing to blowholes formed in the fire bed and consequent large access of air

### Draft and Grate Surface

The force of draft required in general practice for tan burning is somewhat higher than that required for producing the same boiler output with bituminous coal. No definite figures can be given for the force of draft as related to tan burned per square foot of grate surface, owing to the widely varying designs of furnace and methods of firing. It may be stated, however, that for full capacity not less than ½-inch draft should be provided for in the uptake of a horizontal-tubular boiler, when the boiler is set so that the gases flow under the shell and through the tubes directly to the stack or uptake.

Owing to space required, facility in cleaning fires, minimum radiation from furnace and expense of building and repairing, it is desirable to make the furnace grate area as small as possible and still conform to capacity requirements. It is therefore necessary to know the boiler horsepower developed per square foot of grate surface. This depends upon the rate of combustion of the tan, which is an extremely variable quantity, but averaging the results of nine typical boiler tests, it may be said that under usual conditions for oak tan the boiler horsepower per square foot of grate is about 2.08; and for hemlock tan 1.5 boiler horsepower per square foot of grate is an average figure.

When coal is burned in the same furnace with the tan the development per square foot of grate varies, of course, with the richness of the mixture and with the other usual conditions. In four cases out of five selected at random the boiler horsepower per square foot of grate was 2.5 to 2.7.

### Grates

Grates for tan-burning are made in different patterns, but usually contain from 20 to 30 per cent. air space, the actual opening between the bars being 3/16 to ¼ inch. Larger spaces than these allow the tan to fall through into the ashpit. A shaking grate is hardly necessary for burning tan alone, owing to the small percentage of ash. No clinkers form; only a very fragile crust on the grate obtains in three or four hours. In some cases fires are cleaned only once in twelve hours with good results, though like a coal fire, a tan fire should be shaken or disturbed very little. If a slice bar is used on a brightly burning tan fire, dense smoke results and the flame is killed for some time.

The temperature in the throat of a properly designed tan furnace burning tan alone will reach 1500 degrees Fahrenheit. The depth of fuel on the grate varies with the design of the furnace and the method of firing. In ordinary practice the tops of the cones of tan directly beneath the firing eyes vary from 2 to 5 feet above the grate surface, while the depth of tan where the cones meet will be from 6 to 18 inches, depending upon the design and firing of the furnace.

When spent hemlock tan forms a cone from the conveyer discharge on the fireroom floor it forms an angle of slide of about 55 degrees to the horizontal. Inside a hot furnace, however, this angle is about 45 degrees, and in laying out a tan furnace the latter angle is used in figuring the distribution of fuel on the grate. The angle of slide of tan on a sloping grate is 39 to 41 degrees, and these angles were used in planning the special tan furnace referred to previously.

### Single Furnace Best

Among other experiments with this fuel the author has made tests to compare results of double settings with single settings and believes that the single setting should have the decided preference. A possible though not a decided improvement in combustion is sometimes obtainable with a double setting, but this is more than offset, especially in small plants, by the advantages of convenience for cleaning, repairs and adaptation to load given by the single setting.

### $CO_2$ Content in Flue Gases

The combustion of tan, as indicated by flue-gas analyses made with an Orsat apparatus, compares most favorably with the combustion of coal in factory plants where the same amount of attention is paid to the boiler room. In fact, the percentage of $CO_2$ runs higher than in the ordinary coal-burning plant. For instance, the average $CO_2$ of 17 evaporative tests of different tan-burning furnaces was 11.3 per cent.; the lowest average $CO_2$ in any of the tests was 4.3 per cent., which represented unusually and abnormally poor conditions; and the highest average $CO_2$ in any one of them was 16.0 per cent. The CO averages about 0.5 to 0.6 per cent. and ranges from practically zero up to 2 per cent.

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George Clark, head of the Clark Engine and Boiler Works, Kalamazoo, Mich., was killed by a passenger train recently. The deceased was crossing the tracks and became confused by the approach of two trains from opposite directions.

# Notes on Hydraulic Wor

## Plungers, Valves and Frames for Hydraulic Jacks. Manner of Testing. Making and Treatment of Cup Leathers. Gutta Percha Forms

### BY W. BURNS

Fig. 1 shows part of the plunger of a hydraulic jack, used for lifting and forcing purposes. As they are often handled very roughly all parts are made of ample strength; and if clean water is used in them they require very little attention. The parts which require to be most looked after are the packing on the piston and the leather seats on the valves. If the piston packing is slack, a great deal of time and energy will be wasted, owing to the water leaking past, especially if a heavy weight is being moved.

As will be seen from the sketch, the packing consists of a narrow strip of leather wound spirally around the reduced part of the plunger. The ends of the strip are tapered in order that they may bed squarely against the shoulders. Care should be taken when fitting the packing strip not to make it too thin, as it is easy to reduce it from the outside after it is wound on. Soft, pliable leather should be used. The edge of the chamber into which the plunger fits is usually rounded or chamfered off to facilitate the entering of the plunger.

Before entering, the plunger should be well oiled or greased in order that the packing may enter with a minimum of friction. Should the packing show a tendency to creep up the plunger and not plunger should be withdrawn and the packing reduced by filing with a sharp, coarse file. In entering, the plunger should be lightly tapped in with a piece of wood; enter the chamber, it is too thick and the

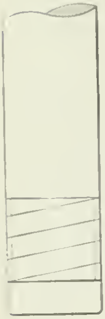
FIG. 1

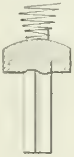
FIG. 2

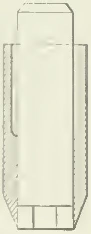
FIG. 3

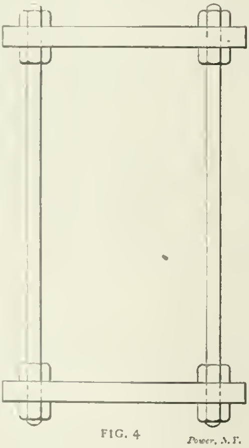
FIG. 4

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and if carefully fitted it will last a long time.

THE INLET AND OUTLET VALVES

The inlet and outlet valves require to be kept in good order. Of these the outlet valve is perhaps the most liable to be worn out, as it is constantly under pressure when the jack is in use; while the inlet valve is only under pressure while pumping is being done. If the outlet valve is leaking the water will escape into the cylinder, and if the plunger packing is in good order the pressure will force the plunger to the end of its stroke.

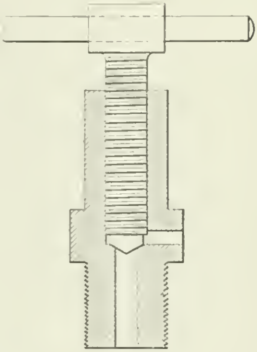
FIG. 5

If the inlet valve is in good order jack will rest in this position; but, shoul either of them allow the water to esca the jack will not hold its load, and a c tinual pumping will require to be k up, which, to say the least, is very an ing while a heavy load is being handl

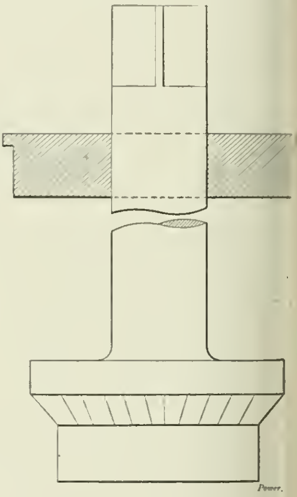
FIG. 6

As will be seen from Fig. 2, the is recessed at the head to hold a s leather ring which forms the wor face; three or four grooves being cu the stem to form a three- or four- valve. A light brass spring is atta to the top of the valve to close it quickly; it is also necessary as the may be used in any soft of position, without springs the valves might close. With this type of valve face, seat seldom requires to be touched any small pieces of grit, etc., usually bed in the leather.

In renewing a valve leather, the old can usually be picked out with a sh pointed tool of some sort. The new should be made slightly thicker than depth of the recess, some care being t to make the center hole and the ou edge a nice fit for the recess. A s punch is sometimes used to make washers.

Fig. 3 shows the construction; it is handy, if there are a number of to be overhauled, and it saves time. center punch is an easy fit inside ube; this allows the washer to be re- oved readily; as, if made from the solid, here would be some difficulty in removng the leather.

After the ring is fitted, the valve is aced in its seat and lightly tapped on p to bed the leather tightly into place d form a seat; it should then be taken

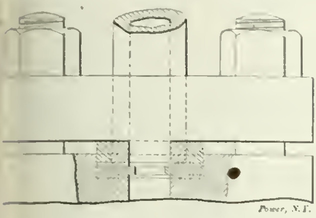

FIG. 7

and any surplus leather which may ect beyond the edge trimmed off. A g screw, the point of which is tapered form a valve face, and fits into a small ass valve, is often used to allow the ter to escape from the pressure cham- to the reservoir. This screw is slacked k slightly when lowering a weight the jack, the rate being easily con- lled from a scarcely perceptible move- t to any desired rate within the limit the jack.

### Testing Frame for Hydraulic Jacks

After a jack has been overhauled it is rable to test it to ascertain if it works rly and will hold its load. If a heavy ight has to be supported for any time a jack it is a good plan to make this even though the jack may not re- re overhauling, as it is sometimes a us matter if a jack will not hold n under a heavy load.

A very handy stand for testing purposes shown in Fig. 4. It consists of heavy s top and bottom held together by r long studs of suitable size. The gth should permit the longest jack in to be placed in position with a thick k of wood on top. Wood is used as ields slightly under pressure and should ack sink down slightly the pressure ld still be maintained: while if no is used and the jack is in direct con- with the plates, should it settle slight- e pressure is instantly removed; and, ay, a jack has been placed in the e for test on the previous evening, e morning, if it is clear of the , the length of time the pressure been on cannot be known. When g the wood, it is usually always in tact and a good idea of the amount pressure it has stood can be determined.

The cup packing on the plunger seldom goes out; it sometimes becomes hard through want of use and not being immersed in water; this, however, is easily remedied by soaking it in hot or cold water for a short time, or in melted paraffin, and then placing it in the jack, after being well greased.

### Pump Plunger Cup Leathers

Fig. 8 shows a pump plunger fitted with cup leathers. If the chamber is smooth and in good order these will last for a long time before it is necessary to renew them, and even when the chambers are scored and worn they will work and give satisfaction for some time. In entering, care should be taken to avoid injuring the edges of the cup. Should the edges of the cup be larger than the bore of the cylinder, a good method is to wind some fine twine tightly around the cup; this will usually compress the cup enough to permit it to enter, when the twine can be removed.

If this method will not answer, a ring of the same diameter as the cylinder should be got and the cup forced into it, the rounded edge being entered. This may reduce the leather enough to let it enter.

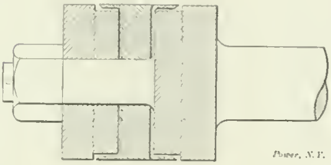

FIG. 8

The washer between the two leathers should be formed at the edges, as shown, to fit the rounded edge of the cups; if this is not done, the leather is often fractured at this edge, as, though the cup is rounded at the edge when new, the pressure soon forces it back to a sharp corner. The edges of the cup should be from 1/16 to 1/8 inch clear of the shoulders of the head, and chamfered as shown. Small grooves are often cut in the washer and plunger to hold the leather in place. A fine thread is preferable for the clamping nut, as the leathers can be clamped more tightly, and the nut has less tendency to unscrew; it should be locked very securely, as with the great pressure and the constant jarring it unscrews very readily.

### Guttapercha Joints

Guttapercha forms a very good cover joint, though leather or soft rubber may be used. In making the guttapercha joint a suitable length of round section is cut, the ends softened by heating and then joined together. After the joint has hardened the ring is placed in position and the clamping bolts screwed up; the ring flattens out under pressure and fills the jointing space. This joint fills up any defective places in the joint faces.

When soft rubber is the material used the two joints are screwed metal to metal, and the rubber simply held in a suitable recess; the pressure of the water acting on the inside edge of the ring expands it tightly into place and prevents leakage. To allow any air to escape which may have gathered in the chamber while the pump is at rest a small snifter valve (Fig. 5) is used.

A tool for truing up the valve seats is shown in Fig. 6. It is in the form of a milling cutter; the bush at the top fits into the recess for the cover and keeps the tool in line. If the valve faces are grooved or pitted in any way, it is usually quicker and better to use this tool to true them up and turn or file up the valves, as grinding in is very slow and unsatisfactory owing to the width of the faces.

Packing leathers can usually be bought in various sizes and forms, though they can be very easily and cheaply made.

### Mold for Cup Leathers

Fig. 9 shows a very handy mold for making cup leathers. It may be made from any convenient material, malleable iron being very suitable, or hardwood may be used. An ordinary black bolt of suitable size and length may be used for tightening up; as there is usually a hole in the center of the leather for holding it in place in the machine, the hole for the bolt does no harm.

The leather is first softened by placing it in hot water; it is then placed on the die block and the bolt screwed up. Care should be taken to prevent wrinkles forming on the edges; this may happen if the leather is too thin to fill up the space.

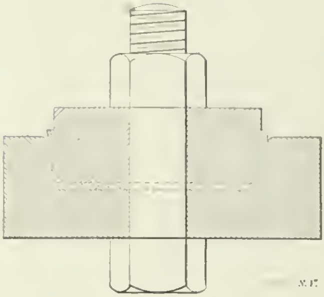

FIG. 9

The skin of the leather should be to the outside. After forming and allowing the cup to set the edges should be trimmed and beveled off.

Occasionally in a flanging press it is desired to reduce the speed of the flanging ram; this is readily accomplished by fitting in a washer with a small hole between the pipe connections and the machine (Fig. 7). A joint is of course placed on each side of the washer. Where heavy hydraulic pipe is used there is no need to fasten the flange to the pipe beyond making the screw a nice fit; if the ends of the pipe are faced squarely they will form a tight joint.

# Repairing a High-Speed Engin

## Tightening a Pressure Plate. Taking up Wear on Valve Yoke. Some Rocker Arm Troubles and Simple Methods for Their Remedy

### BY W. H. WAKEMAN

Fig. 1 is an end view of the pressure plate and automatic valve of a high-speed engine which forms part of the equipment of my engine room. These parts stand vertically when in service, but the points that I wish to present are brought out better by showing them lying horizontally because they were so placed on the bench when taken out of the steam chest. The valve *A* lies in the pressure plate *B* and when both were new there was no lost motion at this point, but several years of service had caused the valve to become loose enough to develop a disagreeable noise when conditions were right for it. A piece of sheet brass 1/32 inch thick could be forced into the space at the end of the valve, but was too tight to be safe, and it is not a good idea to have parts which may become detached in the steam chest of an engine.

Fig. 2 illustrates the method adopted for safely overcoming this objection. It shows the valve in a vertical position. Two 5/8-inch holes were bored in the top and filled with Babbitt metal until there was a little heap above each hole. When cool this metal was driven in tightly with a hammer to counteract the effects of shrinkage due to a reduction of temperature. They were then trimmed and the tops filed off until a snug fit in the pressure plate was secured. As it is impossible for these to come out with the valve in place there is no danger of wrecking the valve by one of them being caught in a steam port.

Returning to a consideration of Fig. 1, which shows a 12-inch scale on the face of the pressure plate, there is an open space below it showing that the valve is slightly worn. The design of this engine permits of a very simple and inexpensive remedy for this defect, as it is only necessary to plane enough off from the pressure plate to compensate for the open space above the valve *A*. Care should be taken, however, to measure this space accurately, because in this case it was not the same at all points, owing to unequal wear, and this condition will be found in other cases. At one side it was 0.004 inch and at the other 0.002. This was determined by putting slips of paper of varying thickness under the scale, noting which one filled the space at a certain point, and measuring the thickness of it with a micrometer. The side which showed the greatest space was raised 0.002 inch with a slip of paper, and the planer tool was then set to remove 0.002 inch at the lowest point, which, of course, caused it to take off 0.004 inch at the highest.

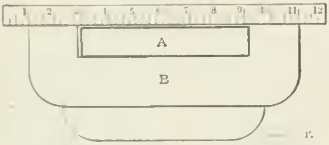

FIG. 1. PRESSURE PLATE AND VALVE OF HIGH-SPEED ENGINE

Both pressure plate and valve were then put in place, and the valve rod connected. After securing the steam-chest cover by nuts provided for this purpose, the valve rod was disconnected from the governor and the valve moved through its extreme travel by hand to test the measurements taken and the planer work, for if either was imperfect there was danger of causing a wreck by binding the valve and thus preventing it from moving when the flywheel revolved. As it moved freely, steam was admitted to the cylinder in order to heat the whole, after which the valve was again moved by hand, as there is always a chance for such a valve to bind when heated, even if it did not when cold. This valve moved freely as before. After other repairs were completed, the parts were properly connected and steam admitted to the cylinder, resulting in a noiseless valve under working conditions.

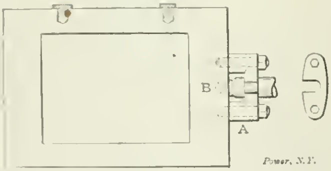

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FIG. 2. METHOD OF ADJUSTING VALVE CLAMP

The clamp used to fasten the valve rod to the valve is shown at the right of Fig. 2. It appears in due position at *A*, where it is held in place by two studs. The builders of this engine evidently intended to have the ends of this clamp filed off whenever it was necessary to compensate for wear, but in order to save time and secure a much better job, the ends were planed off, and very thin copper washers put on the studs until the rig thickness was secured, because this clar must always be free to come off from t valve rod while the engine is runnii in case water enters the cylinder a causes excessive pressure. When sli wear causes too much lost motion at t

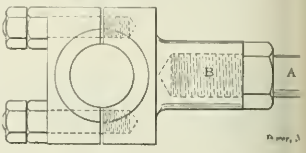

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FIG. 3. PROVISION FOR ADJUSTING WEAR

point, a washer is removed and the justment is quickly completed.

A hole was bored at *B* in Fig. 2 an steel plug carefully fitted to a driving This plug has a head which is larger t the body, thus giving a firm seat on edge of the valve. The valve rod co in contact with this plug every time t the valve is moved toward the head and as the motion is reversed 600 ti per minute, even the slightest lost mo will increase comparatively fast. When the valve had only a flush surface at point, which answered every purpose a time, but the adjustment could not maintained in practice because when valve surface was worn by the rod, a pression resulted. The rod must go the slot over a high place, hence whe running position it was loose, and t was no remedy without doing a job of chine work on it, and this is not al practicable at times when an engineer a chance to take his engine apart and just it. The steel plug *B*, Fig. 2, great improvement, because it is abov surface of the valve, hence the rod into place without touching anything and when the surface of it becomes out of shape by long service it can e be refaced with a file.

Adjustments for wear on the rod this engine are made by closing the parts of a brass box closer together. box is illustrated in Fig. 3. Some gineers prefer to remove the cap, file off the surface and replace it, but there are two reasons why this is not the best m to adopt. There is not always time enough to do this when the rod needs adjusting, and it is difficult for anybody to file a perfectly true and parallel surface. A much better way is to plane the surface even t 32 inch and put on enough thin copper washers or liners to make the cap loose on its bearing when the nuts are set down firmly, but not loose enough to cause objectionable lost motion. When the box has worn enough to be noisy, take out one liner, and replace the cap. The effect of this is to reduce the lost motion by one-half of the thickness of the liner. Consequently if it is 0.004 inch thick the cap will be let down 0.002 inch. This is convenient and accurate and when the nuts are tightened properly there is no

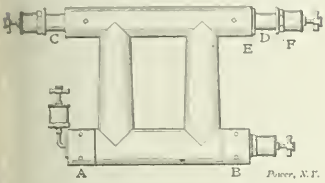

FIG. 4. LUBRICATION OF BEARING

nger of the cap becoming loosened by the effects of high speed.

Two prick-punch marks are shown at and *B*. If these are located, say, 4 ches apart before the check nut is loosd, when it becomes necessary to reve the rod for any cause, it will be an y matter to replace it exactly where it as before, by adjusting it to bring the rick-punch marks 4 inches apart as bere. Where these bearings are lubricated grease, as shown in Fig. 4, it is a good a to bore an oil hole in each cap, so that few drops of oil may be put on the bear-

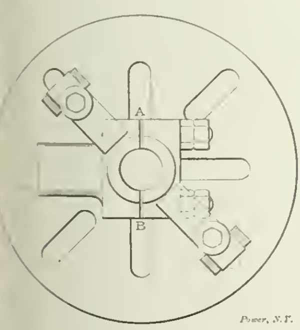

FIG. 5. BORING BOXES ROUND

g every day. This keeps the grease m becoming dry and hard, and affords chance to keep the bearing lubricated h oil until it is time to shut down, in the grease cup does not feed steadily. ig. 4 also illustrates the rocker on engine. *A* and *B* are the lower bears, and as the shaft is cast in one piece ith the rocker, it cannot be removed for pairs. Consequently when it wears flat the bearings it must be filed round ain. The shaft in the upper bearings *C* d *D* also wears flat because the boxes do not turn completely around on them, thus bringing wear on two sides only. This shaft is passed through a hole in the upper part of the cast iron rocker and is held in place by the two set screws shown. It was necessary to make a new shaft for this place, for if the old one was repaired it must necessarily be smaller in the bearings after being turned in a lathe and made round, which would not be satisfactory in practice.

This would be still more objectionable after the boxes had been refitted, as it was necessary to strap each one on the faceplate of a lathe, as illustrated in Fig. 5. and bore it out in order to make it round, which, of course, increased the diameter of the hole. The copper liners above mentioned may be put in place before the box is bored out, if desired, see *A* and *B* Fig. 5.

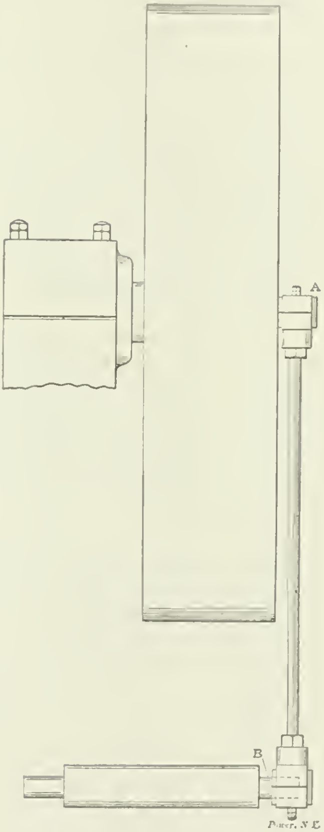

FIG. 6. PLAN OF GOVERNOR WHEEL AND ROCKER

The collar shown at *E*, Fig. 4, was not on the old shaft, but was put on the new one for the following reasons: Fig. 6 is a plan of a part of this engine, showing the governor wheel and the rocker The pin shown at *A* was also worn flat and was not a first class fit in the hole where it was held by a nut on the small end. A new pin was made and fitted into place, after which the box was adjusted ready for use. When the other end of this rod was brought down to the rocker, it did not fit properly on the old shaft, but left an open space at *B* When forced against the rocker it was badly out of alinement, and although it had been used for several years in this condition, it was not tolerated further. The new shaft was fitted with a collar ¼ inch wide at *E*, Fig. 4, which filled the space *B*, Fig. 6, and thus the two bearings of this rod were brought into alinement and have been more satisfactory ever since.

The head at *F* Fig. 4, was formerly a piece separate from the shaft, which was held in place by the shank of the grease cup that passed through it and screwed into the end of the shaft, but the head is now in one piece with the shaft, thus securing another improvement. Of course it was impossible to have a solid head on the other end, as it was necessary to drive the shaft through the hole in the rocker, therefore, a loose head was provided and is held in place by the grease cup, as shown in Fig. 4.

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Official announcement is made by J. G. Jones, general manager of the Northern Idaho and Montana Power company, that construction work on a plant to cost $100,000 will begin within 30 days. The plant will be located at Sandpoint, Idaho. There will also be a power house and substation. The company has awarded the contract for the building of a substation at Newport, Wash. This building and machinery will cost $15,000.

The new power house at Sandpoint will have 1500 horsepower. The substation will have a transformer capacity of 600 horsepower and will be constructed to accommodate 1500 horsepower when this amount is needed. For the enlarged plant the company has purchased 600 horsepower in water-tube boilers, a 750-horsepower engine and generator and a 200-kilowatt generator.

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Prospects are rapidly rounding into shape for a legal battle, triangular in its character, with representatives of the big water-power merger, the Manistee Navigation Company, and the Federal Government at the three corners of the contest. The whole matter grows out of the plan to build a series of dams on the Manistee river, in Wexford county, Mich., for electric generation. Already the war department and the navigation company have shown their hands, quietly, but shown them nevertheless. All that remains is for the water-power company to break into the ring and it is said by those in close touch with the situation that the corporation will contest its right to build dams

# Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think,
Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

## Burning Wood in Gas Producers

The following data give some of my experiences while in charge of gas and power plants at the Moctezuma Copper Company, at Nacozari, Sonora, Mexico, during 1908.

The gas-plant equipment consisted of two sets of Loomis-Pettibone down-draft producers with one common wet scrubber and one Root exhauster, each set having its own vaporizer or boiler. The scrubber was filled with trays of coke, having large water sprays above the top and several trays. The water used was pumped back and used over, with the addition of fresh water. Two gas holders were provided, one for water gas, which was burned in the igniters, assay furnaces, machine shop and round house. The other holder was much larger and held the producer gas at a pressure of about [illegible] of water. As there was only one scrubber, a general clean-up could not be made without a complete shutdown. In about a year's time we had two general clean-ups and one shutdown besides on account of fire in the wood-sheds of the gas plant. Several partial shutdowns were caused on account of accidents, such as broken belts in the power house or breakdowns of the engines.

The method of firing the producers was as follows: First, a layer of coarse lump coke was placed by hand on top of the grate bars, then coarse coke to the depth of 3 feet was dumped in through the firing door and leveled off, and a few sticks of wood were thrown in and lighted by means of burning oily waste. The blower was then started, creating a draft down through the producers and water-sealed valves and up through the vaporizer and blower to atmosphere. This was continued and more wood added from time to time until the coke was incandescent and the vaporizer had a pressure of about [illegible] to 80 pounds. Then more fuel was added and the producer was ready for service, the valve to the exhauster being opened and the valve to the blower being closed simultaneously. Five hours was the usual time required to get a set hot, and about three or four hours after the set was put in, a water-gas run was made by forcing steam up through one producer and down through the other for about two minutes, then reversing for two or three minutes more. From then on, a water-gas run was made every hour. A vacuum of about [illegible] inches of water was carried until a set had been running three to four days, when the vacuum raised to as much as 30 inches of water and sometimes even more. When one set became too full of ash, the other set was cut in and the first set shut down and cleaned.

The power house was supplied by a 16-inch main, 5-inch pipes leading to each cylinder of each engine. The equipment consisted of eight single English Crossley 18½x24-inch engines, two opposed two-cylinder English Crossley 18½x26-inch engines, and one opposed two-cylinder American Crossley 18½x27-inch engine.

TABLE 1. FUEL PER HORSEPOWER-HOUR AT SWITCHBOARD.

| Month, 1908. | Fuel per H.P.-hour, Lb. | Coke, Lb. | Oil Cost per H.P.-hour. | Waste Cost per H.P.-hour. |
|---|---|---|---|---|
| July | 1.9137 | 0.044 | 0.00087 | 0.000019 |
| August | 1.893 | 0.0356 | 0.001047 | 0.0000143 |
| September | 2.178 | 0.0358 | 0.00085 | 0.0000103 |

TABLE 2. HORSEPOWER DEVELOPED AND GAS CONSUMPTION.

| Month, 1908. | Electrical Horse-power. | No. of Days Fires Run. | Approx. Av. Gas per Min., Cu.Ft. |
|---|---|---|---|
| July | 593.9 | Mostly 4 days each. | 1300 |
| August | 590.8 | One 6-day and five 5-day runs | 1291 |
| September | 573 | Five 5-day and one 4-day run | 1275 |

All of the engines were fitted with double hot tube igniters and nonadjustable timers. The English engines were equipped with hit-or-miss governors and the American engine with a Riter governor, which is of the combination throttling and hit-or-miss type.

The American engine had about 140 pounds compression and about 420 pounds maximum pressure, while the English engines had about 90 to 100 pounds compression and 275 to 300 pounds maximum pressure.

All of the engines were provided with constant-feed lubrication, the oil being supplied from a 1½-inch main above the engines, which in turn were supplied from a filter tank, to which the waste oil was returned to be filtered and used over again.

The eight single engines were each belted to a 75 kilowatt 265 volt Gen Electric direct-current generator, and tl three double engines were belted to 15 kilowatt Crocker-Wheeler 265-volt direc current generators. All of the generato were connected in parallel at the ma switchboard which was equipped with tl usual direct-current instruments. Tl double engines run about 180 revoluti per minute and the single engines abo 205 revolutions per minute. All labor w Mexican, except the chief engineer a a machinist repair man. Eight-ho shifts were in force and the fuel w scrub oak, sycamore, cedar, etc.

The fuel per horsepower-hour at t switchboard for three months of 1908 given in Table 1 and in Table 2 the hor power developed and gas consumption

The load was easily carried with t double, or one double and two single, four single engines off. All of the gines were started with compressed

In regard to wood firing in the gas p ducers, care must be taken to keep fuel bed fairly even and free from passages, as the coke will burn out the bottom of the fire and a change have to be made to the other produ set in a hurry, for with the air pass in the fire the gas will be diluted to s an extent as to stop the engines. approximate heat value of the wood is about 125 B.t.u. per cubic foot.

E. B. Rothwel

## An Odd Case of Motor Trou

Last winter we installed a 20-ho power two-phase induction motor to d a load in "multiple" with a water-wl It gave first-class satisfaction and we perienced no trouble until this sum when, because of low water, it bec necessary for the motor to carry 25 t horsepower at times, but this it refuse do, slowing down and dropping ou step.

We went over all the connections found them tight, tried the incoming age and found it practically the sam both phases and all it should be; we going to write the makers to see they could suggest when one day the tor refused to start, after standing a three hours. The incoming voltage as normal, but when we disconnected ne wire on each phase from the motor, c ed the compensator, and tested again, we found only one leg alive.

We located the trouble inside the compensator and found one of the incoming leads burnt in two inside the insulation and about two inches above the lug on the switch. The wire had been cut before the insulation was put on and a few strands of No. 20 wire had been trying to carry the current but the drop had been so much that practically all the current was going to the other phase, so that sometimes it had to carry 120 per cent. overload, which was too much for it, and the motor broke out of step.

We cut off the lead above the break, soldered the lug and have had no trouble since, the motor carrying sometimes as much as 30 horsepower without a murmur.

J. B. CRANE.

Breadalbin, N. Y.

## Condenser Design

The accompanying table giving head, pressure and velocity of water in connection with condenser design has been of service to the writer and will undoubtedly be useful to others. The velocity of water under given heads was computed from the formula,

$$V^2 = 2gh,$$

that the actual velocity was based on a discharge coefficient of 0.62.

W. VINCENT TREEBY.

ford, England.

CONDENSER DESIGN.

| Head. | | Vacuum, 30-inch Bar., Inches. | Pressure, Lb. per Sq.In. | Velocity, Feet per Second. | | Head. | | Vacuum, 30-inch Bar., Inches. | Pressure, Lb. per Sq.In. | Velocity, Feet per Second. | | Head. | | Vacuum, 30-inch Bar., Inches. | Pressure, Lb. per Sq.In. | Velocity, Feet per Second. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Feet. | Inches. | | | Theoretical. | Actual. | Feet. | Inches. | | | Theoretical. | Actual. | Feet. | Inches. | | | Theoretical. | Actual. |
| [illegible] | [illegible] | | 0 0043 | 0 80 | 0.49 | 2.6 | 31¼ | 27.72 | 1.126 | 12 9 | 8 0 | 24 0 | 288 | 8 93 | 10 39 | 39 3 | 24 3 |
| [illegible] | [illegible] | | 0 0086 | 1.13 | 0.7 | 2.7 | 32 7/16 | 27.64 | 1 169 | 13.2 | 8.2 | 25 0 | 300 | 8 0 | 10 82 | 40.1 | 24 8 |
| [illegible] | [illegible] | | 0 0130 | 1.39 | 0.86 | 2.8 | 33⅝ | 27.55 | 1 212 | 13 4 | 8 33 | 26.0 | 312 | 6 97 | 11 26 | 40.9 | 25 3 |
| [illegible] | [illegible] | | 0 0173 | 1.60 | 0.99 | 2 9 | 34 13/16 | 27 45 | 1.255 | 13 7 | 8 5 | 27.0 | 324 | 5 95 | 11.69 | 41.7 | 25 8 |
| [illegible] | [illegible] | | 0 0216 | 1 79 | 1 11 | 3 0 | 36 | 27 35 | 1 30 | 13 9 | 8 63 | 28 0 | 336 | 5 07 | 12 12 | 42.5 | 26 3 |
| [illegible] | [illegible] | | 0 0259 | 1.97 | 1 22 | 3 1 | 37¼ | 27 25 | 1.342 | 14 1 | 8 74 | 29 0 | 348 | 4 5 | 12 55 | 43 2 | 26 7 |
| [illegible] | [illegible] | | 0 0303 | 2.12 | 1.31 | 3 2 | 38 7/16 | 27 18 | 1 385 | 14 3 | 8 86 | 30 0 | 360 | 3 51 | 12 99 | 43 9 | 27 2 |
| [illegible] | 1 | | 0 0346 | 2 27 | 1.40 | 3 3 | 39⅝ | 27 1 | 1 429 | 14 5 | 8 99 | 31 0 | 372 | 2 96 | 13 42 | 44 7 | 27 7 |
| [illegible] | 1 1/16 | | 0 0389 | 2.41 | 1.49 | 3 4 | 40 13/16 | 27 0 | 1 472 | 14 8 | 9 17 | 32 0 | 384 | 1 85 | 13 86 | 45 4 | 28 1 |
| [illegible] | 1¼ | 29 94 | 0 043 | 2.54 | 1.57 | 3 5 | 42 | 26 95 | 1 515 | 15 0 | 9 30 | 33 0 | 396 | 1 003 | 14 29 | 46 1 | 28 5 |
| [illegible] | 2 7/16 | 29.92 | 0 086 | 3.59 | 2.23 | 3 6 | 43¼ | 26 85 | 1 559 | 15 2 | 9 4 | 34 0 | 408 | 0.00 | 14 71 | 46 7 | 28 9 |
| [illegible] | 3⅝ | 29.73 | 0 130 | 4.39 | 2.72 | 3 7 | 44 7/16 | 26 75 | 1 602 | 15 4 | 9 54 | 35 0 | 420 | | 15 16 | 47 4 | 29 3 |
| [illegible] | 4 13/16 | 29.65 | 0 173 | 5.07 | 3.14 | 3 8 | 45⅝ | 26 65 | 1 645 | 15 6 | 9 67 | 36 0 | 432 | | 15 59 | 48 1 | 29 8 |
| [illegible] | 6 | 29.58 | 0 216 | 5.62 | 3.48 | 3 9 | 46 13/16 | 26 5 | 1 689 | 15 8 | 9 79 | 37 0 | 444 | | 16 02 | 48 8 | 30 2 |
| [illegible] | 7¼ | 29.48 | 0 259 | 6.22 | 3.85 | 4 0 | 48 | 26 45 | 1 73 | 16 0 | 9 9 | 38 0 | 456 | | 16 45 | 49 5 | 30 6 |
| [illegible] | 8 7/16 | 29.39 | 0 303 | 6.71 | 4.16 | 5 0 | 60 | 25 6 | 2 16 | 17 9 | 11 1 | 39 0 | 468 | | 16 89 | 50 1 | 31 0 |
| [illegible] | 9⅝ | 29.3 | 0 346 | 7.18 | 4.46 | 6 0 | 72 | 24 7 | 2 59 | 19 7 | 12 2 | 40 0 | 480 | | 17 32 | 50 7 | 31 4 |
| [illegible] | 10 13/16 | 29.23 | 0 389 | 7.61 | 4.72 | 7 0 | 84 | 23 8 | 3 03 | 21 2 | 13 1 | 41 0 | 492 | | 17 75 | 51 3 | 31 8 |
| [illegible] | 12 | 29.12 | 0 43 | 8 03 | 4.98 | 8 0 | 96 | 23 0 | 3 46 | 22 7 | 14 1 | 42 0 | 504 | | 18 19 | 52 0 | 32 2 |
| [illegible] | 13¼ | 29.05 | 0.476 | 8 41 | 5.22 | 9 0 | 108 | 22 2 | 3 89 | 24 1 | 14 9 | 43 0 | 516 | | 18 62 | 52 6 | 32 6 |
| [illegible] | 14 7/16 | 28.94 | 0.519 | 8.79 | 5.47 | 10 0 | 120 | 21 4 | 4 33 | 25 4 | 15 7 | 44 0 | 528 | | 19 05 | 53 2 | 32 9 |
| [illegible] | 15⅝ | 28.85 | 0 563 | 9 15 | 5.67 | 11 0 | 132 | 20 09 | 4 76 | 26 6 | 16 49 | 45 0 | 540 | | 19 49 | 53 8 | 33 3 |
| [illegible] | 16 13/16 | 28 79 | 0 606 | 9 49 | 5.88 | 12.0 | 144 | 19 32 | 5 20 | 27 8 | 17 23 | 46 0 | 552 | | 19 92 | 54 4 | 33 7 |
| [illegible] | 18 | 28 68 | 0.649 | 9 83 | 6 1 | 13 0 | 156 | 18 5 | 5 63 | 28 9 | 17 91 | 47 0 | 564 | | 20 35 | 55 0 | 34 1 |
| [illegible] | 19¼ | 28 58 | 0.693 | 10.26 | 6.33 | 14.0 | 168 | 17.75 | 6 06 | 30 0 | 18 6 | 48 0 | 576 | | 20 79 | 55 6 | 34 7 |
| [illegible] | 20 7/16 | 28 5 | 0.736 | 10 56 | 6.52 | 15 0 | 180 | 16 75 | 6 49 | 31 1 | 19 3 | 49 0 | 588 | | 21 22 | 56 2 | 34 8 |
| [illegible] | 21⅝ | 28 44 | 0.779 | 10.86 | 6.7 | 16.0 | 192 | 15 88 | 6 93 | 32 1 | 19 9 | 50 0 | 600 | | 21 65 | 56 7 | 35 1 |
| [illegible] | 22 13/16 | 28 33 | 0.823 | 11.16 | 6.88 | 17 0 | 204 | 15.0 | 7 36 | 33 1 | 20 5 | 60 0 | 720 | | 25 99 | 62 1 | 38 5 |
| [illegible] | 24 | 28 25 | 0.86 | 11.47 | 7.07 | 18 0 | 216 | 14 11 | 7 79 | 34 0 | 21 08 | 70 0 | 840 | | 30 32 | 67 1 | 41 6 |
| [illegible] | 25¼ | 28.15 | 0.909 | 11.77 | 7.26 | 19.0 | 228 | 13.32 | 8 22 | 35 0 | 21 7 | 80 0 | 960 | | 34 65 | 71 8 | 44 5 |
| [illegible] | 26 7/16 | 28.05 | 0.953 | 11.97 | 7.38 | 20.0 | 240 | 12.4 | 8 66 | 35 9 | 22 3 | 90 0 | 1080 | | 38 98 | 76 1 | 47 2 |
| [illegible] | 27⅝ | 27 98 | 0.996 | 12.27 | 7.57 | 21.0 | 252 | 11.5 | 9.09 | 36 8 | 22 8 | 100 0 | 1200 | | 43 31 | 80 3 | 49 8 |
| [illegible] | 28 13/16 | 27 88 | 1 039 | 12.47 | 7.7 | 22.0 | 264 | 10 53 | 9 53 | 37 6 | 23 3 | 150 0 | 1800 | | 64 97 | 99 5 | 61 7 |
| [illegible] | 30 | 27 8 | 1 082 | 12 67 | 7.82 | 23.0 | 276 | 9 86 | 9 96 | 38 5 | 23 8 | 200 0 | 2400 | | 86 63 | 113 4 | 70.3 |

## Power Transmitted by a Belt

The power transmitted by a belt is directly proportional to its speed. A safe rule is:

*Use one horsepower for a speed of 1000 feet per minute, with a belt of single thickness, 1 inch wide.*

This is a more liberal allowance in favor of the belt than is usually given, but will increase its life in far greater proportion than the increase in first cost.

*Double belts will transmit about 1½ times as much power as single belts.*

This rule applies to belts running over pulleys of equal diameter, or where the arc of contact is 180 degrees. For smaller arcs of contact, use the coefficients found in the following table:

| Deg. | 90 | 100 | 120 | 130 | 140 | 150 | 160 | 170 | 180 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|
| Coeft. | 0.65 | 0 70 | 0.75 | 0.79 | 0.83 | 0.87 | 0.91 | 0.97 | 1.00 | 1.00 |

To increase the power transmitted, either increase the speed of the belt by using larger pulleys, or use a wider belt.

Example: A 3-inch, single belt is running over a 24-inch driving pulley, which makes 200 revolutions per minute. How many horsepower will it transmit?

The circumference of the pulley in feet is

$$2 \times 3.1416 = 6.2832 \text{ feet.}$$

As the speed of the pulley is 200 revolutions per minute, the speed of the belt will be

$$200 \times 6.2832 = 1256.64$$

feet per minute. For every inch of width it will transmit

$$\frac{1256.64}{1000} = 1.25664$$

horsepower. Then, a 3-inch belt will transmit

$$3 \times 1.25664 = 3.76992 \text{ horsepower}$$

If it is desired to increase the power in the above example to five horsepower, it may be done by using a wider belt in the proportion of 3.75 to 5, or in reality a 4-inch belt. The same thing could be effected by increasing the size of the pulley in the same proportion, or

$$3.75 : 5 :: 24 : 32.$$

It would thus require a 32-inch pulley. A double belt of the same width would transmit 1½ times as much power or

$$1.5 \times 3.75 = 5.63$$

horsepower, which would be a little more than the required five horsepower.

H. D. CHAPMAN.

Washington, D. C.

## An Unusual Engine Trouble

A large old-fashioned slide-valve steam engine driving a factory plant had been in use for about twenty years and had, up to the time of the last addition to the factory and consequent increase of the work required of the engine, been amply powerful. But since that time it had not been able to do the work with any degree of satisfaction, and the management at last decided to put in a gas engine, although that meant an outlay of money which at the time was inconvenient.

One of the engineers was far from satisfied that the old engine was giving its full power, so he made a test, which indicated that the engine was really not giving nearly its full rating, and that the reason was that steam was leaking past the piston. As time was precious just then an absolutely thorough overhauling was not considered feasible, but the piston was removed, the cylinder rebored, new piston-rings fitted and the valve refaced and reseated. The engine was then tried and found to give practically the same results as before. Several "experts" were then called in but they were at an absolute loss to determine the trouble. The engineer who had originally found that full power was not being obtained again went to work. He decided to lay all rules and past experience aside and experiment by resetting the valve by guess. This he was doing when a small pair of calipers that he had been using slipped from his hand and fell down into one of the ports of the steam chest. In trying to recover them, he squeezed his hand into the port and was surprised to feel the sharp edge of a hole at one end or side of the passage. Closer examination showed that one wall of the steam chest was almost entirely hollow and that the blow hole had broken t[illegible] the opposite port, allowing [illegible] the steam to go through to the opposite side of the piston.

The engineer got a couple of pieces of [illegible], placed them against the holes in the [illegible] and daubed a bunch of clay against them to hold them in place. Then he drilled a [illegible]-inch hole near the top of the outside hollow wall of the steam [illegible] and poured in very hot melted [illegible] metal, the entire job requiring but a couple of hours. The next day the engine pulled the entire factory without the slightest trouble. This simple repair saved an outlay of several thousand dollars.

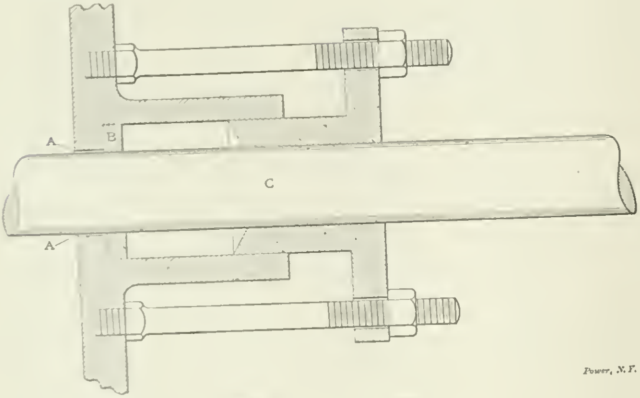
ROY M. WOLFE.

Lancaster, O.

## Reducing Packing Expenses

The engines that I had the following experience with were of a well known make, with 17[illegible]x18-inch cylinders; the piston rods were about 2¾ inches diameter, the engines made 205 revloutions per minute and were direct-connected to alternating-current generators.

As I had never used the packing that these engines were packed with when I took charge of the plant, and as this packing did not last over 30 days, I tried another make of packing which I had used before and which would run about 60 days. After giving it a trial I was surprised when I had to pack the stuffing boxes in about 30 days' time. As the piston rods were in good shape I looked for the trouble elsewhere, and when I examined the bottom of the stuffing box I found that the clearance around the rod as shown at *A A* in the sketch was about 1/16 inch. After bushing the box with a brass ring *B* which was made about 1/64 inch larger than the rod, and a tight fit in the stuffing box, I ran the engines two months and over with one packing of the box.



REDUCING PACKING EXPENSES

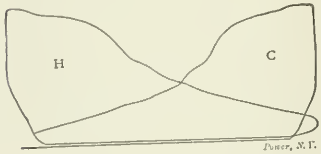
In fitting the ring *B* I made it large enough so that it required considerable pressure to force it to the bottom of the box, the ring being forced down by slipping a piece of 3 inch pipe over the piston rod, after disconnecting the rod from the crosshead, and turning the engine by hand, allowing the crosshead to force the pipe and ring to the bottom of the box.

Tampa, Fla. R. L. MOSSMAN.

## 1200 Feet Piston Speed

Having never seen any Porter-Allen diagrams illustrated in POWER that I can recall, I inclose one.

I was running the engine at the time and, in order to get the goods out that were ordered from the factory and keep all parts of the shop in operation we had to run the engine 300 revolutions per minute until a new engine was installed to take the place of old one. It was built by C. T. Porter, in 1876, at Newark, N. J. I merely inclose the card to show what the engine was doing—not because it is a perfect one by any means though I will say that the engine ran quietly and did not heat. If Mr. Porter is alive he will remember installing it in Erie county, Penn.



C. T. PERRY.

Oil City, Penn.

## Yes; but How Would You Do

In the discussions in the various e gineering books and papers I find ve little in regard to nitrogen and its effe in fuel economy. In practice, for e pound of coal burned to carbon diox under a boiler, about sixteen pounds air is required in order to furnish necessary amount of oxygen. As nit gen constitutes about 80 per cent. air this means that over twelve pou of nitrogen, per pound of coal burn absorbs heat to the temperature of co bustion without contributing in any w to its generation. While this gas may a medium for transmitting heat to boiler surfaces, yet if it were possible extract the nitrogen from the air form the dioxide over the grates in presence of oxygen only, would not economy be effected?

If this were a commercial possibi would it not hold true as well with tion-gas producers by increasing richness of the gas and save the heat is now carried off by the 50 per cent so of nitrogen one always sees in gas analysis?

In the generation of water gas witl this diluent it seems to me consider time and fuel would be saved in "bl ing up."

THOMAS H. HEATI

Seattle, Wash.

## Emergency Cure for a Slippi Belt

I recently had an experience wit slipping belt that may benefit s brother engineer. The belt in ques was 30 inches wide and drove a kilowatt generator. The driving p was 15 feet 3 inches in diameter and driven pulley 4 feet, on 25-foot cen The belt had been allowed to be very greasy—in fact it looked as if it been soaked in oil. The generator p had a nearly straight face, and whe got a 150-kilowatt load or better, the would slip and run over against the of the wheel pit, but not always same side. As the belt was 90 feet cleaning it looked like a job, and as would have to be done between mid and 6 a.m., we looked for something e The general manager owns an aut bile, and he said autoists used F earth on their friction clutches when became so greasy as to slip. He gested that we try some of it or belt, and sent us a supply. We menced using it immediately and the application brought an improve Each morning at starting I applied three tablespoonfuls of the earth t belt and in two days that belt forgot o slip, even with a full load on the generator.

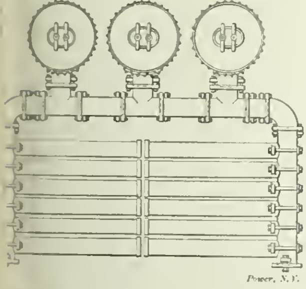
This may be an old remedy, known to ome engineers, but it was new to me nd I give it here for the benefit of those who may not know of it. With any of e belt dressings on the market with hich I am acquainted, it would have een necessary to clean the belt before pplying the dressing, but with the Fuller's earth this was not necessary.

W. A. WATSON.

Radnor, Ohio.

## Interesting Boiler Experiences

When I was a young "feller," it was med that no explosions took place en steam was shut off from an engine, but that they had occurred when throttle was opened; the explanation g that the circulation of water was rted suddenly and the quick evaporan set up made a much greater strain the boiler than a much higher pressure would do. This had reference to



. 1 HEADERS OF A SUPPLEE BOILE

beats on which, while the pressures low, the cylinders and boilers were l

e first water-tube boiler I had experic with was a Supplee, made something l the accompanying Fig. 1. All the j ts were ground joints of the ball type, s at expansion could take place in any c tion. This was a 100-horsepower b r and at the time we were carrying 5 nds pressure, the safety valves bei at 75 pounds. The boiler had b nt of use, as I had been putting i furnace to try producer gas.

e fire was burning regularly and st was raised to about 60 pounds when I rned it into the main. The stop valve w a 4-inch globe valve, outside screw a square thread. I gave this valve a t of perhaps ¼ revolution of the w el, when there appeared to be a jump w in the boiler and some of the joints in e connections under the drums leaked fo an instant.

e drums were 24 inches in diameter an the large connections equaled about a 7-inch pipe, the vertical columns being about the same size. In other cases I have noticed slight jumps in a boiler at such times.

There is another idea in connection with this: In the earlier days it was the custom to have a steam drum into which the boilers delivered the steam and from which the engine took it. One installation had two tubular boilers and a steam drum 36 inches in diameter and 16 feet long. The steam pipe to the engine (4-inch) was possibly 35 feet long.

Pressure was raised to 80 pounds and then the throttle valve was opened slightly to warm the engine. It was a poppet-valve engine and the valves could be opened so that the steam would blow right through to the atmosphere. On opening the throttle, the pressure went down to below 30 pounds and then steam began to blow through. The cause was that the air in the drum and pipe had been compressed and steam had not entered.

When the valve was opened, this air was blown out and steam, coming in contact with the cool surfaces, was rapidly condensed and we had to wait until steam could be raised, but the ebullition in those boilers must have been rapid for a moment.

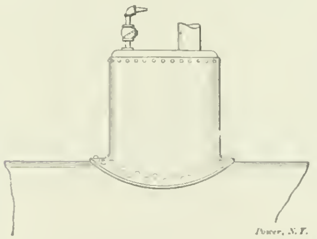


FIG. 2. SHOWING AUTOMATIC AIR VENT

Since that time, for many years it was my practice to be always sure that a bleeder was open to clean out all the air when getting up steam, until P. H. Bullock explained a simple, automatic vent for the purpose: Put in a ¾-inch nipple, a ¾-inch swinging check, opening inwardly and standing vertically, and then an ell to keep out dirt. See Fig. 2. When drawing water out of a boiler, this lets in air and prevents a vacuum. When raising steam, the air will all be cleaned out, as the valve does not close until about two pounds pressure has been raised. For boilers larger than 300 horsepower there should be more than one.

When the boiler and piping are entirely free from air, steam is raised much easier and quicker and pressure will not be reduced as rapidly when the valve is opened, and when the valve is over 4 inches, there should be a bypass valve, and only this small valve should be used until the pressure is very nearly equal.

W. E. CRANE.

Breadalbin, N. Y.

## A Peculiar Motor Trouble

A 7½-horsepower shunt motor, which had been used on an elevator, had just been received from an electrical-repair firm to which it had been sent for thorough overhauling. This motor had been out of commission for about six months. At first the armature only was sent to be repaired and as this did not prove satisfactory the whole motor was sent in. The motor always sparked badly and the commutator was badly burned. The armature on its first trip was overhauled and a new commutator put on. However, when the motor was assembled it overheated to such an extent that it could not be used. The same was true after the entire motor came back from the second trip. The people who owned this piece of machinery were very much disgusted with the repair work, and their disgust did not decrease when the bill was received.

The writer having several spare hours one day became interested in this motor. It would run for five or ten minutes when the bearing on the opposite [illegible] the commutator would be so hot that it smoked. When the armature was standing still and the line voltage impressed upon the field, the armature would crowd against this outer bearing with such force that a man could not push it away. The same was true when the motor was running, as all efforts to "jiggle" the armature backward and forward were fruitless. This showed that something was wrong with the distribution of the magnetic flux. The poles were measured and seemed to line up all right, and the air gap seemed to be the same under each pole.

Next the polarity of the poles was tested, and here is where the trouble was. The motor had four poles, three of them south poles. This caused the armature to be strongly attracted toward the three south poles, and in running the bearings heated badly. The south pole that was wrong was speedily changed to a north pole by reversing the connections, and the outer bearing was smoothed up in the lathe with sandpaper. After this the motor ran smoothly, without any overheating. The overheating in the motor before it was sent to be repaired was probably in the armature. It could not have been due to this arrangement of poles, as the motor had been running for three years. The armature was repaired, but the men who did it were careless in assembling the motor after the thorough (?) overhauling and were more careless in not testing the machine before sending it back, as this mistake could not have passed unnoticed.

The "Spring" meeting of the American Society of Mechanical Engineers will be held at London, July 26 to 29, the society having accepted the invitation of the Institution of Mechanical Engineers to meet with them.

# Subjects Under Discussion

Comment, Criticism and Debate upon Various Articles, Letters and Editorials Which Have Appeared in Previous Issues

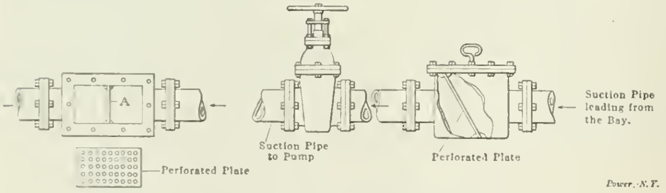
BRING OUT YOUR IDEAS

## Seaweed and Condensers

I noticed an editorial on "Seaweed and Condensers," in the September 28 number, setting forth the trouble the Pacific Light and Power Company had to contend with on account of seaweed. Having experienced similar trouble for years, at Barren island, N. Y., I was very much interested. We tried all the plans named in the article referred to, without avail, and water we must have, and that continuously, because in addition to our engines and boilers, we had an acid plant which could not do without cooling water. We had the suction pipe extended out in the bay as far as possible without interfering with the channel. A box was built around it perforated with $\frac{1}{2}$-inch holes, making a strainer. We had a flange joint on the suction pipe just above high-water mark [illegible] is to lift the suction pipe out, clean it as quickly as possible, and connect it up again. This was a heavy pipe, so I kept a sling always attached to a rigger above the dock to hook on the tackle to lift the pipe out with. Sometimes the device would work well for several days and at other times we had to lift the pipe out two or three times in one shift, especially after a southeasterly storm. On many occasions I have been called out in the night, when the suction pipe had become choked and there was only one man on duty attending to the pump. He could not do anything alone. Anyone can imagine how I felt getting out of a warm bed, on a cold night, and going out on the deck to disengage that suction pipe, clean it and put it back.

After trying many things, such as blowing it out with steam, pumping back water from our reserve, etc., I came across the idea to put a strainer in the boiler room, and we never had any more trouble. The accompanying sketches show the details of the strainer, which we had made [illegible] the Guild & Garrison pump works in Brooklyn.

There is a brass plate, $\frac{1}{2}$ inch thick, perforated with $\frac{1}{4}$-inch holes, the plate being twice the area of the suction pipe, bolted with hinged bolts. This plate can be removed in one minute and another put in without stopping the pump. I have seen times when the strainer would choke up a dozen or more times in one shift, yet it never delayed us five minutes. The men in charge could tell by the pump action when the strainer was getting choked and in one minute the dirty strainer was taken out and a clean one put in without stopping the pump. Of course I had a straightway valve between the strainer and pump, that could be closed at any time necessary.



STRAINER FOR SEAWEED

This strainer had been in about three years when I left the company's employ, seven years ago. It was at the E. Frank Coes fertilizing works on Barren island.

WILLIAM MELLEN.

Brooklyn, N. Y.

## Value of Professor Rateau's Turbine Blade Experiment Questioned

I have read with interest the description of Professor Rateau's method for measuring the losses in a steam turbine, on pages 568 and 569 of your issue of October 5.

The tests are similar in part to those published in Stodola's book on the Steam Turbine, in chapter 25. In both cases stationary blades are used whose shape is precisely that of the blades in actual turbine elements. Therefore, as those blades are made principally so as to take into account the peripheral velocity, it is obvious at once that they must be of little value when tested in stationary condition.

The first thing to have done would hav been to determine, by actual measuremen the velocity of the jet and the energ delivered by each jet, then to determin how many turbine blades were affecte by the jet, and find out the residual energ of the steam leaving the buckets. Th work possible would be proportional t the difference between the energy delivere to the buckets and that released from th buckets. The quality of the steam shoul be ascertained at the delivery end of th nozzle, and at the delivery end of th bucket. The pressure registered by th scale would be the measure of the wor actually done by the buckets, and th ratio between the work done and th work possible would be the efficiency the buckets.

The second series of experiments far from being conclusive. In the fir place, it does not apply to anything do in usual practice. A series of blades fixed close to the delivery end of the no zles; the steam coming from the nozzl passes through this series of blades a impinges upon another series of blad the impact on which is measured. T fixed blading is, according to the auth of the same shape as the movable bladin That obviously does not correspond practice. What should have been do even with the movable blades kept of same shape, was to introduce betw the nozzles and the fixed blading anoth movable set of vanes, the impact on whi would have been recorded separately. other words, there would have been th a set of nozzles deliv-ring a certa amount of energy into a set of moval blades, the steam issuing from these pa ing through a set of fixed vanes, whi would direct it against a second set movable blades whose impact would al be recorded. Before conclusions could drawn from such an experiment it wo be necessary, as suggested for the fi case, to measure the energy of the leaving the nozzle, then the energy of t steam leaving the movable blade, a the energy of the steam leaving the s tionary blade, and finally the energy the steam leaving the second set of m able blades. Only in this way would it possible to approach actual conditions taining in practice. The stationary bl should have been of the exact form, t is, nozzled shape, used in regular bines. Where so much was actually stake it seems strange that ordinary p autions were not taken to obtain logical results.

From my point of view these experiments appear to be useless and somewhat childish. They are, however, quite a revelation, indicating the state of the art in turbine design. It is interesting to note the various shapes of the turbine blades used, and it is quite obvious that the eminent author is far from positive as to the action of the jet of steam on the bucket, that is, whether this action is that of a jet, pure and simple, acting on curved surfaces, or that of a stream transferring energy while traversing an interbucket passage proportioned to properly receive this energy.

It is difficult to see how such experiments, except by chance, can furnish proper coefficients to be used in estimating the efficiency of a given turbine, since the energy lost by impact and friction in the blading is for the greater part transformed into heat, which is given up again to the steam as it proceeds from stage to stage, thereby raising its quality, and in a degree superheating it. The problem is of such complexity that it is wise not to draw definite conclusions from such a set of evidently imperfect experiments.

E. G. Arthur.

New York City, N. Y.

## Designing a Vacuum Tank

I notice that Prof. W. Kent feels somewhat inquisitive as to how the vacuum tank described in my article in the August issue was finally made for he says: "so that the reader wonders if the tank was ever built and if so, how thick it was made," in his letter on page 497 of the September 21 issue.

I should mention that I left the article with the "end hanging in the air" purposely with the hope of bringing out suggestions as to how this tank should have been designed and, in fact, the article as I wrote it finished by asking for suggestions from others as to what they would have done had they been in the writer's place, but the editors must have dragged their blue pencil through it, for it did not appear in print and therefore did not quite accomplish what I anticipated.

I am pleased to be able to give Prof. Kent the sequel to this story. The tank in question was considered somewhat larger than necessary and was reduced to [illegible] inches by 16 feet long. The shell was made of 5/16-inch boiler plate and 3/8-inch plate for the back end which was dished or bulged about 16 inches. The front end contained a large, heavy, cast-iron door and frame. The shell was reinforced by angle iron bands running round it at equal intervals, the angle iron being 4x3/8 inch with 4-inch leg radially. The highest vacuum obtained in this tank to my knowledge was between 26 and 27 inches.

If Prof. W. Kent will kindly state what practical formula or method is used for designing such tanks, I feel sure that many readers, including myself, will feel very grateful to him.

George P. Pearce

Exeter, N. H.

## More About Experts

I note with interest the discussion of the meaning of the term "expert." I have not gone to the trouble, as some have done, to look it up in the dictionary, but I believe that I know pretty clearly what the word means. If it has any meaning at all it can have but one, as we understand it, and that is a man—or woman, either, for that matter—who thoroughly understands a trade or profession, both theoretically and practically.

I know the disgusting memories that cling to many of us in association with that word, but that should not cause us to forget what is due those who really are experts, and who have striven honorably to become such. They richly deserve all the reward they are likely to get.

For the sake of the real experts, it is a pity that there cannot, apparently, be devised some method whereby the general public could be enabled to distinguish between the real and the counterfeit, the genuine and the fake. The reason why the fake expert thrives is that many employers who know nothing about the mechanical departments of their business seem to assume that a good pair of lungs indicate wisdom, and the fellow who can tell the longest-winded yarn and talk the loudest through his hat is the best man.

In this connection, the engineer comes in for some of the blame, for he is nursing the very parasite that he complains of. He is doing this by failing to keep in touch with his work, and also his employer. As I have said, many men who own machinery know little or nothing about mechanics, but this does not imply that they cannot be made to understand enough to enable them to coöperate with their engineers, if the engineers will get right down to brass tacks and make the effort to impart the requisite knowledge. The counterfeit experts do but little harm to the real engineer, for where he is the counterfeit is not required, and seldom gets in. The fake expert thrives where the engineer is asleep, and his existence is made possible and profitable because of the existence of a vast number of fake engineers. Hence, when you see the fake expert in evidence, you can bet dollars to doughnuts that with the employer it has been a case of choosing between the devil and his half brother.

There is a legitimate field for both the engineers who make a business of operating plants and those who make it their business to install them. There are many whom I could call expert operating engineers who can get first class results in operating electrical machinery, who would make a bungling job of it were they to undertake to wind a field coil for the simplest machine. Again, there is too much for one man to master fully in the fields of steam, electrical, refrigerating and hydraulic engineering, and in the thousand and one applications of the science. Therefore it may happen that in the design and installation of one plant a great number of experts will be coöperating and consulting together and combining their knowledge for the purpose of making the installation as a whole more perfect than any one of them alone could make it. In this the expert operating engineer might well have a place, for his experience in operating will enable him to see things that conduce to convenience that the others might not. Therefore, they all have their places, and if they are competent and fill the places they occupy in a creditable manner they should all alike be respected, and not abused.

I call to mind an experience when going to take charge of a plant where there was a gas engine of medium size that had been giving a good deal of trouble. The former engineer was still there when I arrived. There was also an expert (?) who advised that distilled water be run onto the main bearing of the engine, instead of oil, in order to make it run cool. There was an ice-making plant in connection, and this was easy, but it would of course reduce the output of the ice plant, as the distilled water was to be taken from the storage tank. I was standing in the crowd, and the expert advised this, and the manager, twenty-six years old, ordered the engineer to have the pipes connected up. The engineer and two helpers spent nearly a day in carrying out this order, and the show went on. In about two minutes the babbitt began to cut and throw up a metallic "frost." The expert yelled for oil, and so the Standard Oil Company, unknown to itself had its life preserved on that day.

I told the manager when the expert gave that advice that I had a seven-year old boy at home whom I would thrash for making a suggestion of that kind. Now I know that such experiences as this must disgust men of sense, but let us stop and ask ourselves if it is fair to judge other men who are what they claim to be by this fake. Would a good engineer want to be ranged alongside of the fake or botch in his own line of work? The fact is, this man was not an expert. He could not have been even a man of good, common horse sense. I have not a word to say in defense of such. I despise them heartily, but I do want to [illegible] engineers [illegible] enough to allow those who are really experts the credit that belongs to them. Design and installation require experience along different lines than is required for operation, but experience along all of them is required to make an economical, convenient and satisfactory plant. All can work together in harmony, and if each does his part as he should there will be enough credit for each without robbing the others.

William Westerfield.

Lincoln, Neb.

## Who Can Explain the Diagrams?

I had a similar trouble to Mr. Browne's, but found out that it was due to the threeway indicator cock not being near enough to the center of the length of the cylinder. It was over twice as far from the head end as from the crank end. After I changed it and placed it nearer the center. I obtained better diagrams, but it is not in the exact center yet on account of an obstruction at the side of the cylinder. Fig. 1 shows the diagrams before making the change and Fig. 2 those taken after the change.

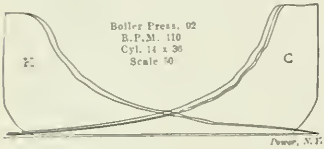


FIG. 1

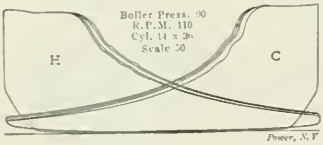


FIG. 2

George Dreyer.

Gibsonburg, O.

## Burning Partially Consumed Coal

Some time ago there was published a statement that the janitors of certain schools had been ordered to sprinkle the partially consumed coal from the school furnaces with a solution of salt and oxalic acid, and the writer of the article referred to questioned the utility of what he termed "holy water." Perhaps the following will solve the problem:

Partly burned coals generally have an outer coating of ash surrounding the good portion and preventing its combustion, as anyone can see by breaking up what seems to be only a lump of ash. This may not hold good in furnaces heating high-pressure steam boilers, but in domestic heating arrangements, where the temperature is comparatively low, it does occur largely.

Now oxalic acid (crystallized) and salt both decrepitate strongly, that is to say, each little particle bursts into a number of smaller particles when heated. A solution of these two substances would penetrate the porous coating of ash, but would be unable to go any farther, as the more compact coal will not take in moisture so readily, and on evaporation the solids would be deposited. When the ashes are heated, the multitude of tiny explosions caused by the decrepitation of the solid salt and acid would tend to throw off the clinker and allow the unburnt portion to come in direct contact with the hot gases of the fire and so burn and be utilized. So the "holy water," like many other things apparently equally mysterious, has its usefulness after all.

A. Allison.

Brooklyn, N. Y.

## Some Erroneous Ideas

In the September 14 issue, H. C. Hartley makes some bad mistakes trying to correct "Some Erroneous Ideas." He speaks of unbalanced pressure on the back of an engine valve and says that it would not exist if there were no ports to the cylinder. He tries to upset correct theory with poor experiments. It is true that if the steam gains access to the under side of the valve there will be little unbalanced pressure. When a partial vacuum is created under a glass bell our friend will find that there is an unbalanced pressure on that bell and that it requires some force to move it and if steam under pressure has access to one side of the engine valve and not the other there will also be an unbalanced pressure. Of course, when the pressure of the steam is allowed to equalize on both sides of the valve the unbalanced pressure disappears.

As to the tension in the bolts of a cylinder head the facts are as follows: When the nut on a bolt is tightened so as to give the bolt an elongation of 0.001 inch the metal under the nut is compressed about 0.0002 inch. This metal under compression acts as a spring and reacts against the tension in the bolt. Now, to go back to Mr. Hartley's spring demonstration. Take a long spring and stretch it out: Put between the ends of this spring a slim piece of hickory of such size that the tension in the spring will cause it to bow. Now, any additional pull on the end of the spring will put additional stress in the spring which is exactly what happens to the bolts of the cylinder head when steam under pressure is admitted to the cylinder.

A. T. Hutchins.

West La Fayette, Ind.

## Kerosene in Boilers

Noticing the fact that the question of using kerosene oil as a steam-boiler scale remover, or preventive, is undergoing its periodical revival, suggested to my mind the possibility that perhaps some of your readers might be interested in hearing of a sad experience along this line that fell to my lot many years ago.

Along in the early 90's I happened to be in charge of a plant for which steam was supplied by a battery of five 56-inch by 16-foot horizontal tubular boilers. The load upon this plant had been gradually increased until it became necessary to make use of all five of the boilers during the evening peak load. This condition of affairs, of course, introduced some difficulties in the matter of cleaning boilers, and it was our custom to let down a boiler every other day—after the peak load dropped off—cool it down hurriedly and get it cleaned in time for the peak load next evening, in this way each boiler being operated 10 days between cleanings.

These boilers were fed with Missouri river water through a closed type of heater, and had been operated a year or more before any kind of scale preventive had been used in them. During the second and third year's service boiler compound of a local brand, favored principally because of the fact that its manufacturer was in close touch with the city boiler inspector, was used on them.

About the end of the third year's service it was evident that the tubes were becoming coated with a thin scale, in spit of the use of the compound. It was the that I decided to try the efficiency of kerosene oil. We began by applying a gallo to each boiler, putting it in through th manhole before filling the boiler.

In about five or six days after applyin the oil to the first boiler the fireman cam into the engine room and reported th boiler leaking. Examination showed bag, close up against the front wall, th plate being down about 2 inches over a area about the size of a hat. There wa a slight crack in the center from whic water was dripping.

When we attempted to knock in th manhole plate, after letting the boile down, we found it necessary to make us of a heavy plank, and we found about tw bushels of fine scale piled up against th front head, just behind the plate.

Of course, that boiler had to be patche and we were very anxious about the othe boilers, fearing that they might be damaged before we could let them down f cleaning. The plant just had to be ru and, hurry as rapidly as we could w found three more of the boilers slightl bagged before we could get around t them. The other three did not have t be patched, however, as they were on slightly down and were easily driven bac every one of the five boilers we found ween one and two bushels of fine scale p up near the front head.

w, as a matter of fact, there was no vy scale in these boilers, but only a w distributed coating of thin scale. The rs had been inspected but a short time re the trouble by both the city inspec- and the insurance inspector and no plaint had been made in regard to e

y advice to those contemplating the f kerosene oil for the first time, as le remover, is to proceed with great n I can assure them that the kerosene will be quite likely to take off some nd to do it quite rapidly.

above took place many years ago. that time I have frequently had oc- n to make use of kerosene oil as a remover. I say "remover" ad- ly, for it seems to me the action of l is intermittent—thin coatings of alternately forming and then break- se from the plate. On this account sti n the advisability of making use oil in boilers—scale is always likely e off in large quantities, intermit-

sas City, Mo. J. M. Kent.

## A Peculiar Power Plant Accident

t October 5 issue O. J. Lynge says: ld like to be told how the water t the cylinder" which was the f the accident he relates.

not pretend to say positively how pened, but from his statement, I ve my opinion as to how it could y likely did occur.

e time of the accident the en- s running at 100 revolutions per and taking steam at 100 pounds e An engineer having experience tomatic cutoff engines knows that when running light there is very i any, steam pressure on the pis- l especially on the low-pressure f a compound engine. From Mr. statement this engine exhausted a pipe from the steam cylinder condenser or receiver as it is he pipe turns four right angles, a vertical lift of about 15 feet horizontal distance of 30 feet 6 Right here is where I think a e was made in not having a trap e kind to keep the condensed water t this pipe. The receiver pressure, d, was 5 pounds, which means a rature of 162 degrees, which is too r any pump to lift 1 foot, much less t The hot water that got into the nser was carried up by the exhaust a and in my opinion, the water that was in the exhaust pipe when the t driving the circulating pump was ut out, rushed back into the low- pre sre steam cylinder and did the me; the engine was making 100 revolutions per minute and running light, so that on cutting out the circulating water the condenser was certain to get warmer, the steam cylinder offered the least resistance, as it was acting as a pump. The most peculiar thing I see in it is that it did not occur before.

William Mellen.

Brooklyn, N. Y.

## Heat Transfer and Future Boiler Practice

In September 21 issue, Arthur H. Allen has worked out an ingenious type of boiler to comply with a totally mistaken theory of heat transmission. As Mr. Allen himself says: "the whole thing, indeed, depends entirely upon the validity of the views expressed by the various authorities mentioned in this article," such views being mainly based on an alleged "law" that heat transmission is nearly proportional to the speed of flow of gases, and not to the temperature difference between gases and water in the boiler.

As any boiler user can verify, there is no such "law;" the fact is the contrary, that, under equal conditions of temperature, every increase in speed of gas flow slightly reduces the efficiency of heat transfer. The theory that a scrubbing action of gases promotes heat transfer is equally unfounded, and so is the theory that the temperature in any part of a boiler can be other than the temperature corresponding to the steam pressure.

The *Journal* of the Junior Institution of Engineers, London, for February, 1909, reports Dr. Nicolson's lecture on this theory of heat transmission, and also the criticism which immediately followed the lecture showing that the theory could not be made to fit the facts; and to this criticism, and to similar criticisms by such leading journals as *The Engineer* and *Engineering*, no effective reply has been made.

Apart from heat losses in ashes, in leakage and radiation, the efficiency of any boiler is simply the ratio of final to initial gas temperature. There is a very great difference in boiler efficiency as the initial temperature is reduced by inefficient combustion; on the other hand, the loss of efficiency due to increasing the volume and velocity of gases by burning more coal, is small, but quite certain if the initial gas temperature is kept constant.

With most firing methods, the mixture of air and combustible gases is better, and the furnace temperature therefore is higher, with a strong draft than with a low draft; and the improved boiler efficiency often attained at forcing duty, though undoubtedly due to the higher initial temperature, has been wrongly ascribed to increased velocity of gases.

With clean boilers of any type, it is impossible to heat the tubes or plates appreciably above the temperature of steam in the boilers, no matter how much the boiler is forced. It is therefore easy to increase boiler capacity, either by using larger furnaces or by forcing the rate of combustion; but providing the firing efficiency is kept uniform, forced duty inevitably means some drop in boiler efficiency.

Standard type boilers, both cylindrical and water-tube types, are simple and accessible, and nothing can be gained by complicating boiler design. The simplest of all boilers, viz., the well known Lancashire boiler, with large unobstructed flues, involving low velocity flow of gases, cools the gases down to as low a point as any other type of boiler, with similar furnace temperature, and is a standing refutation of the high velocity theory.

Many boilers are capable of improvement in capacity, as their furnaces are unduly small for burning anything but the best grades of coal. But it is totally undesirable to get from 10 to 100 times the evaporation per square foot of heating surface, even if it could be done without loss of efficiency; as this would mean one-tenth to one-hundredth of the existing reserve of steam and water; and few boilers will give dry steam even when forced to twice their normal rating.

There is, therefore, no scope for improving boiler efficiency by complicating boiler design; but on the other hand, most firing methods are highly inefficient, and the remedy is to adopt a system correctly controlling both fuel feed and draft, and giving the best possible mixture of air and gases so as to maintain maximum furnace temperature This is achieved, consistently with simplicity and durability, by grateless underfeed stokers, which complete combustion within the burning fuel itself, thus leaving no margin for improvement in efficiency.

Erith's Engineering Company, Ltd.

London, England.

## Adjusting Bundy Steam Trap

I have been looking for more or less criticism regarding the letter, published on page 404 of the issue of September 21 under the above caption, but having seen none, I would like a little information as to just how Mr. Engle made a tank steam trap operate as a vacuum trap, and also where he obtained the trap, which is a design that has never been built to my knowledge. For instance, in his illustration the main body represents a separating tank trap, while the valve represents that belonging to the return trap.

In the third paragraph where the adjustment is dealt with, how does Mr. Engle do it with the combination he has shown. How long has it been since a Bundy trap has been operated by steam pressure? I always had an idea that the weight of water operated the body of the trap without regard to the steam pressure in the trap or on the line.

In the sixth paragraph is something about adjusting the valve disk, but how can it be done with a vacuum trap valve on a separating trap body and, how does he get the combination trap and valve to work?

I am sure that a detailed account, accompanied by sketches showing the original valve and trap, together with other sketches showing the changes as made would be of interest to a lot of us fellows who are anxious to know more about his method of procedure and the results obtained by changes made as described in his letter.

W. J. RITTER.

Passaic, N. J.

## Mr. Schmitt's Parallel Operation Trouble

In your issue of October 12, Arthur P. Schmitt has an article on small and large dynamos in parallel. A wiring diagram showing the connections would have served to clear up the matter. Still, there are things which may occur that require no diagram. He states: "When the small unit is running and we cut in the large machine, the amperes will drop to zero on the small one." Doubtless, before cutting in the large machine its voltage was brought up to the voltage of the small machine under load. If the compounding on the large machine is such that on taking load it raises in voltage, it will naturally take all of the load from the smaller machine. If the machine is slightly compounded so that there is no material rise in voltage, the machines should run together. This may be the cause of the trouble.

Possibly also the equalizer connections between the machines are so small as not to serve their purpose. For proper parallel operation, the degree of compounding on the two machines should be the same and the equalizer connections should be of very low resistance. The compounding depends not only on the series windings of the machines, but to a considerable extent on constancy of speed by the engines through all variations in load; if the speed does not remain nearly constant, every variation should be the same under the same conditions of load. If these factors are looked out for, there should be no trouble in the operation of these two machines in parallel.

Boston, Mass. HENRY D. JACKSON.

## How Shift Changes Waste Money

J. M. Whitham, on page 408, has drawn a vivid picture of boiler room conditions and shown in detail how a considerable waste may, and no doubt does, occur in many plants. Then he proceeds to give a very simple remedy which would sound logical to many managers.

Now let us look at this problem from another standpoint. Mr. Whitham admits the men are tired from their long hours of work, as indeed they may well be. After a man has put in twelve hours in a dark, hot boiler room at the hardest kind of labor he would hardly be human if he were not in a hurry to get out when his time was up. Many men are expected to be on duty every day in the year; so imagine a man working under these conditions for a few straight months and then ask yourself what reason he has to take any special interest in his work.

When we make the boiler room as light, airy and comfortable as possible, then give the men reasonable hours and good pay, we have taken the first step toward real economy in the boiler room. Under poor conditions not only the waste mentioned may occur, but the firemen will be more or less careless in general and get along as easily as possible at the expense of the plant. Fifty cents a day might mean the difference between desolation and comfort in the home of many a fireman and, when we consider how little coal fifty cents pays for, it would certainly seem worth while to give the firemen a job that they will value and take an interest in.

LEON ROUNDY.

Concord Junction, Mass.

## Cylinder Lubrication

When I read of a marine engineer not using cylinder oil in his engines, I wonder if it can be possible, without serious results to the walls of the cylinder and piston packing. Metal packing would become so dry it would burn out, would it not?

I have my doubts as to the success of such a venture when it comes to the four-valve St. Louis Corliss, Nordberg, Hamilton and other such types of engine. We have a feeling here in the Bryant paper mill that we could not get along without cylinder oil.

There are a few things to keep in mind when buying cylinder oil for the engine room, such as the type of engine, the steam pressure, speed, heavy or light duty, and boiler compound.

I have seen the time when I felt sure the stuff that was being used for boiler compound was knocking the life out of the oil before it got through the throttle valve. It seemed as if we had to use double the amount of oil, not to mention the bad words the steamfitter used when working overtime to stop the leaks in e joints.

I have under my charge five St. L s Corliss engines, the heavy duty kind. e is a 22 and 44 by 48 cross-compound 5 revolutions per minute; one a 14 and by 42 cross-compound, 85 revolut per minute; one a 12x30 single eng 85 revolutions per minute, and two 14 variable-speed engines running at f m 35 to 130 revolutions per minute. e steam pressure on the gage in the en e room is from 135 to 140 pounds.

About three years ago, we were tr several kinds of cylinder oil to find which would give the best results in cylinders. The kind which proved t the most satisfactory for our use is "650 dark-valve cylinder oil" from Union Oil Company, Cleveland, O.

When giving the different kinds o a trial, the same care was given alik all, but with the "650" a barrel o gallons lasted 55 days of twenty-hours each, used in seven cylinders. the 22-inch high-pressure side we one drop of oil to every 20 revoluti in the low-pressure side one drop t revolutions. In the single engine used one drop to 30 revolutions. lubricators are sight-feed. This that we were not using quite one g in seven cylinders per day of twenty hours. The large compound engi running under a heavy load, and at is overloaded.

We have since increased the oil fe the high-pressure side to one dr every 12 revolutions, to be on the side when doing all it can. We u the average, the year round, a barr 52 gallons every forty-eight or fifty making a little over one gallon twenty-four hours of work days.

When we open a cylinder, we fi free from all gummy substances cylinder walls have that color shows us that the oil is doing good

A. I. HA

Kalamazoo, Mich.

I am in charge of two 150-horse single-acting twin gas engines, runn 180 revolutions per minute, 10 hou day. The cylinders are 21x20. W 1/2 pint of oil on each engine pe that is, 1 pint for the four cylind have another engine, of 250 horse running at 150 revolutions per n The cylinders are 19x25. This is a acting tandem two-cylinder engine a use 2 quarts of oil per day of 10 We use high-viscosity gas-engine oi ing 30 cents per gallon. We get t from the Erie Oil Company, Erie, nn.

C. S. BUSH Y.

De Young, Penn.

My engine is a 10x15 center-cran running at 170 revolutions per minute The dicator diagrams show 40½ horsepower use one pint of oil each 12 hours.

William C. Bryant.

Brooklyn, N. Y.

On my No. 1 engine, a horizontal cross-mpound, 24 and 48 by 48, running at revolutions per minute, 66 hours per k, I use on the high pressure cylinder gallons of William P. Miller's No. 5 cylinder compound, and on the low-ssure cylinder 5 gallons of Standard Company's heavy Capitol oil.

On No. 2 engine, same type, 26 and 52 48, running at 81 revolutions per min-, 60 hours per week. I use the same and practically the same amount.

he cylinders are in excellent condi-n, without a scratch of any kind.

On a 10x12 McEwen engine, running at revolutions per minute, 50 hours per k, I use 1 quart of William P. Miller's nder compound. On a Westinghouse matic compound engine, 11 and 19 by 300 revolutions per minute, 60 hours week, I use 5 pints per week of Wil- P. Miller's No. 725 cylinder com-nd.

E. J. Thornton.

emis, Tenn.

n an Atlas automatic simple engine, 8, running at 190 revolutions per ute, 125 pounds pressure (gage), we one pint of "600 W" vacuum cylinder every 15 hours.

n an Ingersoll-Rand straight-line air pressor, 18x18, compound air end, pounds gage pressure (steam), one of "600 W" oil is used every 12 rs.

F. W. Owsley.

ebb City, Mo.

n our engine, a 22x23-inch, running at revolutions per minute, we use 7 drops per minute of dark "Eureka" cylinder oil.

D. Bailey.

ve Hill, Ky.

a Nordberg Corliss, 16x36, running 240 revolutions per minute. I use a little e than a quart of "Valvolene" oil every 10 hours. The engine has been running 19 years and is in good condition.

R. Townsend.

ttle Falls, Wash.

se three pints of "Matchless" cylinder oil, or two pints of "600 W," on a 14x36 Corliss engine running at 86 revolutions, or 516 feet of piston speed, per ute.

C. D. Cook.

tica, Kan.

our 12x36 Corliss, running at 90 revolutions per minute, we use two pints f cylinder oil on a 24-hour run. On 15 and 8 by 16 tandem-compound Norwalk air compressor, running at about 100 revolutions per minute, we use two pints on a 10-hour run.

William Beaton.

Gold Roads, Ariz.

My two engines are 225 horsepower, running at 225 revolutions per minute on alternate shifts of twenty-four hours each. We use one half gallon of "600 W" cylinder oil, made by the Vacuum Oil Company, on each engine on a 24 hour run. That is, each engine requires one half gallon of cylinder oil in twenty four hours.

H. B. Adcock.

Newnan, Ga.

I remember when the best we could do was to use tallow. Of course, we did not have high-speed engines and it answered the purpose very well, but with the first-class oils in use today I do not see why cylinder lubrication should be a problem. I am using an oil that costs 90 cents per gallon in New York. I have one heavy-duty Corliss engine, 18x36, 100 revolutions per minute, that requires only one pint of oil for a 10-hour run, and the valves and cylinder have surfaces as smooth as it is possible to obtain. The trouble some engineers have with valves sticking and failing to lift is the result of using some cheap oil that is sold them, and some buyers think that it is economy. The sooner engineers find that they cannot get a first-class cylinder oil cheap, the sooner their troubles will be over. My advice is to get the best and stick to it.

J. A. Epply.

Thomasville, Ga.

I am using "Buckeye" cylinder oil costing us about 28 cents per gallon. It is dark green in color, of 625-degree fire test and is compounded. The engines are Atlas single-valve automatics, one a 22¼x30, running at 105 revolutions per minute, the other a 12x18, running at 180 revolutions per minute. The steam pressure is 110 pounds. I use 1½ pints on the large engine per 10 hours and the cylinder seems to have plenty of oil, but I use about 3 quarts on the small engine, as the steam has to travel about 300 feet to this engine and is very wet, and if I cut down on the oil much the governor works hard. I pump in a little graphite about once every twelve hours, and it helps to keep the valves in good shape.

L. A. Cole.

Blacklick, O.

I regret that I cannot give all the information asked for, for the reason that I have never received any cylinder oil from my supplyman since I have been in this plant, and do not even know the name of the oil. My engine and boiler were installed twenty-five years ago. It is an 8x12 horizontal slide-valve engine, with the valve on the side of the cylinder, making under load about 110 strokes, to 120 strokes no load, boiler pressure not to exceed 50 pounds. I use a 1-pint lubricator of oil in two weeks. The engine is run eight hours per day, except Sundays and holidays. The lubricator is a Detroit single sight-feed.

I have had the valve chest cover and cylinder head removed several times and have found no signs of cutting.

Perhaps the following may be interesting: The boiler is 42 inches in diameter and 8 feet long, and contains 44 three-inch tubes set in brickwork in the usual manner, except that after the gases of combustion pass through the tubes they pass over the top of the shell to the stack. I used from July 1, 1908, to July 1, 1909, 128 long tons of Cumberland run-of-mine coal.

The engine furnishes power for running presses, stamping and stitching machines, etc., in a printing and bookbinding establishment employing about forty hands.

S. F. Lemon.

Washington, D. C.

I am running a 20-ton Frick ice machine, with a 13½x15-inch Corliss engine; speed, 75 revolutions per minute. We use the condensed water for ice-making, so have to keep the consumption of oil down as much as possible. We use "Valvoline," the "pure mineral" grade, costing 85 cents per gallon. I use one drop every 45 seconds, or a pint in about 15 hours. My cylinder and valves are in good condition, and this quantity does very well, although if we did not save the steam we would expect better results from a "compounded" oil fed a little more liberally.

Albert J. Wickes.

San Luis Obispo, Cal.

The engines at the plant of Smith & Co., of Urbana, used the following quantities of oil for the year ending September 20, 1909: five barrels of "Matchless" cylinder oil, 15 barrels of "Solar Red," 1 barrel of "Polar Ice Machine" and 25 pounds of "Artic" cup grease. The engines are a 14x20 Corliss running at 85 revolutions per minute, being the steam end of a standard 40-ton refrigeration York machine, a 6x10 Atlas slide-valve running at 200 revolutions per minute, and a York slide-valve, 6x8 running at 250 revolutions per minute.

George G. Bennett.

Urbana, Ill.

I am running a 16x36-inch Corliss and a 10x12-inch slide valve. We carry steam pressure, 100 pounds. I use Premium valve oil made by Underhay Oil Company, Boston, Mass.

On the Corliss I use 1 quart for a run of 11 hours, on the other 1 quart for a run of 22 hours; this engine is hard pushed all the time, running 250 revolutions per minute.

I have used this oil for several years with good results.

M. W. Carter.

Richford, Vt.

POWER AND THE ENGINEER

DEVOTED TO THE GENERATION AND TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.
355 Dearborn Street Chicago.
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of POWER solicited and paid for Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "POWPUB," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During 1908 we printed and circulated* 1,836,000 *copies of* POWER.

*Our circulation for October, 1909, was (weekly and monthly)* 135,000.

*November* 2............ 42,000
*November* 9 .......... 30,000

*This paper reaches 42,000 separate readers each month and 30,000 each week.*

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*

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## Two Notable Boiler Explosions

We chronicle in this issue two remarkable failures of steam boilers. The first to occur was that of a Manning vertical tubular boiler, the first one of the type, since its introduction by Charles H. Manning twenty-seven years ago, to explode. Captain Manning never took out any patent upon the design, and it has been built in considerable numbers by various boiler makers for use all through the East, but the one to fail was a comparatively new one built but two years ago under Captain Manning's own supervision in the shops of the Amoskeag Manufacturing Company and used in the operation of that plant of which he is general superintendent.

Was the failure due to deficiency in the design, workmanship or operation?

The distinguishing feature of the Manning boiler is an offset in the shell just above the crown sheet, giving greater diameter to the water-leg portion and a larger furnace, but with the main intent of introducing elasticity into the shell so that it can accommodate itself in length to the changing length of the tubes should their expansion be different from that of the shell. That there is a movement in the double-flanged ring or O. G. which forms this offset has been demonstrated by actual measurement, as well as by the fact that flanges, inadequate for the conditions of their operation, have cracked along the lines about which such movement was localized. There are those who maintain that such change of shape is due, not to unequal heating but to pressure; that since the tubes and the shell are in contact with water of the same temperature for most of their length, and the gases in the top part of the tubes are comparatively cool, there can be no great difference in their temperature and expansion, and that if there were the tubes would simply bow or buckle under compression enough to take it up. It has been shown that the change in length and the movement in the O G takes place when the boiler is subjected to hydraulic pressure, when no temperature effect is involved. If there were no offset or the offset were too rigid to permit the shell to stretch, the stretch of the tubes under pressure would manifest itself in the bulging of the tube sheets. The O G in this case was 5/8 and stiffer in shape than that used with earlier boilers for lower pressures, and it has been suggested that it was too stiff to permit the movement that it was intended to provide for. It was, however, similar to that in the eleven other boilers of the battery, and to numerous other boilers of Captain Manning's design, and these have shown no signs of trouble from this cause.

In the exploded boiler all of the tubes drew out at their lower ends, allowing the crown sheet to bulge downward abo six inches in the center and uniforn all around. They were not beaded n flared, simply expanded in.

In 1881 the Hartford Steam Boiler I spection and Insurance Company h some tests made at Colt's Armory 3-inch tubes expanded with a Dudge expander one into a plate 3/8 thi and two into plates 15/32 in thic ness. It took 6000 pounds to start t tube in the 3/8-inch plate, and 4500 a 7000 pounds the two others and pounds additional to pull each of th out.

Another test made upon 3-inch tu expanded into 3/8 plate projecting 3 and flared so that the external dia eter at the extreme end was 3.2 incl the diameter of the tube entering plate being expanded to 3.1 inc showed for two specimens.

| | | |
|---|---|---|
| Stress sustained without yielding ...................... | 20,000 | 18 |
| Stress which first produced yielding .................. | 20,500 | 19 |
| Stress which occasioned failure | 21,000 | 19 |

The effect from flaring was q marked, but the holding power of simply expanded tube was four times much as was required for 80 pounds ordinarily spaced tubes and in view the injurious effects upon the tube c of tooling the metal flaring and bea were not too strongly urged. In the ploded boiler each tube would have sustain a pull of something like a If the holding power is proportional the circumference or diameter a 2½-i tube would require 3750 pounds to s it where a 3-inch would require 4 If there can be as much difference holding power as between 4500 and in two examples of the same size kind made purposely to be tested, th is apt to be a considerable differenc them as ordinarily made. Captain M ning has a design in which the hol the tube sheet is tapered outward the outside edge slightly chamfered, w should make a very strong joint but does not appear to have been use the boiler which failed. Is it pos that this got by in the shop? Ca Manning is inclined to lay the accide faulty operation. The pressure had down, as it is likely to be with the heavy morning demand, and the fire were fighting to recover it. A natural thing would be for the w tender to shut off the feed, and wit new water coming into the central umn and the diminished head from ca ing the water as low as he dared. Ca in Manning thinks it would be quite s- sible under the action of the forced es for the water to lift and allow the et to heat up enough to cause it to let

Whatever the cause, the Amos ag Company has decided to bead all its il- ers and it is being done at an enor us cost of time, labor and tubes.

Of the details of the Milwaukee xlosion little is known at present. It is nother instance of the failure of the ater-tube or "safety" type although re is an intimation that the initial fail e was in the steam main rather than the boilers themselves. The occur ce, whatever the initial cause, seems have located the weak point of the sign for all of the boilers so far as have learned failed at the same point. t the bottom of the drum where it had n perforated to receive the vertical s and for the rivets of the reinforce strip. These boilers were also but years old and had been inspected the Hartford Steam Boiler Inspection Insurance Company only about two ks before. This is also another ex le of the Monday morning explosion. st explosions happen when starting up. Amoskeag was one of these, and y when starting up after a period of ess as after a Sunday or a hodiday.

## Load Factor

What is the load factor of a power t? We have always considered it ratio between the actual output of rgy and the output that would have delivered if the plant had operated aximum load continuously. For ex e, if a plant is capable of delivering thousand kilowatts continuously, and actual output is eighteen thousand watt-hours per day, we should say its load factor was seventy-five per t, because the actual output would be ee-fourths of what it would have been l load had been carried continuously is is the only rational definition of factor when one is considering plant ncy. However, a good many man rs of important power and lighting anies use the actual maximum de d on the plant as the criterion in d of the full-load ability. For ex , if the maximum load on a plant ne thousand kilowatts were eight dred kilowatts and the total energy ered during the twenty-four hours re eighteen thousand kilowatt-hours, t maximum-load criterion would make load factor nearly ninety-four per , whereas it would really be only nty-five per cent. This method of ning the load factor is obviously un f to the power-plant equipment. More it has no real significance. This ximum load that occurs during twenty r hours might vary considerably, and such a way with respect to the average ld as to make the so-called load factor it up and down from day to day, with a teadily increasing average load.

t is a well known fact that power-p t machinery operates at its best efficiency when it is carrying somewhere r what is commonly called full load. In considering the economy of a plant, therefore, the load conditions are taken into account; that is, the economy is considered in the light of the load factor—the proportion of full load represented by the average load. When conditions are such that a plant must operate with a low average load, it is manifestly unfair to reckon the load factor on the basis of the maximum actual peak load.

In central-station practice it is desirable to keep track of the relation between the average and the maximum loads, but we can see no reason why this should be called the "load factor" when that term has an established meaning very different from the one mentioned. Why not call it "demand factor?"

## Emergencies Bring out the Man

Men often prove their right to advancement by their behavior in emergencies. Steam plants are installed to be run, and while economical operation is much to be desired and should receive the attention to which it is entitled by its importance, emergencies either great or small often arise which must be met instantly regardless of the immediate economies of operation.

During a night run at a mine pumping house, both the pump and inspirator refused to deliver water to the boiler and the chief engineer was called from his bed to attend to the matter.

From the behavior of the feeding apparatus it was evident at a glance that there was a leak in the suction pipe that allowed air instead of water to go to the pump and inspirator: But where and how large was the leak? How long would it take to find it and how much time would be needed to repair it? These and other questions the engineer may have asked himself as he looked over the situation, but he spent no time in trying to answer. The necessity for the continuous operation of the pumps was the only question in which he had any interest at that moment. How to get water to the pump and inspirator and how to get it there quickly was the problem.

Air hose for the use of the drills was plenty and with such help as was available at the mouth of the mine he laid an overground suction line from the well to the inspirator with air hose. Another to the pump followed and the station was soon in working order. This was only a minor sort of an emergency and the way in which it was met was perhaps not the best. But, it was immediate and effective and while there was nothing spectacular in the matter of running two lines of rubber hose over the ground the promptness of action was admirable. The job was not cheap; it was not permanent and it was not neat and workmanlike, but it kept the mine running while a new suction pipe was being put in.

It is these little things in the daily life of the engineer and the method of handling them that mark the difference between the engineer and the engine runner

## Air Supply for Boilers

Boiler plants are usually designed throughout with considerable care, the grate area is properly proportioned to the heating surface to produce the best results for the kind of fuel to be used. The heating surface is proportioned to the expected steam consumption to permit economical production of steam. The chimney is designed in hight to give the proper intensity of draft, the area is made sufficient to care for the volume of gases to be handled, and the passages from the grate to the stack are made with sufficient area properly to care for the passage of the gases without undue friction.

The grate is carefully designed to give sufficient area for the passage of the air required for combustion, but at this point, as a rule, all hands quit the job, the air required for combustion being allowed to get into the boiler room and under the grates as best it may. The ashpit doors, which are generally the only openings admitting air beneath the grates in an installation using natural draft, usually duplicate the fire door in size and number, and if they are arranged so that they admit of ready removal of the ashes, the designer assumes that his work has been thoroughly done.

Fortunately, this method of designing when used with the average return-tubular or water-tube boiler installation gives sufficient area for the admission of air, but with the vertical tubular and wet-bottom locomotive-type these openings are often absurdly small. It does not seem logical that the area through the ashpit doors should be so restricted that the velocity of the air required for combustion through these openings should be greater than that of the gases in the flue or stack, however such designs are met with. Admission of air to the boiler room is another point that is rarely if ever considered by the designer.

Assuming a boiler plant developing six hundred boiler horsepower, under average conditions, there will be required for the combustion of the one and a quarter tons of coal per hour, necessary to develop this capacity, about fifty thousand pounds of air, or practically eleven thousand cubic feet of air per minute. It does not seem that such a volume of air should be required to get into the boiler room haphazard, and in cold weather, when the boiler room is more or less thoroughly closed up, the entrance of the air required often imposes unnecessary work on the stack

# Power Plant Machinery and Appliance

## Original Descriptions of Power Devices
## No Manufacturers' Cuts or Write-ups Used

## MUST BE NEW OR INTERESTING

### Improvements in the Buckeye Boiler Skimmer

The Buckeye Boiler Skimmer Company, Akron, O., recently made improvements to its skimmer, one of which, Fig. 1, shows the knuckle joint, the new design having a concave washer on top and a wire-inserted gasket below the shell.

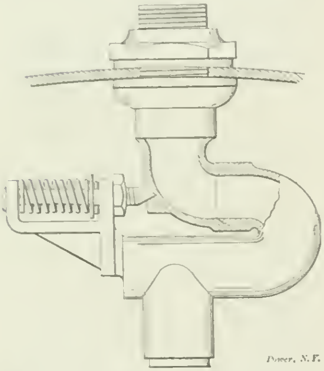


FIG. 1. NEW DESIGN OF BUCKEYE SKIMMER JOINT

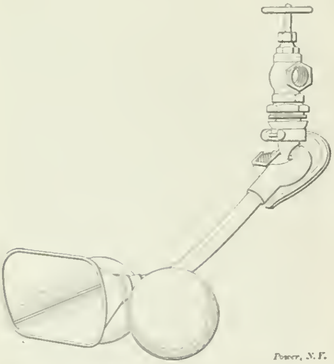


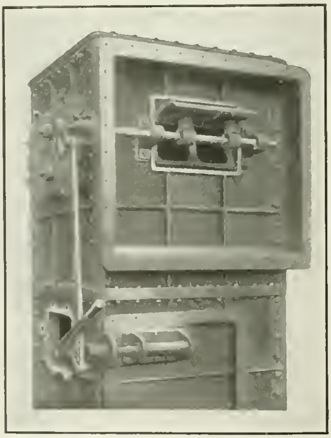
FIG. 2. BUCKEYE SKIMMER ATTACHED TO JOINT

The gunmetal pin is now constructed in such shape that it is impossible for it to become loose; it is also considerably heavier in design and a much longer taper so that it will not wear. There is also a reinforcement above and below where the spring holds the knuckle joint together, and the whole knuckle joint in itself is much heavier than the old one.

Fig. 2 shows the skimmer attached to the knuckle joint, but having a support attached to it. This design is for use when the skimmer is installed in water-tube boilers. The funnel is considerably wider than the old design, covers more space in the boiler and is much stronger. The floats of the new design are perfectly smooth and are made stronger and more durable than the old, it is said. The operation of the skimmer is practically the same as in the old design.

### Improvement in Steam Stack Heater

Some time ago, the Harrison Safety Boiler Works, Seventeenth and Clearfield streets, Philadelphia, Penn., put out a new type of combined heater and receiver for use in connection with exhaust steam-heating and drying systems. In order to be able to cut the body of the heater out of circuit, for cleaning or inspection while the heating system continues in operation, a manually controlled valve was provided to shut the separator off from the heater body and another to close the passage between the separator trap and the overflow of the heater, the latter being necessary in order that t trap might continue to drain the se arator when the heater was cut out circuit without allowing steam to ent the heater by way of the separator dra pipe and trap.



CONNECTION BETWEEN VALVE STEMS

The steam valve between the separat and the heater is of the semi-cylindric rotating type, and is held against its se by springs, and also by the pressure the steam. Where a pressure of 5 poun per square inch or more is carried in heating system, the total pressure o the valve of a large heater would ren operation difficult, by forcing the va tightly against the seat.

In order to obviate this, a special va gear has been devised. The operat handle is attached to the spindle of lower valve instead of to the upper formerly, and the lower end of the c necting rod engaging the pin on the sh crank of the lower spindle is slotted, that the lower spindle has a certain cess of motion over that of the up spindle. The amount of this excess tion is so adjusted that in closing, upper valve shuts off first, and then sta still while the lower valve rotates thro the remaining arc of its motion, wl it is enabled to do by reason of lost motion in the conecting rod. In way, the upper valve is closed while tl is still pressure in the heater to bal the pressure of steam on the outsid the valve. Subsequently the lower v closes, cutting off the heater, after wl any steam contained therein will be densed or escape from the vent with which an open heater is always vided. Once both valves are closed, operating handle is removed from spindle before the cleaning doors of heater are opened, making it impos for the steam valve to be opened the handle is replaced.

In opening the valves, the lower will swing through a sufficient ar establish communication for steam thr the separator drain pipe and trap the heater, equalizing the pressure or steam valve before the latter begin move. Once the pressure is the sam both sides of the valve, the latter slide easily, and the operation of ing can be completed. During this o tion the valve in the vent pipe of heater should be closed, to permit sure to build up in the heater wher lower valve is first opened.

# New Form of Fery Radiation Pyrometer

he great drawback to the employment o pyrometers in furnaces whose tem- p tures are higher than 1000 degrees

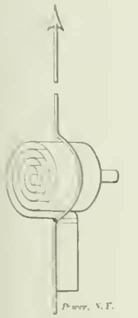


FIG. 1

C grade has been the destruction of r meters by the intense heat, and it n t until the radiation or optical s of measuring temperatures were that this difficulty was overcome. radiation pyrometers the heat radi- t by the hot body is measured in vari- ways by the heat effect it produces, as by the electric current set up the radiation heats one or more ns of two dissimilar metals, the n produced by the heating of a nd metal strip, or the change in ce of a fine metal ribbon. The governing the amount of heat or radiated in relation to the actual rature of the hot body have been by several observers. One type ation pyrometers is that invented fessor Féry of the Ecole Municipale hysique et de Chimie Industrielles, in which some of the heat rays

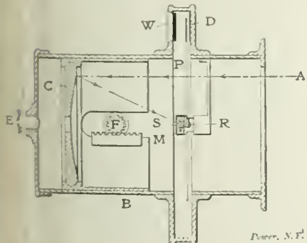


FIG. 2

the hot body are concentrated by a of a concave mirror on to one n of a small thermoelectric couple. Th ouple when heated sets up an elec- tr ive force which is indicated on a lv ometer, the scale of which is d l in degrees of temperature. The great disadvantage of this form of pyrometer is the fact that a galvanometer has always to be used in conjunction with it; this necessitates a comparatively level spot on which to place the galvanometer, and the employment of leads to connect the pyrometer to the galvanometer.

Realizing this drawback, Professor Féry has designed a new pyrometer which while having practically all the advantages of the old instrument, does not require a galvanometer and leads.

The principle and construction of this new instrument are simple. Instead of the heat rays being concentrated on a thermoelectric couple as in the earlier instruments, they are focused on a small bimetallic strip made of two metals rolled into the form of a spiral which unrolls when heated, owing to the largely different coefficients of expansion of the metals used.

Fig. 1 shows an enlarged view of the spiral, its center being fixed while its outer free end carries a light aluminum pointer which, as the spiral unfolds, moves in front of a scale calibrated in temperature. The spiral is very small, actually measuring less than 1/8-inch in diameter, and 5/64-inch wide. It is blacked so as to absorb as large a quantity of heat as possible. Any radiation passing through its convolutions is reflected back onto it by means of a very small mirror placed behind it. (Not shown in Fig. 1.)

Fig. 2 shows diagrammatically a sectional view through the instrument, *A* representing one of the heat rays which, coming from the furnace or hot body, strike the concave mirror *C* and are reflected to a focus on the small spiral *S*. The pointer *P* moves in front of the scale *D*, the observation being taken through the glass window *W*. A shutter, not shown in the illustration, is provided in front of the instrument, to screen off all radiated heat until it is desired to take a reading.

In order to eliminate errors which may arise through change in the actual temperature of the instrument, an adjustment is provided by which the center rod supporting the spiral may be turned and the needle thus set to the zero on the scale. It is important that this zero adjustment should be made immediately before taking any observation, the shutter in front of the pyrometer being closed while the setting adjustment is made by a small knob on the side of the instrument. On opening the shutter and exposing the instrument to the heat rays the pointer will be seen to rise rapidly to some point on the scale, and then to pause; this point is the temperature of the hot body. As the instrument as a whole gets hotter, the pointer will creep up slowly, and if the pyrometer is left in position for a comparatively long while a second zero reading must be taken, and a correction applied for the new zero reading.

Extreme scientific precision is not claimed for the new instrument, but an accuracy of between 1 and 2 per cent. is readily obtainable.

As will be seen from Fig. 3, the instrument is portable and is supplied with a light, rigid, wooden tripod. Fig. 4 shows the front view of the pyrometer with the temperature scale and pointer. As at present constructed the instrument is made with three different scales which it is believed will cover most commercial requirements. These scales are:

Five hundred degrees to 1100 degrees Centigrade, which will cover practically all annealing, hardening, and case hardening temperatures; 500 degrees to 1400 degrees Centigrade, which will cover practically all the temperatures met with in gas works, the pottery trade, etc. It is on the whole the most generally useful range; and from 500 degrees to 1700 degrees Centigrade, covering any temperature in a steel works.

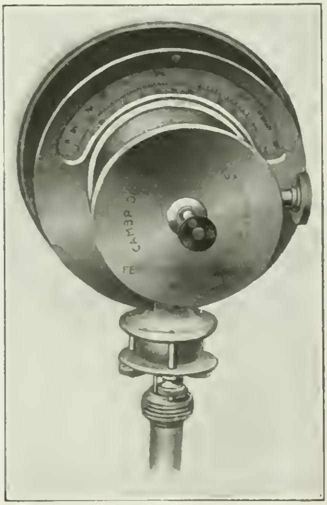


FIG. 3

In order to get true temperature readings with this, and all types of radiation pyrometers, the condition which should be fulfilled is that the hot body sighted on should be contained within a chamber the walls of which are at approximately the same temperature as itself. This condition is fulfilled in most practical cases, such as in taking the temperature of the inside of a gas retort, firebox, annealing, hardening, or muffle furnace, etc. The error caused by the fact of the furnace door being open when sighting is negligible, especially as the instrument is calibrated under these same conditions. If it is desired to take observations without opening the door of the furnace or making any opening in the wall, the arrangement illustrated by Fig. 5 may be adapted. A cast-iron or fire-clay tube is built into the furnace wall, the tube being closed at the end A which is inside the furnace and open at the outer end. Since the tube takes up the temperature of the

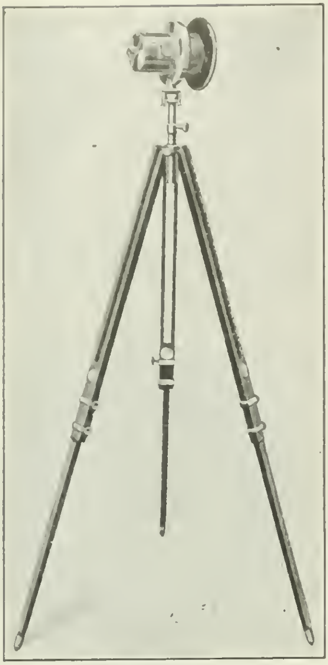
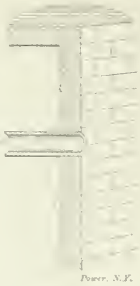


FIG. 4

furnace for some distance along its length, it fulfils sufficiently closely the required conditions of a closed chamber with walls at the high temperature and therefore by sighting on the blind end *A* we get the true temperature without allowing any cold air to find its way into the furnace, or flame to come out.



Power, N.Y.

FIG. 5

In measuring the temperature of a crucible of molten metal, or an ingot of steel, or any body which is not inside a closed chamber with hot walls, the reading obtained will be lower than the true temperature of the body. The amount by which the reading will be low depends chiefly on the nature of the surface of the body itself, for instance, in the case of a block of carbon, it will be very small since carbon is what is known as "black body," while in the case of a crucible of copper with a clean surface the reading will be perhaps a hundred degrees or more below the true temperature.

Although no definite figures can be given for this apparent error as it depends on local conditions, yet, if the conditions remain the same, the error will be a constant one, so that it may be determined once for all experimentally by measuring the temperature of the body first inside and then outside the furnace.

This new Féry pyrometer is being constructed by the Cambridge Scientific Instrument Company, Limited, Cambridge, England, which also has the sole manufacturing and selling rights in the United States.

## New Pressure Controlled Speed Regulator

In the accompanying illustrations is shown a type of controller designed for use in connection with an electric motor operating the blower of a mechanical stoker, boiler-feed pump, gas-pressure blower, etc. For mechanical-draft systems, the controller is so arranged as to adjust the speed of the motor and the blower driven by it to the number of revolutions per minute necessary to furnish the amount of draft required for a given demand on the boiler. So long as the steam pressure is constant the speed of the motor is not changed, but any variation in pressure above or below the amount for which the controller is adjusted results in a decrease or increase of motor speed, the draft being thus automatically regulated so as to keep the boiler pressure practically constant.

The complete controlling equipment for use in connection with a direct-current motor consists of a standard manually operated starting rheostat (provided with no-voltage release), and a special speed regulator designed to vary the speed of the motor in accordance with variations in the pressure of the boiler system served by the stoker. The speed-regulating part of the equipment may be designed to reduce the speed of the motor below its normal rated speed by inserting resistance in the armature circuit, or to raise the motor speed above normal by field weakening, or by a combination of these two methods, to provide for any percentage of speed variation within the limits of standard practice for motor-speed regulation.

The appearance of the direct-current
blower regulator designed for arma
regulation only, is shown in Fig. 1. A
similar controller has been designed
armature and shunt-field regulation.

The blower regulator consists of a
panel mounted on the front of an a
iron cage, the panel carrying the co
segments, over which a double-ended l
moves, and the cage containing the
essary regulating resistance. The l
is actuated by the piston of an hydr
cylinder, the admission and exhaust
valves of this cylinder being in turn
trolled by the movement of a pres
regulator diaphragm, one side of w
is subjected to the boiler pressure.
normal boiler pressure on the under
of the diaphragm is balanced
weighted lever bearing upon the to
the diaphragm in such manner that
lever will rise or fall as the boiler
sure rises above or falls below the n
pressure for which the lever is cou

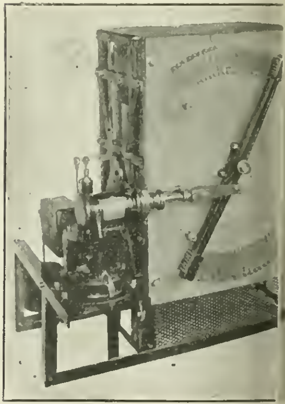


FIG. 1. REGULATOR DESIGNED FOR AMM
REGULATION

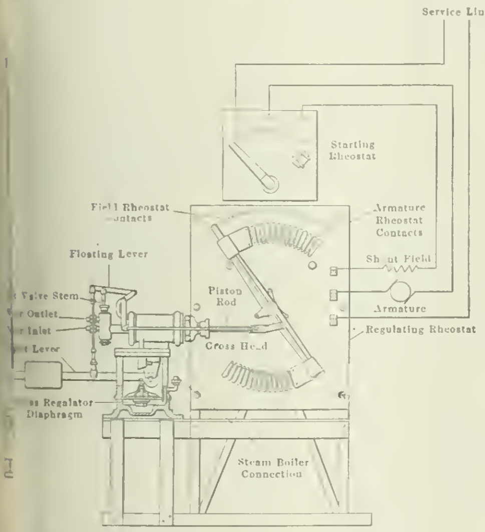
balanced. This up and down mov
of the lever operates a pilot valv
trolling the admission of water
hydraulic cylinder shown to the
the slate panel and, due to this pr
the piston of the cylinder is move
and forth, operating in turn the d
ended lever which rides over the
segments mounted on the slate.

In the diagram shown in Fig. 2, t
are assumed to be banked and the
and blower are at a stand still. The
pressure is therefore low and the
lever is pressing the regulator dia
down and at the same time depressi
pilot-valve stem and floating lever.
ting water to the cylinder, the pist
of which is shown fully extended T
double-ended contact lever of the
lating rheostat is in the position it
assumes when the boiler pressure
namely the full speed position, in
all armature resistance is out of

d all field-weakening resistance in cir- iit. As it is necessary to start the motor ith some resistance in circuit, a separate irting rheostat should be provided for is purpose, this being shown in the dia- am just above the regulating rheostat

Assume now that the motor has been irted by means of the starting rheostat is running at maximum speed with akened field and all armature resistance t of circuit. The steam pressure will adually rise under the influence of forced draft until it reaches a point re its pressure is sufficient to lift the ght lever. This in turn will lift the t-valve stem and floating lever, open- the valves and admitting more water the cylinder, but through a different nel, the water being now conducted the right-hand end of the cylinder so t its pressure is exerted to force the n back into the cylinder, this in turn ving the lever of the regulating rh tat, the upper end of which first cuts ou e field resistance, button by button, g the motor down to normal speed hen (if the boiler pressure is still normal) cuts out the armature re- e, segment by segment, reducing ed of the motor to the minimum.

ld the boiler pressure fall, the se of the series of operations just bed takes place. The diaphragm n, permitting the weight lever to move ward, this in turn drawing down the valve stem and floating lever. Water w admitted to the left-hand end of ylinder forcing the piston out and ng the contact lever of the regulating tat over the segments and finally the field resistance buttons until the is again operating at maximum spe.



2 DIRECT-CURRENT REGULATOR

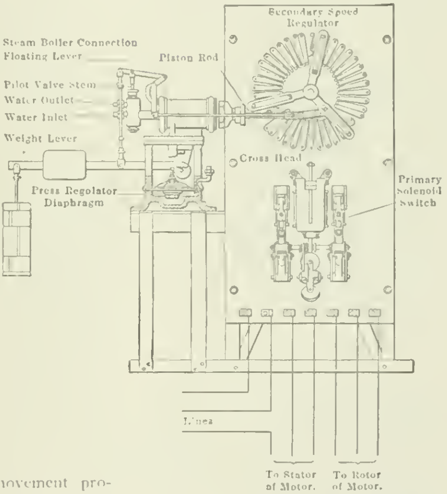


FIG. 3. ALTERNATING-CURRENT REGULATOR

It should be noted that the operation of cutting resistance in and out of circuit is not a continuous operation, but proceeds step by step with pauses between each movement of the contact lever. This is accomplished by the bell-crank connection shown just above the left end of the cylinder. The lower extremity of this bell crank is connected to the piston rod of the cylinder and the upper end to the floating lever. It will be remembered that any upward movement of the weight lever results in an upward movement of the floating lever admitting water to the right hand end of the cylinder, thus forcing the piston to move inwardly (or to the left), while any downward movement of the weight lever admits water to the left-hand end of the cylinder, forcing the piston rod out (or to the right). As soon as the piston begins to move, however, it exerts (through the bell-crank connection) a pressure on the floating lever exactly contrary to the movement produced by the weight lever. That is to say if, under the influence of increasing steam pressure, the weight lever moves up, the pilot-valve stem and floating lever will also move up and the piston rod of the cylinder will start to move to the left. This movement of the piston, however, is presently checked by the operation of the bell crank attached to it, which pulls down on the floating lever, depresses the pilot-valve stem and shuts off the water pressure, stopping the movement of the piston and the regulating rheostat lever actuated by it. The movement of the regulating rheostat lever proceeds, therefore, step by step with a pause after each movement, resulting in a gradual cutting out of resistance and increase in motor speed if the boiler pressure continues to fall below its normal value and, conversely, in a gradual cutting in of resistance if the boiler pressure continues to rise above the normal pressure for which the weight lever is counterbalanced, the result being that the speed of motor and blower is automatically varied from time to time so as to maintain the pressure in the boiler practically constant, the actual variation being not more than one or two pounds above or below normal.

The system of pressure-controlled speed regulation just described applies to direct-current motors. For the control of alternating-current motors, a regulator such as is shown diagrammatically in Fig. 3 is used, the operation of this apparatus being similar to direct-current controllers. If the motor used in connection with alternating-current regulators is of the slip-ring or wound rotor type, the motor speed is varied by means of resistance connected in the rotor, or secondary circuit, of the motor. The same system of control can be adapted, however, for use with single-phase motors of the replusion or self-starting type.

In the case of direct-current controllers a starting rheostat provided with no-voltage release must be used with the speed-regulating apparatus. For alternating-current controllers this starting rheostat is replaced by a solenoid-operated primary switch interconnected with the regulating rheostat lever so as to prevent the starting of the motor except when all starting resistance is in circuit. This solenoid switch is shown in the diagram immediately below the circle of contact segments.

The Cutler-Hammer Manufacturing Company, Milwaukee, Wis., is the manufacturer

# Inquiries

*Questions are not answered unless they are of general interest and are accompanied by the name and address of the inquirer.*

### *Changing Point of Cutoff*

If the point of cutoff is changed on the low-pressure cylinder of a compound engine without changing the cutoff on the high-pressure cylinder, will it affect the terminal pressure of the low-pressure cylinder?

M. T. E.

The terminal pressure is determined by the number of expansions and the number of expansions, in a compound engine, is found by multiplying the ratio of expansion in the high-pressure cylinder by the cylinder ratio. The point of cutoff in the low-pressure cylinder has no effect on the terminal pressure in that cylinder.

### *Motor Speed Adjustment by Resistance*

Knowing the armature resistance, full load current and speed of a direct-current motor, how can the proper resistance be figured to cut the speed down to some other stated speed?

G. T. B.

Using the following symbols:

$$s = \frac{\text{Required speed}}{\text{Full speed}},$$

$$c = \frac{\text{Current at required speed}}{\text{Full-load current}},$$

$I$ = Full-load current,
$E$ = Full line voltage,
$R$ = Armature resistance,
$r$ = Rheostat resistance,

the required rheostat resistance will be given by the formula

$$r = \frac{E(1 - s)}{cI} - R\left(1 - \frac{s}{c}\right);$$

also,

$$r = \frac{E(1 - s)}{cI} + R\left(\frac{s}{c} - 1\right)$$

When $s$ is smaller than $c$, the first formula is to be used; if $s$ is larger than $c$, use the second formula. For example, if the required speed is one-half the full speed and the required current is two-thirds the full current, $s = 0.5$ and $c = 0.667$, and the first formula is easier to use, but if $s = 0.8$ and $c = 0.4$, the second formula is easier because of the nature of the expression in brackets at the right.

### *Overcharging an Ice Machine*

How can one tell when a compression ice machine is overcharged?

H. G.

No harm will be done by increasing the charge of ammonia above that actually required to maintain a solid flow at the expansion valve until the liquid begins to encroach upon the condensing surface. To be sure, it occasions an additional investment, but in the majority of plants it is expedient to carry a small stock of liquid to provide for lines and aside from the rather remote possibility of an accident that will cause the loss of the entire charge, it is better to have the ammonia in use in the system than lying dormant in shipping cylinders. Aside from the possibility of failure of the bank, it is better to have one's spare change in his checking account than in a safe-deposit vault.

Assuming that overcharge begins at the point where liquid begins to fill up the lower pipes of the condenser, it may be detected, first, by the lower temperature of the pipes containing the liquid and, second, by an increase in head pressure over that usually observed when running under similar conditions of speed, back pressure and water supply, with sufficient liquid in the system to provide a solid flow through the expansion valve.

### *Changing from Condensing to Noncondensing*

We have a cross-compound Corliss type engine 16 and 30 by 32 running condensing at 150 revolutions per minute with 120 pounds steam pressure and 24-inch vacuum.

What changes in the valve setting will be necessary to run noncondensing with 3 to 5 pounds back pressure on a heating system?

What will be the relative increase in the steam consumption in this case?

J. A. B.

It is hard to tell you what changes to make in the valve adjustment without knowing how the valves are set at present. Your compression will run much higher when the pressure with which you start to compress is 3 to 5 pounds above the atmosphere, that is, 18 to 20 absolute, than it will when it is only 2 or 3 pounds absolute; so that if the engine is now set with much lap on the exhaust valve, some of it will have to be taken off when you run noncondensing. This, and a change of the cutoff of the low pressure so as to raise the receiver pressure and give the low-pressure cylinder a higher initial to make up for the vacuum which you have taken from it, will probably be the only changes which are required. Without knowing the load, and the vacuum under which you have been running, it is impossible to estimate the increased consumption, but it will probably be around 25 per cent. or more of steam consumed per indicated horsepower.

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On Saturday evening, October 16, Illinois Association No. 1, N. A. S. E., of Chicago, Ill., held a goodfellowship banquet and entertainment. The guest of honor was Charles F. Hart, who is on a visit from London, Eng. Mr. Hart has for many years been a member of the Chicago association, and at one time was very active in the affairs of the N. A. S. E., having held the office of National vice-president of the organization. There were fully two hundred in attendance at the dinner to do honor to Mr. Hart.

# Engineering Societies

### AMERICAN SOCIETY OF MECHANICA ENGINEERS

Pres., Jesse M Smith, New York, N ; sec., Calvin W. Rice, Engineering build 29 West 39th St., New York. Next meet New York, December 7-10, 1909.

### NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Wm. C. L. Eglin, Philadelphia, sec. and treas., John F. Gilchrist, 139 Ad St., Chicago, Ill. Association headquarters W. Thirty-ninth St., New York.

### ENGINEERS' CLUB OF PHILADELP

Pres., W. P. Dallett; sec., W. P. Ta 1317 Spruce St. Regular meetings 1st and Saturdays.

### AMERICAN SOCIETY OF NAVAL ENGINEERS

Navy Dept., Washington, D. C. Pres., Admiral John K. Barton (retired) U. S sec. and treas., Lieutenant Henry C. Du U. S. N.

### AMERICAN BOILER MANUFACTURE ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New sec., J. D. Farasey, Cleveland, O.

### WESTERN SOCIETY OF ENGINEER

Pres., Andrews Allen; sec., J. H. Wa 1737 Monadnock Block, Chicago, Ill.

### ENGINEERS' SOCIETY OF WESTER PENNSYLVANIA

Pres., George T. Barnsley; sec., E. K. 803 Fulton building, Pittsburg, Pa. Mee 1st and 3d Tuesdays.

### AMERICAN INSTITUTE OF ELECTR ENGINEERS

Pres., Louis A. Ferguson; sec., Ralpl Pope, 33 W. Thirty-ninth St., New York. ings monthly, excepting July and August.

### ENGINE BUILDERS' ASSOCIATION THE UNITED STATES

Pres., A. L. Merriam, Oswego, N. Y.; C. H. Sembower, Reading, Pa.

### UNIVERSAL CRAFTSMEN COUNCIL ENGINEERS

Grand Worthy Chief, W. S. Cadwell cago, Ill.; sec., Thomas H. Jones, 244 street, N. E., Washington, D. C. Nex vention, Buffalo, N. Y., August, 1910.

### NATIONAL ASSOCIATION OF STAT ARY ENGINEERS

Pres., William J. Reynolds, Hoboken. sec., F. W. Raven, 325 Manhattan bu Chicago, Ill. Next convention, Roc N. Y., September, 1910.

### AMERICAN ORDER OF STEAM E NEERS

Supr. Chief Engr., Frederick Markoe, delphia, Pa.; Supr. Cor. Engr., William S. ler, 753 N. Forty-fourth St., Philadelph Next convention, Philadelphia, Pa., June

### OHIO SOCIETY OF MECHANICAL, TRICAL AND STEAM ENGINEE

Pres., F. W. Ballard; sec., David 1135 Schofield Bldg., Cleveland, O.

### MASTER STEAM BOILER MAKERS' CIATION

Pres., J. H. Smyth; sec., Geo. M. Cla 1337 N. Maplewood Ave., Chicago, Ill.

### INTERNATIONAL UNION OF ST ENGINEERS

Pres., Matt. Comerford; sec., Robert A. Kee, Peoria, Ill. Next convention, Denver olo., September, 1910.

## ome Tests of Grease Lubrication

*(Continued from page 782.)*

s (Keystone Grease, No. 1 density.) striking feature of this test was the con- al downward slope of the curve of fficient of friction, as compared with saucer-shaped curves given by all r lubricants; 2⅞ ounces were fed to bearing in the last hour's run. Under high temperatures and pressures of the two runs of the test the grease ened considerably, but not enough to it to be squeezed out, which would increased the coefficient of friction. r running successfully for an hour r 3000 pounds total load—which had done with no other grease—a total of 3500 pounds (603 pounds per e inch) was applied, and the journal for nearly a minute before it sud- gripped.

e makers attribute the exceptional mances of the two samples of Key- Grease to the process of manufac- which gives a practically pure petro product with none of the adulterants times used to give body. The tenac- of the No. 1 density in the last test perhaps be accounted for by the r clinging quality of this grease, a re on which its makers lay especial They point out that it tends by its ture to adhere to the journal and whereas a fluid lubricant like oil, grease which (like animal grease) es in service and runs away like oil, stay in the bearing until used up, st be replaced by fresh lubricant as it escapes. Owing to the natural y of the grease to stay in the bear- l forced out by the entry of fresh nt, especial economy is claimed

gh it might not seem at first that tests such as the foregoing had ractical relation to ordinary ma- practice, nevertheless it is well to mind that ordinary conditions es become extraordinary at un- moments. An instance of this ently afforded by line shafting d been running for several years ke reducing room with oil lubrica- An additional load was put on the supporting the stock-room floor l. The slight deflection of the rew the shafting boxes out of l increased the pressure, which not lted in ruining the bearings by but caused the armature of the motor to burn out. Any mill man all instances where journals which done their work regularly for s suddenly heat and seize, owing added load being put on them, or e loss of alinement in the bearings.

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Fish, of the Heine Safety Boiler ny, will address the Engineers' f St. Louis, on November 13, 1909.

## Book Reviews

PRACTICAL ALTERNATING CURRENTS. By Charles F. Smith. Published by The Scientific Publishing Company, Manchester, Eng. Cloth, 475 pages, 5½x 8½ inches; 230 illustrations; numerous tables. Price, $2.

This is the third edition of Mr. Smith's excellent treatise. It shows considerable increase in material as compared with the first edition (the reviewer did not see the second edition), a notable part of which is a new chapter on the single-phase induction motor.

The book is essentially a testing-room handbook. The elementary principles of the various kinds of alternating current apparatus are explained concisely, the behavior of the apparatus is described and detailed instructions for testing it are given. The mathematics are of the simplest kind; knowledge of elementary algebra and geometry will enable the student or test-room worker to follow all of the expositions easily.

CONTINUOUS-CURRENT ENGINEERING. By Alfred Hay. Published by D. Van Nostrand Company, New York. Cloth; 334 pages, 5½x8½ inches; 183 illustrations. Price, $2.50.

The author states in the preface that this book is intended to give an introductory course in the subject specified in the title, and this level is maintained in most part. The chapters devoted to the principles of direct-current dynamo and motor construction and the testing of those machines are considerably more comprehensive than the avowed aim would indicate. They are by far the best portions of the book and with some amplification and the addition of a few practical tables and charts could be made into a very presentable treatise on dynamo design.

The chapters on conductors and insulators are so meager as to be useless, but the remainder of the book is meritorious, though not nearly so praiseworthy as those first mentioned.

There are errors here and there, of course—this is the first edition. For example, on page 103, it is stated that a coil undergoing commutation travels, during that process, an angular distance equal to that covering the thickness of the brush face plus the thickness of one commutator bar. The fact is that the travel during commutation is that represented by the arc of the brush face only; consequently the equation near the middle of page 113 is inaccurate. The discrepancy in some cases might be considerable, in most cases it would not be serious, but its effect is in the unfavorable direction in any case because the actual commutation "frequency" is greater than the formula would make it.

The author's phraseology is not always above criticism. On page 5, for example, he speaks of a magnetic field consisting "of circular lines of force having their centers on the axis of the wire" which carries the field producing current. On page 5[illegible] "the moving coil is joined in series with a resistance and is then connected across," etc. On page 119 the author speaks of "injecting" an e.m.f. into an armature coil. Further, in the footnote on page 303: "If one of the machines should lose its field, owing to a break in the shunt," etc. While these lapses are not important enough to detract greatly from the value of the book as a textbook, they are minor obstacles to an isolated student and mar the otherwise high character of the book.

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## Books Received

"Efficiency as a Basis for Operation and Wages." By Harrington Emerson. The *Engineering Magazine*, New York. Cloth; 171 pages, 4¾x7½ inches; illustrated.

"Power, Heating and Ventilation." By Charles L. Hubbard. The Technical Press, Brattleboro, Vt. Cloth; 647 pages, 5½x9 inches; tables; 412 illustrations; indexed. Price, $5.

"Hydroelectric Developments and Engineering." By Frank Koester. D. Van Nostrand Company, New York. Cloth; 454 pages, 7¼x10¼ inches; illustrated; indexed. Price, $5.

"Electrical Engineering." By C. P. Steinmetz. McGraw-Hill Book Company, New York. Cloth; 455 pages, 5¾x 9¼ inches; 230 illustrations; tables; indexed. Price, $4.

"Elements of Machine Design." By Dexter S. Kimball and John H. Barr. John Wiley & Sons, New York. Cloth; 445 pages, 5¾x9 inches; 196 illustrations; indexed. Price, $3.

"Radiation, Light and Illumination." By C. P. Steinmetz. McGraw-Hill Book Company, New York. Cloth; 305 pages, 5¾x9¼ inches; 127 illustrations; tables; indexed. Price, $3.

"Electric Railway Troubles and How to Find Them." By Paul E. Lowe. Frederick J. Drake & Co., Chicago, Ill. Cloth; 367 pages, 5x7½ inches; 118 illustrations; indexed. Price, $1.50.

"Direct and Alternating Current Testing." By Frederick Bedell, assisted by Clarence A. Pierce. D. Van Nostrand Company, New York. Cloth; 265 pages, 5½x8½ inches; illustrated; indexed. Price, $2.

"Motorman's Practical Air Brake Instructor." By George R. Denehie. Frederick J. Drake & Co., Chicago, Ill. Morocco leather; 280 pages, 4¼x6¾ inches; 151 illustrations; indexed. Price, $1.50.

## Personal

Guy H. Gibbs, who has been with the Westinghouse Electric and Manufacturing Company for the past eight years, four of which have been with that company's Cincinnati office, is now with the Western Electric Company at Cincinnati.

E. G. Kibbe has resigned as treasurer of the Wheeler Condenser and Engineering Company, of Carteret, N. J., in order to take an active part in the management of the Warren Steam Pump Company, of Warren, Mass. Mr. Kibbe will be located at the head offices of the latter company at Warren.

## Society Notes

The New York Engineers Protective Society will hold its forty-first annual entertainment and reception on Friday evening, November 12, at Lyric hall, Sixth avenue, near Forty-second street, New York City. The vaudeville entertainment of high-class professional artists will begin promptly at half past eight o'clock. The arrangement committee promise a night of pleasant sociable enjoyment.

The American Society of Mechanical Engineers will hold its next monthly meeting on Tuesday evening, November 9, at the Engineering Societies building, 29 West Thirty-ninth street, New York. Prof. Gaetano Lanza and L. S. Smith, Massachusetts Institute of Technology, will discuss "Reinforced Concrete Beams" and Prof. Walter Rautenstrauch, Columbia University, will present a paper on "Theory of Certain Machine Members under Varying Load."

[illegible] Association No. 7, N. A. S. E., of New York held its annual smoker on Saturday evening, October 30, at the association rooms, 307 West Forty-fourth street. The usual large attendance that the socials of No. 7 always attract was present and a pleasant evening was spent. Brief addresses were made by Past National Presidents Smith and Stone, and a warm address of welcome was extended by brother Ronnie. The entertainment was furnished by John Foote, E. J. Chapman, William Murray, Robert Webb, C. S. Thompson, John Tracy, Henry Frantzen and Jack Armour. Frank Martin was the master of ceremonies. Refreshments were served. The attendance included many men of prominence in the engineering world.

On page 768 of the November 2 number, a table was inadvertently omitted. This table, which should have been incorporated in the article entitled, "New Type of Jet Condensers," is presented herewith.

RESULTS OF TESTS OF WHEELER RECTANGULAR UNDER TYPE JET CONDENSER.

| Vacuum In. Mer. | Absolute Pressure In. Mer. | Corres. Temp. of Exhaust Steam Deg. F. | Injection. In. Deg. F. | Injection. Out. Deg. F. | Diff. in Temp. between Steam and Circ. Water, Deg. F. |
|---|---|---|---|---|---|
| 28.65 | 1.25 | 85.5 | 44 | 85 | 0.5 |
| 28.7 | 1.2 | 85.0 | 44 | 85 | 0.0 |
| 28.75 | 1.15 | 83.5 | 44 | 83 | 0.5 |
| 28.7 | 1.2 | 85.0 | 44 | 83 | 2.0 |
| 28.75 | 1.15 | 83.5 | 44 | 80 | 3.5 |
| 28.75 | 1.15 | 83.5 | 44 | 81 | 2.5 |
| 28.65 | 1.25 | 85.5 | 44 | 80 | 5.5 |
| 28.55 | 1.35 | 88.5 | 44 | 87 | 1.5 |
| 28.75 | 1.15 | 83.5 | 43 | 79 | 4.5 |
| 28.75 | 1.15 | 83.5 | 43 | 76 | 7.5 |
| 28.6 | 1.3 | 87.0 | 43 | 82 | 5.0 |
| 28.6 | 1.3 | 87.0 | 43 | 82 | 5.0 |
| 28.7 | 1.2 | 85.0 | 43 | 82 | 3.0 |
| 28.65 | 1.25 | 85.5 | 43.5 | 82 | 3.5 |
| 28.75 | 1.15 | 83.5 | 43.5 | 83 | 0.5 |

## Help Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

WANTED—Thoroughly competent steam specialty salesman; one that can sell high grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

AGENTS WANTED to sell Borgmann celebrated engine packings in territories not y covered. See our advertisement on page 8

WANTED—Night engineer to take char of boilers, engines, ice machines, pumps, et with proper assistance; give reference, sala wanted and notice required. Box 55, Pow

WANTED—First-class draftsman and es mator for high class steam power and hea ing work. Address, giving full particula references and salary wanted, Box 826, Cha lotte, N. C.

WANTED—Engineers who can give all, part of their time to selling our steam sp cialties on commission to the trade; goo well known and of highest reputation. B rows Mfg. Co., York, Pa.

## Situations Wanted

*Advertisements under this head are inserted for 25 cents per line. About six wo make a line.*

POSITION WANTED either as steam gas engine engineer by man holding first cl Ohio license; can furnish best of referen as to character and ability. Box 63, Pow

POSITION WANTED as engineer; ha had 11 years' experience on steam turbi and reciprocating engines and all electri appliances; can furnish best of referen Address "W. R. V.," Box 64, POWER.

CHIEF ENGINEER and capable execut accustomed to the erection and operation large power houses and industrial plan would like to connect with a company wh desires a first-class man. Box 65, POWER

CHIEF ENGINEER operating large cen station plants and producing results, wo like to connect with a concern which des a first-class man. Box 66, POWER.

ERECTING ENGINEER, age 35, all-ro mechanic, technical training, operator erector of engines, boilers, generators complete power plant equipment, desires change present employers. Box 67, Pow

ENGINEER, eleven years' experience, wa position in Ohio; experience with Corliss automatic engines, fire and water tube boil d.c. generators, etc.; will go as engineer oiler with chance for advancement; have t and indicator outfit; seven years in pre position; steady, sober and married; age. years. "Engineer," Box 68, POWER.

## Miscellaneous

*Advertisements under this head are inserted for 25 cents per line. About six wo make a line.*

PATENTS secured. C. L. Parker, Soli of Patents, 4 McGill Bldg., Washington, I

ANY FIRM or engineer in charge steam plant that is troubled with scale in boilers can get absolutely free, the best l cator and reducing wheel made, with ve lined mahogany case. For particulars, dress Great Lakes Chemical Works, Ma woc, Wis.

## For Sale

*Advertisements under this head are inserted for 25 cents per line. About six w make a line.*

FOR SALE—20x48 Wheelock engine two 72"x18' high pressure tubular boile good condition cheap. Address "Engin Box 2, Station A, Cincinnati, Ohio.

BATES CORLISS engine, 16x36 (150 h flywheel diameter 12', face 22", with com outfit; immediate delivery. Kindel Bed pany, Telephone 1460 Stuyvesant, New City.

ONE DEEP WELL pump, Laidlaw-D Gordon manufacture; size 12x8½x18" plex, double acting, cylinder 28 feet surface; in good working condition. Ad John Gund Brg. Co., La Crosse, Wis.

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# Torresdale Pumping Plant and Filters

## Low Head Centrifugal Pumping Station with Capacity of 280,000,000 Gallons in 24 Hours and Largest Filtering Plant of Its Kind in the World

### BY THOMAS WILSON

Philadelphia is fortunate in having the largest plant in the world for purifying its drinking water, some of which comes from the Delaware and the balance from the Schuylkill river. Formerly about 95 per cent of the water came from the Schuylkill and the remaining 5 per cent. from the Delaware, but conditions are now reversed and approximately 70 per cent. comes from the river last mentioned. Before the improvements which made this possible were completed, all the water was pumped normally to artificial reservoirs constructed on elevated sites, from which it was distributed through the mains by gravity except in some of the higher districts. The same condition prevails at all the stations on the Schuylkill river, with the exception that the water is filtered before it is delivered to the mains, but the water from the Delaware, all of which passes through the Torresdale station, is first filtered and then pumped under pressure direct into the distribution system. The entire filtration system is comprised of five separate filter stations with a total nominal capacity of 422,000,000 gallons per 24 hours. Of this total the Torresdale pumping station has a capacity of 280,000,000 gallons, or nearly 70 per cent. of the entire amount.

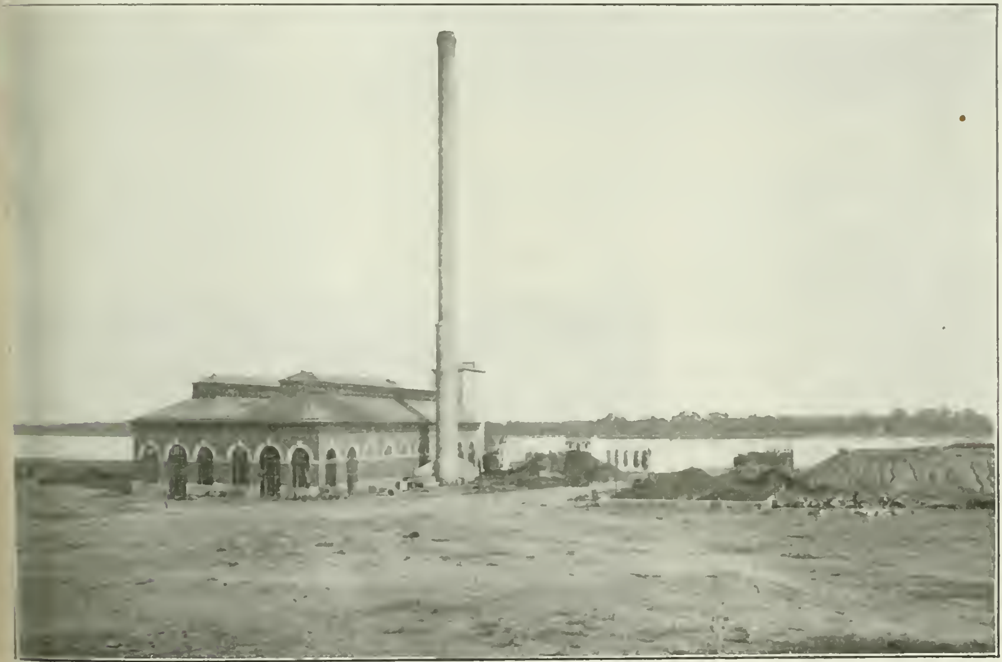

FIG. 1. PUMPING STATION, TORRESDALE

### PUMPING STATION

The Torresdale plant, which has now been completed and has been in operation for some little time, is located on the Delaware river about 11 miles upstream from the center of the city. Its site, at the corner of Delaware avenue and Pennypack street, near the northeastern city boundary, covers 200 acres of ground, and sufficient space has been acquired for future extensions. The station consists of an intake, pumping station, preliminary filters, 65 slow sand filters and a filtered water basin, but of these various departments the power plant will be given special attention.

An exterior view of the plant is shown in Fig. 1 and its location with regard to the filters, river, etc., may be noted in Fig. 2. The building is of granite and mottled brick construction covered with an asbestos slate roof. It is 110 feet wide by 180 feet long and is divided longitudinally into a boiler and engine room, both 54 feet wide and running the full length of the building with the exception of a small reservation on the boiler-room side for office space.

For equipment, the boiler room contains nine 300-horsepower Heine water-tube boilers arranged in batteries of three. Each boiler is provided with 189 tubes, 18 feet long and 3½ inches in diameter, and a drum 23 feet in length by 48 inches in diameter, which give a total heating surface of 3381 square feet; besides 10 per cent. additional surface is obtained

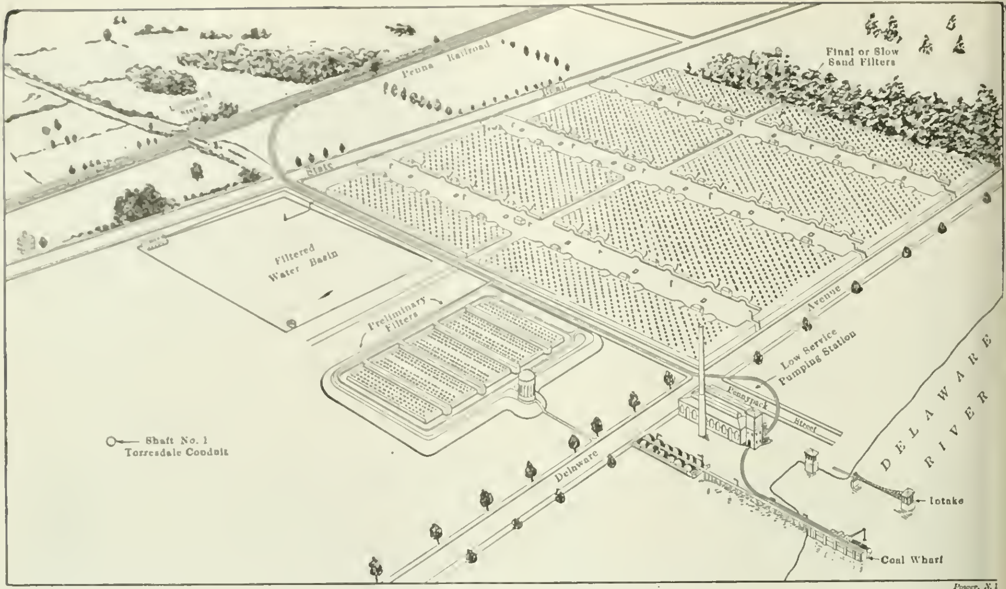

FIG. 2. SITE OF PUMPING PLANT AND FILTERS

in a Foster superheater. Murphy stokers furnish a grate surface of 52.5 square feet, making a ratio of water heating to grate surface of 64.4. The working pressure is 175 pounds gage and a superheat of 70 to 80 degrees is carried. In addition each battery of boilers is provided with a Sturtevant economizer containing 382 four-inch tubes, 8 feet in length, and a draft of 0.6 inch in the flue back of the boiler is maintained by a Custodis concrete stack 250 feet high and 9 feet in diameter all the way up.

### COALING FACILITIES

Semi-bituminous coal is burned on the grates and is delivered to the plant either by water or rail. From the barge which is being unloaded at the wharf in Fig. 1, the coal is unloaded by a locomotive crane, carrying a 1½-ton clam-shell bucket, into a 30-ton car. The tracks are arranged so that the coal may be delivered to the storage pocket south of the boiler house, which has a capacity of 3000 tons, or to the coal tower shown to the rear of the plant. If to the latter, it is first weighed and then dumped to a hopper beneath the track. It is then crushed and elevated to a 200-ton storage bin in the tower. From here the coal is discharged into one-ton cars running along a track over the boilers and is dumped into individual hoppers, one for each boiler, holding 10 tons of coal and delivering by gravity to the furnace. All of the coal-handling equipment is Link Belt apparatus.

From an ash hopper below the boilers the ashes are discharged into small cars and delivered by means of the elevator previously mentioned into a compartment of the coal tower to be disposed of either by rail or boat, or as at present are merely dumped on the premises.

### PATH OF THE FEED WATER

Feed water naturally comes from the river and makes its entrance through 4-inch pipe through which it is drawn a C. H. Wheeler 7½ and 7 by 10-inc pump and forced into a Webster heat which is located in the boiler room a raises the temperature of the water

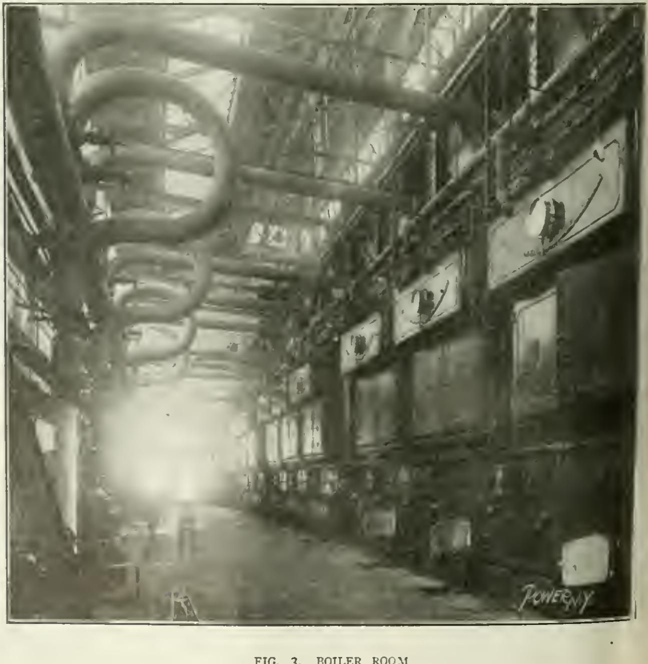

FIG. 3. BOILER ROOM

110 degrees Fahrenheit. Either one of two 10 and 7 by 12-inch Buffalo outside-packed pumps, with their suctions attached to the heater, forces the water through the economizers from which it escapes at 250 degrees to the boilers. Sellers injectors, one for each battery of ilers, are also provided, and Vigilant eed-water regulators control the feed. [wo 3-inch mains, one for injector ser- ice and the other for the pumps, tap to ach boiler, the method of connection be- g as shown in Fig. 4. Ordinary 2-inch woff connections are made from each ıler to a 4-inch pipe which leads to a nk outside the building and thence to e river.

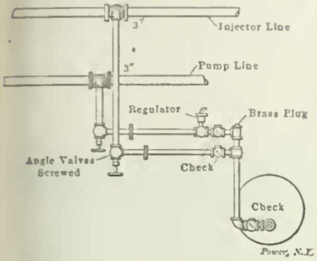

FIG. 4. BOILER FEED-WATER PIPING

At either side of each battery of boilers, all vertical engines are installed to op- te the reciprocating bars controlling e feed of the Murphy stokers. Recently ese have been supplemented by a single ven-horsepower motor, which imparts motion to the bars by means of Rey- ds silent chains, and with power to re easily controls the nine stokers. A "andard" damper regulator made by the lins Manufacturing and Supply Com- y, of Philadelphia, controls the air ply to each furnace.

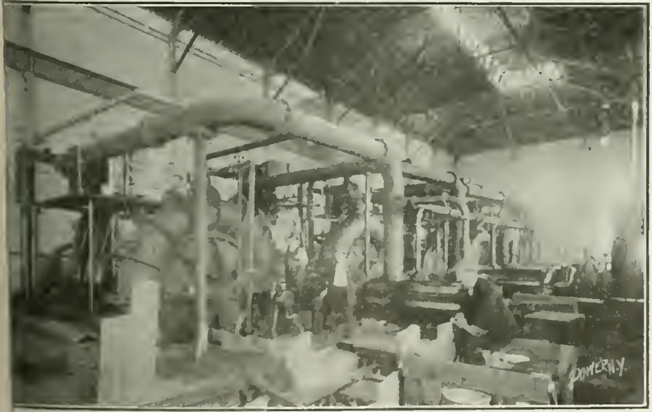

FIG. 5. THE SEVEN CENTRIFUGAL PUMPING UNITS

### STEAM PIPING

Each boiler is connected to a 10-inch header by a leader 5 inches in diameter. From the header 6-inch connections are made to each engine, the pipes dropping to the floor and rising to the unit on the engine-room side of the division walls.

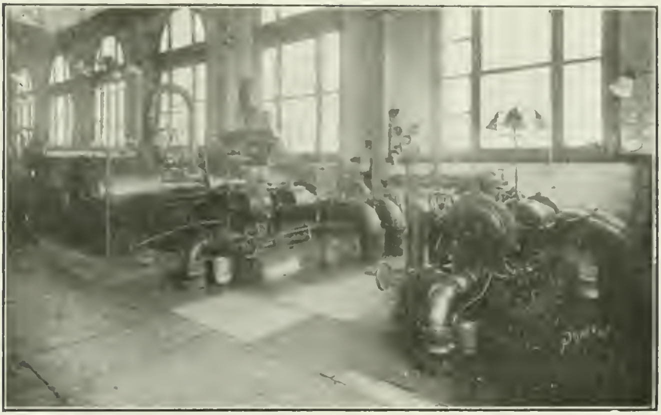

FIG. 6. PUMPS SUPPLYING WASH WATER TO FILTERS

The unusual provision for expansion and contraction will be noted in the circular bends clearly visible in Fig. 3.

### PUMPING UNITS

As previously stated, the station has a capacity of 280,000,000 gallons. Water is pumped from the Delaware river to the preliminary filters, which are 37.5 feet above mean high tide, and is also provided under pressure for feeding the preliminary and final filters. The enormous daily capacity of the station is made up by seven centrifugal pumping units, each having a capacity of 40,000,000 gallons in 24 hours against an average head of 42 feet, and the foundation is now being built for an eighth unit of the same capacity to be driven by a De Laval steam turbine. The six units first installed consist of R. D. Wood & Co. centrifugal pumps, with two 30-inch suctions and a 36-inch discharge, driven by Reeves cross-compound engines, 16 and 32 by 20 inches, making 170 revolutions per minute. The seventh unit, which has been but recently installed, consists of an Allis-Chalmers centrifugal pump, with two 24-inch suctions and a 36-inch discharge, driven by a Bates cross-compound engine of the same cylinder dimensions as the others and making 162 revolutions per minute. All of these units are shown in Fig. 5, the Bates and Allis-Chalmers unit appearing in the foreground.

Each of the centrifugal pumps, which are of the double-suction type, are placed immediately over the pump well, or to be more specific, the intake from the river. They discharge through pipes 36 inches in diameter, provided with hydraulically operated gate valves, into a steel header 11 feet in diameter, which is located on the north side of the engine room. This conduit is connected with a second header so that the water can be delivered to the preliminary filters, or these filters may be bypassed and the slow sand filters supplied direct from the river.

The intake, which is approximately 700 feet in length, is constructed of reinforced concrete. Its section is of horseshoe shape, flat on the bottom and rounding on top, and 14 feet wide by 10 feet 6 inches to the highest point of the arch. As will be evident from Fig. 1, it is provided with two gate houses, one at the outer end and the other midway. The house at the middle position was utilized before the completion of the outer portion of the intake and was originally intended for an inlet from a sedimentation [illegible] to be constructed in the [illegible]. The screens, however, are [illegible] in [illegible] and [illegible] in conformity with the general [illegible] of the other buildings. They are built of concrete and provided [illegible] and removable screens, the gates being operated by electric motors. The screens of each house are eight in number, four fine and four coarse, two of each being in series, so that there are really four channels for the water, and [illegible] opportunity is given for cleaning the screens while one or two of the sets are in operation. The fine screens are made up of [illegible] inch bars set on [illegible]-inch centers, which would provide a [illegible]-inch space between, and the coarse screens are made up of [illegible] inch flats spaced 4 [illegible].

Surface condensers are provided for each of the pumping units. Six were furnished by R. D. Wood & Co. with their units, and each of these contains 423 tubes 8 feet 8 inches long and 1 inch in diameter. In these condensers the water is external to the tube, but in the C. H. Wheeler condenser furnished with the Bates and Allis-Chalmers unit, the water passes through the tubes which are 1 inch in diameter, 426 in number and 9 feet 2 inches long. As cooling water can be obtained at a pressure from the discharge of the large centrifugal units, circulating pumps are not required. A connection is made from the discharge main to each condenser and the water is returned to this main at a point nearer the pump, the amount required being regulated by a hand-operated valve on the pipe leading into the condenser.

### Test of Pumping Unit

Tests of the last unit installed are available and it may be of interest to note its performance. Two tests were conducted, one a 30-day endurance trial and the other a 24-hour economy run. Data obtained in the test last mentioned are presented in the accompanying table, in which the results speak for themselves. The 30-day test was reported briefly as follows:

The test was started in February and concluded in the latter part of March, 1909, the total time being 30 days and 20 hours. During the entire run the engine was stopped only 2 hours and 35 minutes: 40 minutes for the condenser, 100 minutes for testing and 15 minutes for the engine. Just before the engine was stopped at the conclusion of the test an examination was made and everything was found running cool except the high-pressure eccentric and the crank-shaft bearing adjoining it, which was almost too hot to bear the hand on. This heating it was claimed was due to an idle eccentric. The engine had gotten a little loose, especially the low-pressure crank pin, but apparently could have run some time longer. Both the high- and low-pressure cylinders were found nicely polished and lubricated, and the high-pressure valve was in good condition and well lubricated, but the casing in which it worked appeared to be covered with a rough black substance like burnt oil. In conclusion the engine was reported to have operated smoothly and carried its load easily, being run at all times on the governor.

### Auxiliary Pumps and Electric Plant

In addition to the main pumping units the station is equipped with one two-stage centrifugal pump, with a capacity of $2\frac{1}{2}$ million gallons in 24 hours, driven by a 110-horsepower De Laval turbine making 1400 revolutions per minute. This pump furnishes water for the final filters, and the preliminary filters are supplied by two De Laval turbine pumps rated at 75 horsepower and a capacity of 5,000,000 gallons against a head of 60 feet. A Worthington steam pump of large size also supplies wash water to the final filters. These smaller units are shown in Fig. 6, and Fig. 7 is a view of three generating sets installed in the station to supply current for lighting and to the various small motors distributed about the plant. Of the generating sets, the prime movers are De Laval turbines and th generators are Crocker-Wheeler con pound-wound machines. Forty five arc and a number of incandescents form th lighting load, and as the voltage is 22 the arcs are connected two in series. Th exhaust steam from these three lightin units and the three turbine pumps is a delivered into a 22 inch Alberger ba rometric condenser, which takes its wat from the discharge of the main pumps the same way as all the other condense and maintains a vacuum of 28 inches an better right along. This condenser equipped with an Alberger dry-vacu pump, 6 and 14 by 10 inches, while surface condensers are all served com by two Williams dry-vacuum pumps two wet-vacuum pumps of C. H. Whe make.

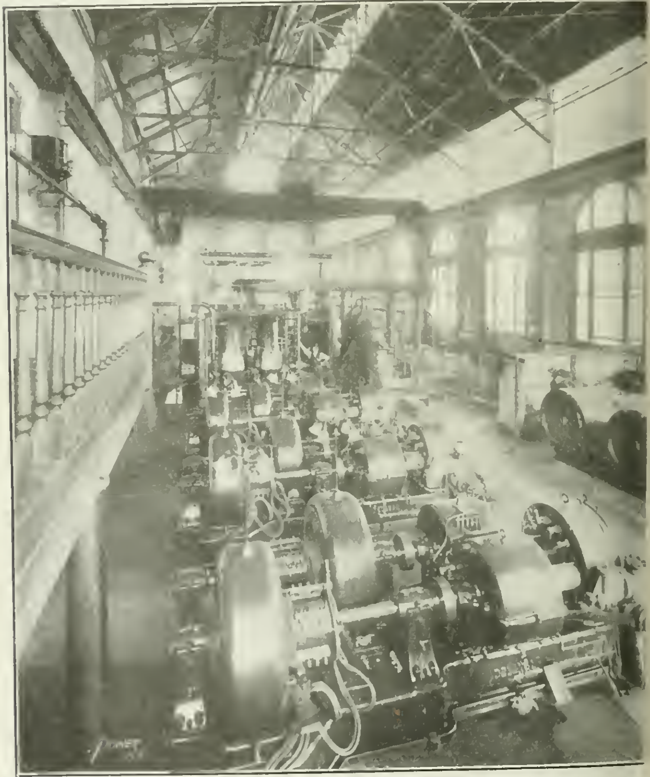

FIG. 7. TURBO-GENERATING SETS IN FOREGROUND

### Preliminary Filters

From the 11-foot conduit leading f the station, the unfiltered Delaware r water is delivered to a system of liminary filters, which are of the chanical type, using both water and air washing, but omitting the coagu These filters are located directly sout of

## OFFICIAL DUTY TRIAL OF BATES AND ALLIS-CHALMERS PUMPING UNIT

| Time | Tachometer R. P. M. | Temp of Steam at Engine C° | Temp of Steam at Engine F°. | Pressures Steam | Pressures Vacuum In. Hg by Gage | Pressures Water Disch. Ft. | Pressures Water Suction Ft. | Pressures Water Total Ft. | Pitometer M. G. D. | Condensed Steam Measured Out lb. | Condensed Steam Total Measured lb. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10.00 A.M. | 163 | 220 | 428 | 170 | 23.8 | 25.10 | 15.35 | 40.45 | | | |
| 10.15 A.M. | 163 | 219 | 426 | 172 | 23.5 | 25.30 | 15.25 | 40.55 | | | |
| 10.30 A.M. | 163 | 218 | 424 | 174 | 23.2 | 25.35 | 15.50 | 40.85 | | | |
| 10.45 A.M. | 163 | 219 | 426 | 175 | 22.8 | 25.20 | 15.50 | 40.70 | | | |
| 11.00 A.M. | 163 | 218 | 424 | 177 | 23.2 | 24.60 | 15.73 | 40.33 | 45.50 | 8.610 | 8,610 |
| 11.15 A.M. | | | | | | | | | | | |
| 11.30 A.M. | | | | | | | | | | | |
| 11.45 A.M. | 160 | 210 | 410 | 170 | 23.1 | 24.00 | 16.15 | 40.15 | | | |
| 12.00 A.M. | 160 | 212 | 414 | 175 | 23.2 | 23.70 | 16.35 | 40.05 | 42.88 | 8.020 | 16,630 |
| 12.15 P.M. | 162 | 214 | 417 | 164 | 23.2 | 23.70 | 16.48 | 40.18 | | | |
| 12.30 P.M. | 160 | 215 | 419 | 175 | 23.5 | 23.50 | 16.75 | 40.25 | | | |
| 12.45 P.M. | 161 | 214 | 417 | 169 | 23.7 | 23.80 | 17.15 | 40.95 | | | |
| 1.00 P.M. | 160 | 214 | 417 | 174 | 23.7 | 23.85 | 17.38 | 41.23 | 41.50 | 7.238 | 23,868 |
| 1.15 P.M. | 16[illegible] | 21[illegible] | 417 | 169 | 23.5 | 23.90 | 17.67 | 41.57 | | | |
| 1.30 P.M. | 161 | 215 | 419 | 171 | 23.7 | 24.10 | 17.91 | 42.00 | | | |
| 1.45 P.M. | 161 | 212 | 414 | 175 | 23.7 | 24.20 | 18.23 | 42.43 | | | |
| 2.00 P.M. | 161 | 210 | 410 | 172 | 23.0 | 24.15 | 18.23 | 42.38 | 40.92 | 8.555 | 32.423 |
| 2.15 P.M. | 161 | | 415 | 173 | 22.7 | 24.10 | 18.37 | 42.47 | | | |
| 2.30 P.M. | 161 | | 412 | 169 | 22.7 | 23.90 | 18.56 | 42.46 | | | |
| 2.45 P.M. | 161 | | 410 | 172 | 22.3 | 23.20 | 18.90 | 42.10 | | | |
| 3.00 P.M. | 162 | | 410 | 167 | 22.6 | 23.30 | 19.50 | 42.80 | 40.75 | 8.298 | 40,721 |
| 3.15 P.M. | 162 | | 418 | 165 | 22.4 | 23.35 | 19.32 | 42.67 | | | |
| 3.30 P.M. | 162 | | 417 | 163 | 22.6 | 23.45 | 19.65 | 43.10 | | | |
| 3.45 P.M. | 162 | | 416 | 167 | 23.7 | 23.60 | 19.38 | 42.98 | | | |
| 4.00 P.M. | 162 | | 411 | 167 | 23.8 | 23.70 | 19.70 | 43.40 | 41.21 | 7.326 | 48,047 |
| 4.15 P.M. | 161 | | 413 | 172 | 22.4 | 23.60 | 20.10 | 43.70 | | | |
| 4.30 P.M. | 162 | | 409 | 176 | 22.8 | 23.60 | 20.27 | 43.87 | | | |
| 4.45 P.M. | 162 | | 412 | 162 | 22.8 | 24.00 | 20.25 | 44.25 | | | |
| 5.00 P.M. | 162 | | 412 | 166 | 23.9 | 23.60 | 20.20 | 43.80 | 40.38 | 8.430 | 56,477 |
| 5.15 P.M. | 162 | | 410 | 165 | 23.0 | 23.60 | 20.00 | 43.60 | | | |
| 5.30 P.M. | 162 | | 407 | 169 | 23.0 | 23.20 | 19.58 | 42.78 | | | |
| 5.45 P.M. | 162 | | 408 | 17[illegible] | 23.[illegible] | 24.00 | 19.40 | 43.40 | | | |
| 6.00 P.M. | 162 | | 414 | 151 | 22.6 | 23.70 | 19.65 | 43.35 | 41.33 | 7,345 | 63,822 |
| 6.15 P.M. | 162 | | 411 | 168 | 22.8 | 23.60 | 18.40 | 42.00 | | | |
| 6.30 P.M. | 162 | | 411 | 160 | 23.0 | 24.20 | 18.35 | 42.55 | | | |
| 6.45 P.M. | 162 | | 408 | 167 | 23.0 | 24.60 | 18.10 | 42.70 | | | |
| 7.00 P.M. | 161 | | 404 | 177 | 23.4 | 24.60 | 18.10 | 42.70 | 41.71 | 7.445 | 71,267 |
| 7.15 P.M. | 162 | | 405 | 157 | 22.9 | 24.60 | 17.42 | 42.02 | | | |
| 7.30 P.M. | 162 | | 416 | 160 | 23.0 | 24.60 | 17.30 | 41.90 | | | |
| 7.45 P.M. | 162 | | 407 | 167 | 23.7 | 24.90 | 17.45 | 42.35 | | | |
| 8.00 P.M. | 162 | | 409 | 172 | 23.4 | 25.05 | 17.25 | 42.30 | 42.58 | 8,253 | 79,520 |
| 8.15 P.M. | 162 | | 399 | 157 | 23.2 | 25.40 | 16.85 | 42.25 | | | |
| 8.30 P.M. | 162 | | 408 | 161 | 23.5 | 25.65 | 16.72 | 42.37 | | | |
| 8.45 P.M. | 162 | | 409 | 167 | 23.7 | 25.45 | 16.20 | 41.65 | | | |
| 9.00 P.M. | 162 | | 404 | 164 | 23.9 | 25.50 | 16.10 | 41.60 | 42.63 | 7,385 | 86,905 |
| 9.15 P.M. | 162 | | 406 | 174 | 24.5 | 25.20 | 15.95 | 41.15 | | | |
| 9.30 P.M. | 160 | | 410 | 170 | 23.5 | 25.00 | 15.95 | 40.95 | | | |
| 9.45 P.M. | 162 | | 411 | 163 | 23.3 | 24.85 | 15.80 | 40.65 | | | |
| 10.00 P.M. | 162 | | 403 | 172 | 23.5 | 24.85 | 16.10 | 40.95 | 42.83 | 7.438 | 94,343 |
| 10.15 P.M. | 162 | | 408 | 162 | 24.3 | 24.80 | 16.12 | 40.92 | | | |
| 10.30 P.M. | 162 | | 404 | 166 | 24.2 | 24.75 | 16.32 | 41.07 | | | |
| 10.45 P.M. | 162 | | 406 | 172 | 24.5 | 24.65 | 16.65 | 41.30 | | | |
| 11.00 P.M. | 162 | | 408 | 164 | 24.2 | 24.50 | 16.70 | 41.20 | 43.21 | 7.185 | 101,528 |
| 11.15 P.M. | 162 | | 402 | 166 | 24.1 | 24.40 | 17.05 | 41.45 | | | |
| 11.30 P.M. | 162 | | 410 | 168 | 24.2 | 24.50 | 17.20 | 41.70 | | | |
| 11.45 P.M. | 162 | | 410 | 167 | 24.0 | 24.70 | 17.40 | 42.10 | | | |
| 12.00 P.M. | 162 | | 407 | 162 | 24.0 | 24.60 | 17.50 | 42.10 | 45.17 | 6.905 | 108,433 |
| 12.15 A.M. | 162 | | 407 | 158 | 24.0 | 24.70 | 17.62 | 42.32 | | | |
| 12.30 A.M. | 162 | | 408 | 172 | 23.0 | 24.50 | 18.00 | 42.50 | | | |
| 12.45 A.M. | 162 | | 410 | 168 | 24.1 | 24.20 | 18.10 | 42.30 | | | |
| 1.00 A.M. | 162 | | 404 | 168 | 24.2 | 24.50 | 18.35 | 42.85 | 43.13 | 8.242 | 116,675 |
| 1.15 A.M. | 162 | | 416 | 165 | 24.0 | 24.50 | 18.65 | 43.15 | | | |
| 1.30 A.M. | 162 | | 412 | 173 | 23.2 | 24.40 | 18.85 | 43.25 | | | |
| 1.45 A.M. | 162 | | 408 | 152 | 23.2 | 24.15 | 18.65 | 42.80 | | | |
| 2.00 A.M. | 162 | | 410 | 166 | 23.5 | 24.15 | 19.10 | 43.25 | 41.67 | 7,267 | 123,942 |
| 2.15 A.M. | 162 | | 402 | 161 | 23.2 | 24.30 | 19.50 | 43.80 | | | |
| 2.30 A.M. | 162 | | 406 | 164 | 23.2 | 24.30 | 19.65 | 43.95 | | | |
| 2.45 A.M. | 162 | | 402 | 163 | 23.2 | 24.15 | 19.85 | 44.00 | | | |
| 3.00 A.M. | 162 | | 401 | 172 | 23.2 | 24.00 | 20.05 | 44.05 | 40.46 | 8,265 | 132,207 |
| 3.15 A.M. | 162 | | 405 | 157 | 23.3 | 24.10 | 20.23 | 44.33 | | | |
| 3.30 A.M. | 162 | | 404 | 161 | 23.3 | 24.00 | 20.20 | 44.20 | | | |
| 3.45 A.M. | 162 | | 408 | 156 | 23.3 | 23.80 | 20.35 | 44.15 | | | |
| 4.00 A.M. | 161 | | 402 | 175 | 23.3 | 23.80 | 20.70 | 44.50 | 40.83 | 7.550 | 139,757 |
| 4.15 A.M. | 162 | | 402 | 159 | 23.1 | 23.80 | 20.70 | 44.50 | | | |
| 4.30 A.M. | 162 | | 406 | 166 | 23.2 | 23.80 | 20.90 | 44.70 | | | |
| 4.45 A.M. | 162 | | 401 | 169 | 23.2 | 23.60 | 21.10 | 44.70 | | | |
| 5.00 A.M. | 161 | | 406 | 161 | 23.1 | 23.70 | 21.05 | 44.75 | 40.21 | 8.295 | 148,052 |
| 5.15 A.M. | 162 | | 404 | 172 | 23.2 | 23.90 | 21.22 | 45.12 | | | |
| 5.30 A.M. | 162 | | 412 | 151 | 23.2 | 23.60 | 20.73 | 44.33 | | | |
| 5.45 A.M. | 162 | | 412 | 175 | 23.1 | 23.60 | 20.75 | 44.35 | | | |
| 6.00 A.M. | 162 | | 422 | 156 | 23.2 | 23.90 | 19.77 | 43.67 | 40.83 | 7,697 | 155,749 |
| 6.15 A.M. | 161 | | 414 | 176 | 23.3 | 24.30 | 19.92 | 44.22 | | | |
| 6.30 A.M. | 162 | | 418 | 167 | 23.3 | 24.30 | 19.25 | 43.55 | | | |
| 6.45 A.M. | 162 | | 414 | 162 | 23.2 | 24.10 | 18.78 | 42.88 | | | |
| 7.00 A.M. | 162 | | 420 | 174 | 23.5 | 24.10 | 18.65 | 42.75 | 40.71 | 7,879 | 163,628 |
| 7.15 A.M. | 162 | | 410 | 174 | 23.5 | 24.60 | 18.50 | 43.10 | | | |
| 7.30 A.M. | 162 | | 411 | 175 | 23.3 | 24.80 | 18.28 | 43.08 | | | |
| 7.45 A.M. | 162 | | 404 | 168 | 23.2 | 24.90 | 17.60 | 42.50 | | | |
| 8.00 A.M. | 165 | | 414 | 168 | 23.2 | 25.00 | 17.22 | 42.22 | 41.67 | 7,852 | 171,480 |
| 8.15 A.M. | 161 | | 416 | 169 | 23.2 | 24.80 | 17.05 | 41.85 | | | |
| 8.30 A.M. | 161 | | 417 | 176 | 23.5 | 25.00 | 15.86 | 40.86 | | | |
| 8.45 A.M. | 161 | | 410 | 173 | 23.3 | 25.00 | 15.40 | 40.40 | | | |
| 9.00 A.M. | 161 | | 410 | 177 | 24.1 | 24.70 | 15.21 | 39.91 | 43.50 | 7,515 | 178,995 |
| 9.15 A.M. | 161 | | 416 | 175 | 24.1 | 25.00 | 14.83 | 39.83 | | | |
| 9.30 A.M. | 161 | | 420 | 172 | 24.1 | 25.10 | 14.65 | 39.75 | | | |
| 9.45 A.M. | 162 | | 414 | 172 | 24.0 | 25.00 | 14.48 | 39.48 | | | |
| 10.00 A.M. | 162 | | 412 | 172 | 23.6 | 25.00 | 14.40 | 39.40 | 46.96 | 7,858 | 186,853 |
| Totals | 15,369 | ..... | 39,042 | 15,932 | 2,224.1 | ..... | ...... | 4,024.03 | 1,012.57 | .. | ......... |
| Averages | 161.8 | ..... | 411.0 | 167.7 | 23.41 | ...... | ...... | 42.36 | 42.19 | ..... | 7,785.54 |

REMARKS

The Cent. thermometer used during the first 4 hours had an air bubble in the mercury column 2 degrees long which was subtracted from the readings. This was replaced at 2 o'clock by a Fahr. thermometer.

The temperature of the water pumped—41° Fahr.—was fairly constant throughout the trial. One cu.ft at this temp. weighs 62.4 lb.

The steam gage was located 5'8½" below the throttle valve. A correction of 2½ lb. must be subtracted for the column of condensed steam on the gage. The steam pressure in the receiver was not recorded.

The steam used was condensed in a C. H. Wheeler condenser and pumped alternately into two tanks at 10 minutes intervals, and weighed.

The suction pressure was read by means of a float and a scale graduated in feet.

The discharge pressure was read by means of a mercury column in connection with a scale graduated to read in feet. The mercury column was so placed in relation to the float that the correction due to the difference of elevation was eliminated.

The quantity of water pumped was measured by means of a pitometer in M. G. D. 15 min. readings were taken during the first 1½ hr. After that every 5 minutes. The rates noted on this log are the averages for each hour.

The run was continuous during the entire 24 hours.

Av. Press., lb. = (167.7 − 2.5) + 14.7
= 179.9 (Temp. = 372.92° F.)

No. of Degrees of Superheat:
= 411.0 − 372.9
= 38.1° F.

Duty in ft. lb. per 1000 lb. steam used:

$$= \frac{\text{M.G.D.} \times 10^6 \times 62.4 \times h \times 1000}{24 \times 7.48 \times \text{lb. steam per hr.}}$$

$$= \frac{\text{M.G.D.} \times h}{\text{lb. steam}} \times 347.5$$

$$= \frac{42.19 \times 42.36}{7785.54} \times 347.5 \times 10^6$$

$$= 79.77$$

the slow sand beds at an elevation high enough to cause the water to pass through both the preliminary and final filters by gravity. They are arranged in rows of 15 each, with two rows in each filter house facing a central aisle. There are four houses and a total of 120 beds, each measuring 20 feet 3 inches by 60 feet in the clear. Each bed is controlled by an individual operating table.

The filtering material consists of 15 inches of gravel varying in size from 2 to 3 inches, 4 inches of gravel varying from 5/8 to 1 1/2 inches, 3 inches of gravel varying from 1/4 to 1/2 inch, 8 inches of gravel varying from 1/8 to 1/4 inch and 12 inches of sand varying from 0.8 to 1 millimeter. The depth of water carried over the filtering materials is 4 feet. After passing through a hydraulically operated valve and an affluent controller, the water passes to the affluent gullet and is admitted to a second 11-foot riveted steel conduit, which carries the prefiltered water to the slow sand filters. Compressed air is supplied to each house by means of a Root blower through a 20-inch pipe running the full length of the building. The air system is connected to the wash-water piping, and air is introduced through the manifold in the bottom of each filter.

### Final Filters and Basin

The final filters, which number 65, are all rectangular in shape, and each has an area of approximately 3/4 acre. They are built of concrete, covered by groined arches and have puddle under the floor and surrounding the side walls. In all essential details they are similar to the other plants. The affluent is discharged into pipes laid under the courts, on which the filters face, and these pipes connect with a reinforced concrete conduit leading to the filtered water basin, which lies south of the final filters and near the preliminary filters.

The basin is constructed on lower ground, and its elevation is such that the water is delivered to it from the final filters by gravity. It is rectangular in shape, 601x762 feet, with an available depth of 15 feet, and has a capacity of 50 million gallons at the normal water line. A conduit 10 feet 7 inches internal diameter carries the filtered water from the basin to the Lardner's point pumping station 3 miles below on the Delaware river, where it is pumped into the distribution system.

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The next meeting of the Boston members of the American Society of Mechanical Engineers will be held at the Lowell building, room 6, Massachusetts Institute of Technology, Wednesday evening, November 17, at 8 o'clock. The subject of this meeting will be a topical discussion on Low Pressure Steam Turbines. This discussion will be opened by H. G. Stott, W. L. R. Emmet, Richard H. Rice, Professor Miller and others. Discussion by nonmembers is cordially invited.

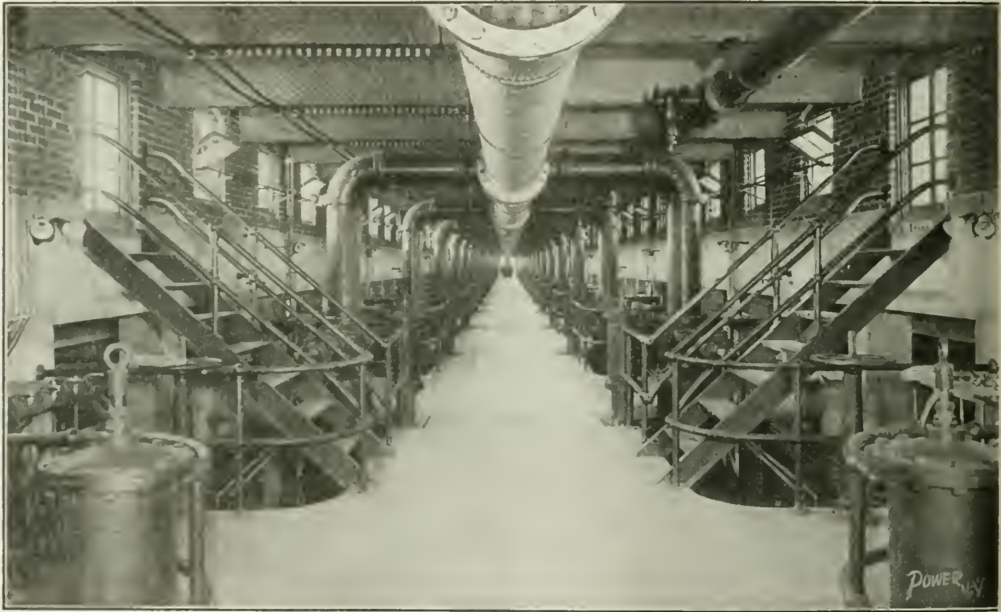

FIG. 8. INTERIOR OF ONE OF THE PRELIMINARY FILTER BUILDINGS

# Evaporative Condensers

By W. H. Booth

In Great Britain the evaporative condenser has obtained considerable favo and it is sometimes made in large size That illustrated was designed to de with 1000 pounds of exhaust steam pe minute at the electricity-supply works c Southend, a seaside town near the mout of the Thames, England. This big cor denser is built up of 2160 gilled 5-inc pipes, each 5 feet long and arranged i 72 flattened spirals disposed in two lon banks of parallel sections. A novel feature in this large apparatus is that th condensed steam is not allowed to b all driven to the lowest point, but i drained out of each section of pipes a three places in the hight of the apparatu as well as at the base.

Steam enters the upper ends of all th 72 spirals, and the drained-off wate comes off very much hotter from th upper drainage pipes than from the lower points. This effects a twofold econ omy, for the water passes off to th feed at a higher temperature and is prevented from parting with its heat to th condensing water outside the pipes.

Water is not always required as a condensing medium. It is probable that i severe climates the surface provide would obviate the necessity for wate cooling, but water is usually trickled ove the pipes, and not more than a third or half of the boiler-feed supply is wanted at the condenser. In a dry climate the evaporation of the trickling film of water is promoted by the absorptive power of the air, and at Southend during September of 1907 the water costs were reduced 26 per cent. as compared with a surface condenser and cooling tower. In January of 1908 the costs per unit were 0.1378 cent. In January, 1909, it should have been 0.10 cent, or 26 per cent. less. It was actually only 0.024 cent per unit or 76 per cent. less. Since water costs 36 cents per 10,000 pounds (1000 English gallons), the saving is important, for a year's water now costs only $1000, as compared with $3335 in 1906, though the units generated have gone up from 1,437,278 to 1,800,000 units.

The air pump, Fig. 3, is an Edwards 12x10-inch three-throw. There are two of these, one being standby. The one at work is run 18 hours daily and consumes 45,000 electrical units per year to drive it. It discharges by way of a Lea automatic recorder. The water service is by centrifugal motor-driven 5-inch pumps, and the condensed-steam wet pump consumes 15,000 units. The condenser not being fully loaded, the circulating pumps only run 3½ hours per day and use 13,000 units per year. The total energy consumed is 73,000 units. A surface plant and circulating pump of equal capacity would, it is estimated, consume 303,000 units, and the relative costs of the Led-ard condenser is as $1500 to $6300 for n ordinary surface-condenser plant. At outhend the surface-condenser tubes be- me very much scaled, but this has now een avoided, and it is much easier to ean the gilled pipes externally than the rface pipes internally.

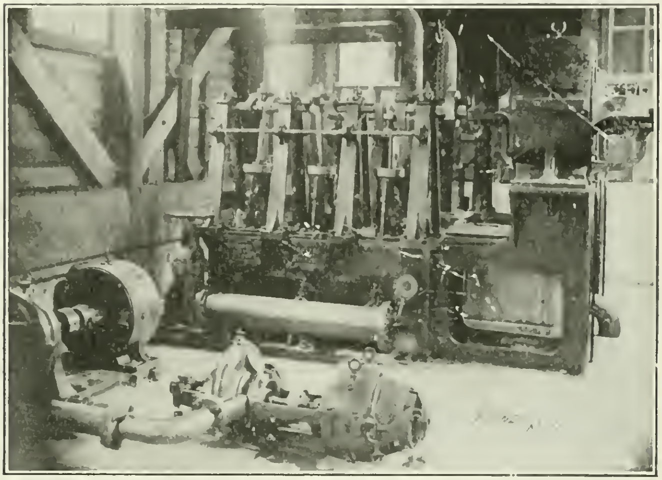

FIG. 2. THE AIR, HOT WATER AND CIRCULATING PUMPS

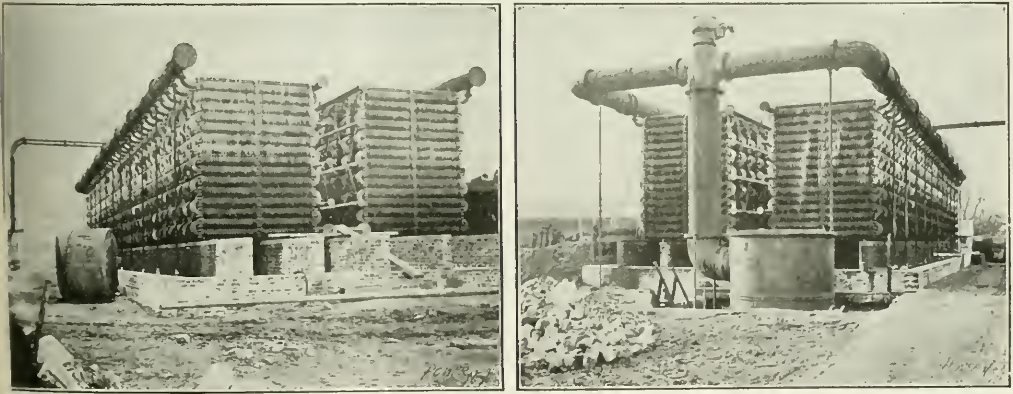

FIG. 1. THE ATMOSPHERIC CONDENSER AT SOUTHEND

Considerable attention has of late been rected upon the removal of the con- nsed steam from surface condensers as soon as formed, and for this purpose division plates or diaphragms have been introduced, and greater efficiency of the condensing surface is claimed to result. The same principle is carried out in the atmospheric condenser by the several drainage points named above, but not quite all water is removed. Some is left at each point to maintain a certain effervescent action which is said to obtain and to be so efficient in transferring heat to the pipe surface to be lost through the pipe thickness.

As many as 27½ inches of vacuum may be maintained with the atmospheric condenser, but at Southend the hotwell is kept to 120 degrees as the most economical temperature all round. This economical temperature cannot be dogmatically asserted to be universally best, for each case must have its own best temperature, and this can only be found by trial.

In the Southend plant there are valves provided for the adjustment of the drainage of the condenser sections as the load varies, thus securing a hot feed with light load as readily as when on full load. The air pumps deliver to a Lea recording apparatus through which the water flows to the hotwell, and the sectional drainage is taken out by a pump and delivered to the Lea apparatus. The station supplies both lighting and power circuits, but there is nothing out of the ordinary in the engines or boilers.

With so large a number of joints it might be feared that there would be considerable air leakage into these atmospheric condensers, but this is not found t[illegible] the [illegible]. The [illegible] per[illegible] [illegible] er, and [illegible] to expand the [illegible]. The [illegible] to expand [illegible] and [illegible] iron [illegible] [illegible] by [illegible] the [illegible] from the [illegible] [illegible].

It is a matter of importance that the [illegible] of the [illegible] should be true and even [illegible] will make [illegible]. The [illegible] shows the general [illegible] plant and its [illegible]. [illegible] of these [illegible] [illegible] consider[illegible] [illegible] the condenser here re[illegible] [illegible] at Southend [illegible] 111x32 [illegible] in addition to the air-pump room and [illegible]. But where room can be found either on the ground or on a comparatively low roof, these condensers are able to give a very good account of themselves. Being so extensive and having so many joints, it is essential to erect them carefully, so that each section may be [illegible] of tightness before it is concealed between other sections.

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The United States Civil Service Commission announces an examination on November 22-24 to secure eligibles for the position of junior engineer in the Geological Survey at an entrance salary of $840 per annum. The subjects and weights are as follows: Elementary chemistry, physics and mathematics, 10; essay on one of a selection of topics, 20; mechanics and dynamics of engineering, 10; special subjects of engineering, 25; training and experience, 35. The application form is No. 1312.

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# "Tom" Sawyer on Receiver Pressure

By F. L. Johnson

"[illegible]" Armour [illegible] half a [illegible] he had [illegible] at a great [illegible] of time [illegible]. [illegible] directly to my desk he [illegible] a [illegible] of manuscript, [illegible] a score of [illegible] red letters under the [illegible], and [illegible] the books on the [illegible] spot he had made, saying as he did so:

"Here! I have always told you that it was not Solomon who said there is nothing new under the sun, but that it was Ben Akiba, a Greek jokesmith, who lived long before Solomon; and Solomon copied it. Here is all of the corroborative testimony that I need to prove my case. There is a whole lot more that I could get, but as those Greeks only had twenty-three or twenty-four letters in their alphabet, and some of them are so different from ours, much that they wrote is hard to understand. But if you will go through these six books you will see that I am and have been right."

As historical research had never been an attractive pursuit for me, I was about to admit the justice of his claim that Solomon was a plagiarist; in fact, I was prepared to admit that the fact that he plagiarized was one evidence of his wisdom, when Sawyer came in. He had become such a frequent caller recently that he was no longer stopped at the gate and asked to give his name and state his business. Sitting in the visitor's chair, and handing me a Manuel Garcia cigar and a match, he said:

"I came in to make a short social call and to say a word or two about something I saw in POWER for September 28, on page 540, where S. A. Reeve says: 'No doubt an engine with sufficient cushion but no lead, or even with negative lead, might run with less friction, but it would lose much steam.' Now, I know that men who are familiar with all sorts of theoretical steam-engine knowledge will agree with Mr. Reeve; but will he take a steam engine, set the valves so that the conditions he names will be fulfilled—that is, sufficient cushion (which, by the way, is none at all) and no lead, and show by measuring the water used and power developed that that of which he has no doubt is a plain statement of the facts in the case? From time to time I see a whole lot of theory in print from the pens of scholarly gentlemen, but not a line from one of them regarding results of any experiments made by anyone to prove that it takes any more pounds of steam to develop a horsepower with one kind of valve setting than it does with another.

"Of course, I know that it takes less steam from the boiler to fill the cylinder up to the point of cutoff, if the clearance is already filled with steam caught by the closing of the exhaust valve and compressed to initial pressure by the piston but I know just as well that it takes power to do this compressing. This power must come from the engine and the engine gets its power from the steam that runs it. Now, what Mr. Reeve says, and he is not alone in this, for several other eminent engineers and authors have said the same thing, is that it is cheaper to run an engine to compress the steam used to fill the clearance than it is to fill it from the boiler. In other words, steam can be made for les

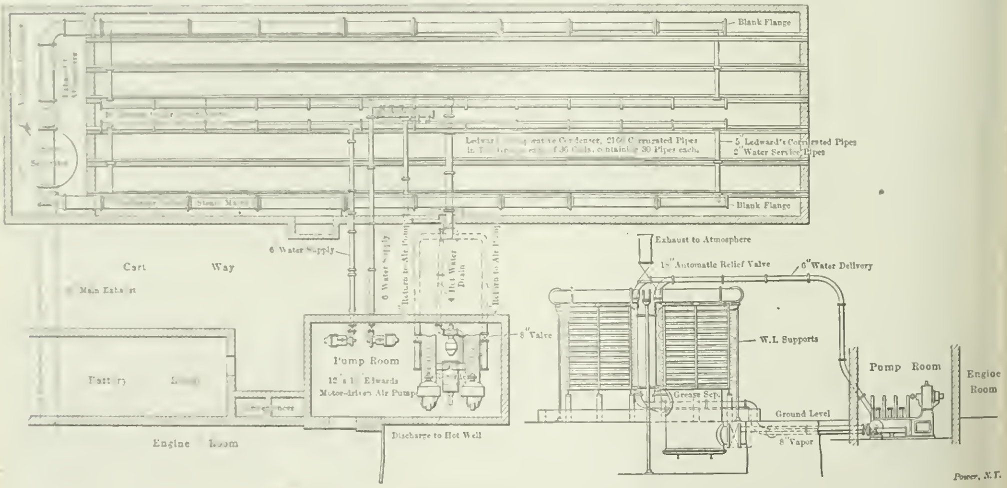

FIG. 3. PLAN AND ELEVATION OF CONDENSER AT SOUTHEND

money in the clearance spaces by compression than in a boiler.

"If it is true that the clearance space can be filled with steam at initial temperature and pressure cheaper by the engine than by the boiler, then a space larger than the clearance space may be filled in the same economical manner, and a compressor may be run compressing exhaust steam which may be used to operate other compressors, and so on, like the 'fleas which have other fleas to bite 'em;' and if we have compressors enough we can shut down the one small boiler needed to start the first compressor just as soon as the cycle is complete.

"I may be, probably am, lame in my conception of what these men have said and what they still continue to say, but I wish some of them would make a few experiments that will prove their contention. If one of them will take a simple engine, give it a fixed load and then measure the steam consumption per horsepower-hour for different kinds of valve setting, I will forever hold my peace. I have several ideas in my head which these technical men tell me are founded on untenable premises. It may be, probably is, so, as I got them from observing the behavior of engines under different conditions.

"One of these ideas is that a low receiver pressure in compound-engine operation is conducive to economy. It has been demonstrated to me dozens of times, on paper, that the highest efficiency is obtained when the steam in the high-pressure cylinder is expanded to receiver pressure. If the high-pressure diagram ended in a point, there was no loss from free expansion. I once had a job as night engineer in a plant where the day man carried fifteen pounds of receiver pressure. When I came on watch I first went over all of the machinery under my care, to see that it was all in good working order. I then turned my attention to the receiver pressure, which I reduced from fifteen pounds to four. In less than five minutes from the time that the receiver pressure was reduced, the safety valves began to blow.

"One of the firemen once told me that he could always tell when I got on the floor, and that the plant could be run with one less boiler while I was on watch. He may have been 'stringing' me for some purpose of his own, but I do know that as the receiver pressure was reduced on each engine the governor of that engine began to revolve in a higher plane, showing that the engine was cutting off shorter than before.

"I know that it can be shown on paper that with the lower receiver pressure there will be less steam compressed in the high-pressure cylinder, and that more steam will be needed to fill the clearance; but I do not know that these paper conditions are a statement of the true conditions, and I want some of these technical men to show me.

"It is plain that with a perfect nonconducting cylinder and a frictionless engine, their contentions would be true, but these things we do not have, and I want the influence of these unconsidered factors measured in terms of pounds of water per horsepower-hour. This I never expect to get, for these gentlemen, with superior smiles at my lack of knowledge of the entropy diagram, get out their pencils and proceed to prove that with the shorter cutoff without compression more steam would be used than with a longer cutoff and compression to initial pressure."

Sawyer was really getting in earnest and directed his talk toward me as though I was the one who was responsible for his annoyance, when a disgruntled subscriber was shown in, who began at once by saying:

"I wrote in here sometime ago, asking you how much air it would take to run an air-lift pump, and as I never got an answer I want to know why."

I gave the office boy his name, told him to go to the files and get the letter. While the boy was out the angry one kept on saying things, to which I replied occasionally with an interrogative "Yes?" Soon the boy returned, saying that there was no letter from this man on file. I then turned to a box of unsigned letters that I keep, asking where he lived. As he gave the name of the city, I easily found his letter, which I handed to him, asking if that was the letter to which he referred.

"Yes," he replied, "that is it, and I want to know why you did not answer it."

"Are you sure that you wrote that letter?" I asked.

"Of course I am," he said; "don't you think I know my own writing?"

"Yes," said I; "I suppose you do, but as you failed to add your signature, I do not see how you could expect a reply."

His look of blank surprise was worth the whole price of admission, as the handbills used to say. He wheeled and left the office without a word, looking neither to the one side nor to the other, while Sawyer, softly whistling "My Wife's Gone to the Country," slowly followed him to the door.

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A mortgage for $50,000,000, given by the Public Service Corporation of New Jersey, was recently recorded in 11 counties of that State, which illustrates how widely the properties of the company are distributed. It includes all the franchises of the Public Service Gas Company and the capital stock of the 84 concerns subsidiary to the parent company. All the property owned by the company is used as a basis for securing this enormous loan.

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# Experiments Bearing upon the Greater Efficiency of the Firebox Heating Surface

There are many experiments proving the simple fact that the heating surface exposed to the direct action of the incandescent gases is more efficient than that merely exposed to hot gases; but with few exceptions investigators make no attempt to separate the heat transmitted by radiation from the total quantity transmitted; in fact, the total transmission is tacitly regarded as being due to convection and conduction. The following experiments are cited by Prof. W. E. Dalby, in a paper upon Heat Transmission, recently presented to the Institution of Mechanical Engineers.

Messrs. Dewrance and Woods in 1842 divided the water space between the tube plates in a locomotive boiler into six equal compartments by means of vertical partitions. It was found that the evaporation per square foot in the first compartment was equal to the evaporation per square foot of the fire box. In the second compartment the evaporation was one-third of that in the first compartment and the evaporation in the remaining compartments was practically nothing.

Graham in 1860 divided a cylindrical boiler set in brickwork into four compartments by vertical transverse plates, each compartment being open to the atmosphere, and found that 67.6 per cent. of the total water was evaporated in the first division, 18.2 per cent. in the second division, 8.1 per cent. in the third division, 5.4 per cent. in the fourth division.

Wye Williams in 1862 arranged six separate evaporating compartments round a common flue tube, the first compartment being quite separated from the remaining five and its heating surface being exposed to the flame. More water was evaporated from the first compartment, which was only one inch long, than from the last two feet of the tube.

Couche in 1876 divided a locomotive boiler into five compartments by means of tube plates. Experiments were made with all the tubes open, and also when half of them were closed. Five distinct drafts were used, ranging from ¾-inch to 3½-inch vacuum in the smoke box. The results show that the evaporation per square foot of surface was from two to three times greater from the fire box section than from the first tube section. As much as 50 pounds of water per square foot of surface was evaporated from the fire-box part of the boiler. The effect of closing up half the tubes caused an increase in the heat transmitted per square foot exposed.

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The man who thinks that his goods will sell themselves usually has a good deal to say about unfair competition.

# The Care of Small Steam Boilers

## What Should Be Done to Render Them Safe and Keep Them in Condition; Some of the Dangers Caused by Incompetency and Neglect

BY WARREN O. ROGERS

The commonest kind of small boiler is known as the vertical fire-tube, and is built in two types, as shown in Figs. 1 and 2. It is practically a locomotive boiler set on end, and consists of a shell in which is placed an internal firebox. It also has two heads, into which are expanded the tubes through which the hot gases pass from the fire to the stack. As the furnace plates and tubes are entirely surrounded by water they cannot burn if kept free from mud and scale and a proper water level maintained. Fig. 1 shows what is termed a through- or dry-tube boiler; Fig. 2 illustrates a submerged type, which is preferable to the dry-tube design, as there is less trouble from overheated top tube sheet and tube ends.

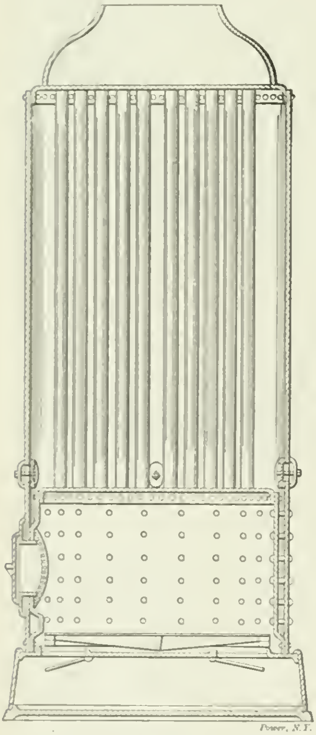

Power, N.Y.

FIG. 1. A COMMON TYPE OF UPRIGHT BOILER

These boilers are suitable for use where floor space is restricted, for hoisting work, excavations and wherever a small amount of steam power is required. They are also a favorite, owing to their low first cost and simplicity of installation, and being easily moved from place to place they are greatly used on construction work of various kinds. Such a boiler is not economical, however, in the use of fuel, because the hot gases have a short passage through the tubes, and also because there is a lack of good circulation of the water within the boiler, while the outside surface is exposed to the cooling effect of the air.

By noting the construction of the boiler, illustrated in Fig. 2, it will be evident that the matter of water level is important, in order to keep the upper tube end protected from the flame. Low water is a common fault with the hoisting engineer, because his attention is concentrated on the management of the engine in hoisting and lowering its load and, becoming absorbed in the hoisting work, the boiler end is neglected.

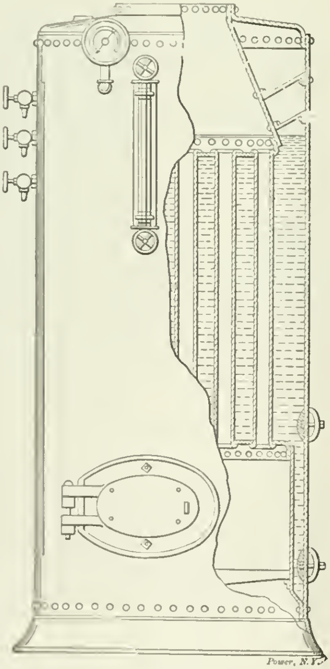
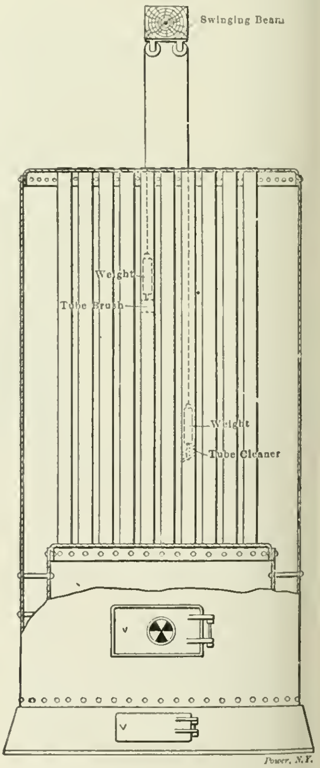

Power, N.Y.

FIG. 2. SUBMERGED TYPE OF VERTICAL BOILER

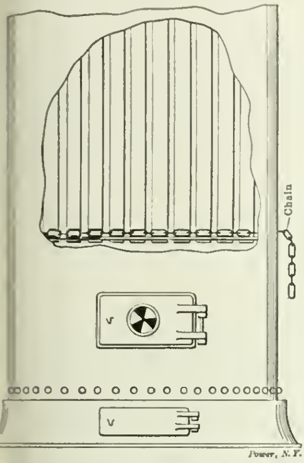
In one instance recently, while passing an upright hoisting boiler, the writer failed to find any water showing in the water glass, although there was a good fire on the grate and a steam pressure of 80 pounds shown by the steam gage. In another instance the water level just showed at the bottom of the gage glass as it rose and fell in the act of ebullition When the engineer's attention was called to the state of the water level he said he had "neglected it a little." Not only should the water show at the proper level, the second gage, but it should also be checked by means of the gage cocks, by occasionally blowing them out during the day. This is something that is almost universally neglected in all types of boiler.



Power, N.Y.

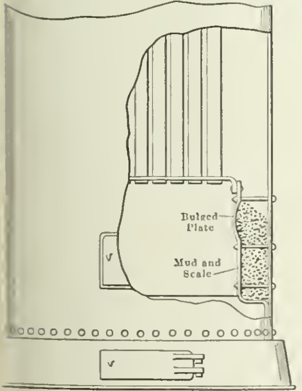
FIG. 3. METHOD OF CLEANING TUBES

Owing to the hard service imposed on small vertical boilers, such as being exposed to all kinds of weather and usage, they rapidly deteriorate, and in most places are exempt from any inspection law, so that "any old kind" may be found n operation on construction work, such s canals, tunneling and hoisting jobs.



. 4. CHAIN USED FOR REMOVING LOOSE SCALE

One fault in boiler operation, altoether too common, is that of forcing a w fire in order to get up steam in a rry. The results of such a procedure, a vertical boiler of the type shown in g t, is to cause a greater expansion



5. PLATE BULGED DUE TO OVERHEATING

the inner portion of the boiler over ht of the outer shell, which causes leak of the tubes in the crown sheet. When ts occurs the leakage soon forms a deit on the interior of the tube, which only reduces the heating surface, but tructs the draft.

Naturally the ashpit must not be allowed to become filled with ashes, as the grate will warp and burn.

The steam gage also requires particular attention because it is subjected to abuse, and the glass face soon becomes broken. When this happens the pointer or hand easily becomes bent and may thus register a false pressure. If the safety valve happens to stick the pressure becomes excessive, which is doubtless the cause of many explosions of this type of boiler. If a hoisting boiler is blown down once a day it is most fortunate. Once a week would probably be more like the actual practice. As the feed water comes from most any source it is evident that the blowing down at stated intervals is essential in order to clean out the mud and loose scale. At least once a day is absolutely necessary.

Another matter that should have the engineer's attention is that of the fusible plug. It should be examined at least every three months, and in cases of bad weather, where scale is liable to accumulate rapidly, the plug should be examined every time the boiler is cooled down for cleaning, as scale is liable to form over the fusible metal and prevent the steam pressure from bursting through the scale after the heat has melted the fusible metal in the plug in case low water does occur. There is more danger from this occurring where the plug is placed in the crown sheet than when placed in any of the tubes, as is sometimes the case.

Owing to the fact that the pressure in the vertical boiler tends to force the inner and outer cylinders apart, staybolts are used to prevent such a happening. The method of placing these staybolts is shown in Fig. 1. These staybolts are usually placed 4 inches apart from center to center and, therefore, each staybolt will withstand the pressure of a surface 4 inches square.

In upright boilers handholes are provided, there being three or four on a level with the crown sheet, or lower tube sheet, depending on the size of the boiler. There will also be one or more at the bottom of the mud space. These handholes are for the purpose of cleaning out scale and mud, and should be removed each time the boiler is cooled down for washing out. It is not sufficient to open the blowoff valve and allow the water to run out and then fill up the boiler and get up steam again. When cleaning a boiler all openings should be accessible, and suitable tools used to remove the scale from the crown sheet, such as a hose and nozzle, chain and tube cleaner.

If the boiler is placed in a temporary position a convenient method of cleaning the tubes can be arranged as shown in Fig. 3. This consists of a swinging crane or bracket having suitable pulleys attached, over which a rope runs, to which weights are supported. To one weight a tube cleaner is attached and to the other a tube brush. As the tube cleaner is forced down through the tube, due to the weight, the other weight is drawn up, the brush sweeping the tube clean. This device is a labor-saver and can be arranged to operate with almost any type of vertical boiler, regardless of size.

The use of a chain for removing scale is shown in Fig. 4. A stiff wire, say a piece of telephone wire, is inserted through one of the handholes on a level with the crown sheet, and either out through the same hole or one next to it. The wire is attached to the chain and the chain is then pulled through the handhole and around out through the other opening. Then water is turned on through the hose and the chain worked back and forth, thus assisting the loose scale out of the handhole. Precaution should also be used in thoroughly washing out the lower parts of the boiler, as an accumulation of mud or scale will cause the plate forming the walls of the firebox to burn and bulge, as shown in Fig. 5. This will necessitate a large patch, which is undesirable, or a new plate.

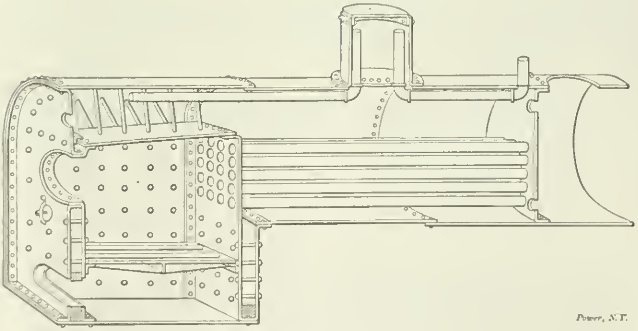


FIG. 6. SECTIONAL VIEW OF A PORTABLE BOILER

Frequently a new or dirty boiler will prime, and a badly proportioned boiler will also cause the same trouble. This is most noticeable when the boiler is being worked up to full capacity. In the case of foaming or priming in a new bo[illegible] the pr[illegible] the remedy is t[illegible] priming the [illegible] opening the throttle [illegible] the water level at the proper height. Opening the fire doors for a few moments and closing the throttle will relieve a case of foaming, but will not remove the trouble.

In Fig. 8 is shown a type of boiler frequently found where a portable steam generator is required. It is of the locomotive type and is usually mounted on wheels or skids. In this boiler the method of staying the front flat surface is shown, and it is at once evident that more precaution against low water should be taken than in the case of the upright boiler, as the crown sheet is directly over the hot fire on the grate, and covered at best with only a few inches of water. It is also evident that scale and mud are to be avoided. If not, the crown sheet will become burnt and when the plate has become weakened enough, the staybolts will pull out and an explosion occur with a result similar to that shown in Fig. 7, if no worse accident happens. Mud and scale should be washed out of the waterleg and the boiler thoroughly cleaned at stated intervals, depending on the condition of the water used.

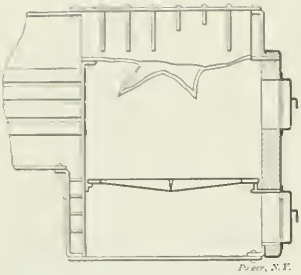
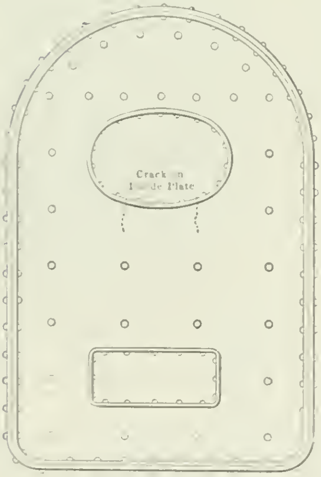


FIG. 7. FAILURE OF CROWN SHEET



Front View of Boiler

FIG. 8. [illegible] IN INSIDE PLATE

The greatest trouble found with most upright and portable locomotive types of boiler is due to lack of care. Usually they are in charge of men who have no engineer's license and when the day's work is done the fire is banked and the engineer forgets all about his boiler until it is time to get up steam in the morning. Naturally, the boiler does not get the attention in the matter of cleaning that it should, hence many are operated in a dangerous condition.

The old adage that a leaky boiler will not explode is strongly believed in if actual conditions as found are a criterion, especially where excavation work is being carried on. Numerous instances of leaky plates, joints, staybolts and rivets were seen on a recent visit to works where these two types of boiler were employed for hoisting purposes and supplying steam to feed drills, pumps, etc. In one instance the mud sheet was cracked on both sides of the fire door, as shown in Fig. 8, and a small-sized Niagara was streaming down the front of the boiler. In another case the same defect had developed and a repair had been tried by calking copper into the crack, but this questionable job did not hold and consequently the boiler was put out of commission.

How many of these boilers are operated day after day under such conditions is a query, but it would seem that a kind providence watches over men who unhesitatingly jeopardize their lives with unsafe boilers.

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## Some Trouble with Motor Drive

By S. Kirlin

When adding more motors to the equipment throughout the factory, do not connect them to the nearest circuit which happens to be handy, and then wonder why they fail to give good results. The chances are that the circuit is already carrying all the current it can and hold up the voltage at the motor terminals, and the addition of another one, even though it be a small one, may be sufficient to cause all on the circuit to give poor service, especially so in case of a heavy load coming on two or more of them at the same time, or in case of starting one with the others running.

When the speed of a direct-current motor falls excessively with an increase of load, go over all connections carefully and see that they are tight; then see that the commutator is true and clean, and that the brushes make good contact in the holders and do not spark; next attach a voltmeter to the terminals and s that the voltage is within 5 or 6 per ce of maximum with full load. If the troul is not located in any of these places, t shifting the brushes in an opposite rection to the direction of rotation of t armature until they show signs of spar ing with a light load. In some mot the distortion of the magnetism throu the armature at heavy loads is suffici to cause the speed to fall considerably less the brushes are set as far back as tl will run without sparking with a lig load. This drop in speed can take pl in some types of motors and still cause enough sparking at the brushes indicate the true cause of the trouble.

A motor will sometimes cause trou if attachetl rigidly to a wall or ceili where there is any great amount of bration. The writer's attention was cal to an incident of this kind in a fact where motor drive was used, in whicl motor was attached to the ceiling so distance from any point of support, a directly underneath a machine on floor above, which ran at practically same speed as the motor. When motor was started, it was found to brate and spark badly. Thinking that armature was out of balance, the el trician spent several days experiment with it in an endeavor to balance but only succeeded in helping it to slight extent. While he was working w it a short time after starting up morning, the belt which drove the chine on the next floor broke, and as sc as this machine stopped the motor stop sparking, and ran with very little vib tion. This gave him a clue to the ca of the trouble; the vibration of the fl with either the motor or the mach above running alone was not great, on account of the motor being attac rigidly to the ceiling directly under machine, the vibration when both w running was sufficient to cause the trou As it was not practical to place a s port under the floor at this point, trouble was cured by placing some di of rubber about an inch thick under e support where the motor was attached the ceiling.

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As evidence of the complete satisf tion that angle-compound high-speed gines are giving, the American Eng Company, of Bound Brook, N. J., rep orders for two 500-horsepower ang compound engines to be used for r ning centrifugal pumps of the In borough Rapid Transit Company po plants. This order is the result of good performance of similar engines stalled earlier in the season. Bloomi dale Brothers have installed a 400-ho power engine of the same type, and three lighting units installed in the l nord apartments are now in continu s operation.

# Setting the Valves of the Twiss Engine

## An Old-time Engine of Peculiar Design, Having a Valve within a Valve, the Closing of the Steam Valves Being Accomplished by a Spring

In the past POWER has described the ethod of setting the valves of many igns of engines, some of which are t now made. These articles attracted uch attention and interest that back bers were soon exhausted, which led these articles being compiled in book rm.

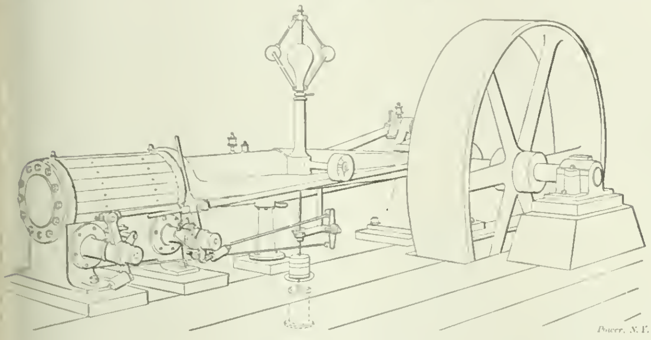

FIG. 1. TWISS AUTOMATIC CUTOFF ENGINE

ently, as a result of a query, it was d that directions for setting the es of the Twiss automatic-cutoff en- were not included in this book of ve setting, and as there are quite a engines of this type in operation, the lowing information is published for benefit of those who are, or may be rating them. Fig. 1 shows the general gn of the valve-gear side:

fore proceeding with the valve setg attention is called to some of the res of this engine, which are neces- understand before the valves can properly set.

am is admitted from the steam rtment, through the main valve the cutoff-valve chambers, which provided with two nearly opposite ports, Fig. 2, thus securing a ly balanced cutoff valve. The valve, ever, is sufficiently off the center to r that it is properly seated by the pressure. This arrangement ses double opening of the cutoff valve a given travel, and these opposite ts admit steam to corresponding inal ports in the main valves into a pass- within its annular body connecting h the external main steam port.

he usual exterior exhaust cavity is nd in the main valve and adapted to n the steam and exhaust ports, and is rly balanced by packing rings and a strip inclosing a balancing area opposite the exhaust cavity.

The valve drivers engage and operate the valves by means of lugs shown in Fig. 3, which fit into corresponding recesses in the drivers. The stems of the main drivers are hollow and journaled through the long bonnets of the valve chamber, with a crank or rocker arm keyed upon their outer end. These cranks are connected by an adjustable connecting rod, and operated by an eccentric on the main shaft by means of suitable connection. This allows of disengaging, so that the engine can be reversed or worked by hand. Both main valves vibrate together as a single plain valve, and control the steam admissions and exhausts.

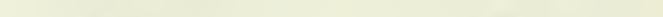

FIG. 2. CROSS-SECTION OF CYLINDER, PISTON AND VALVES

The cutoff-valve drivers have arms keyed upon their outer ends by which they may be hooked to and vibrate together with the valve crank in their open position. A suitable catch or latch link is provided on each main-valve crank for that purpose, and can be liberated by striking a suitable tripping cam which is operated by the governor to regulate the point of cut off, which is from zero to nearly half stroke.

The cutoff valve is closed by a spiral spring, one end of which is connected with the main-valve crank, the other end being connected with a hollow cup or cover which incloses the spring and is secured to the cutoff-valve stem by a set screw; this provides a method of adjusting the tension of the spring. The opening of the cutoff valve is effected by a stationary stop engaging the arm of the cutoff valve, which by the continued advance of the main-valve crank opens the cutoff valve, and also winds up the spring to a stronger tension at each stroke.

To secure the quiet closing of the cutoff valve, an air cylinder is secured to the main-valve crank and vibrates with it. An air-tight piston is fitted to it and connected with the cutoff-valve arm, which in closing confines a portion of the air in the cylinder, the amount being regulated by a pet cock.

In case it is necessary to change the speed of the engine, it may be accomplished by removing weights from the governor, the weights being shown in Fig. 1.

With this understanding of the design of the valves and valve gear the directions for setting the valves are readily followed.

To set the valves of this engine, remove the back bonnet, when two marks will be seen on the main-valve seat. The upper mark is in line with the steam edge, and the lower mark with the exhaust edge of the steam port. Upon the end of the main valve will also be seen two marks, the upper mark being in line with the steam edge, and the lower mark in line with the exhaust edge of the main valve. A mark will also be seen on the end of the cutoff valve and another on its seat. When the marks are together the cutoff valve is just beginning to open. The amount of lap of the two cutoff valves when closed should be about 3/16 inch for a 10-inch and 5/16 inch for a 16-inch cylinder.

To set the main valve, adjust the length of the connection between the main-valve crank, or arm, so that about two-thirds of the total lap of the main valve will be on the steam side and one-third on the exhaust side of the steam port. Then adjust the length of the eccentric rod so that the main valve will travel equal distance each side of a central position. Next place the eccentric 90 degrees back of the crank, with the crank on the center, and move the eccentric in the direction in which the engine is to run, the amount of lap and lead, and secure it in that position.

To set the tripping device, block the governor [illegible] inch high and move the engine over so as to bring the eccentric in its extreme position nearest to the cylinder. Then block up the cutoff crank on the head end of the cylinder, or end farthest from the engine crank, and adjust the trip rod for that end so that it will just trip. Without changing the position of the eccentric adjust the position of the stationary stop on the opposite end, so that the last link will hook onto the cutoff valve arm with a clearance of about 1/16 inch. To set the opposite end, block the governor ¾ inch high, and repeat the operation.

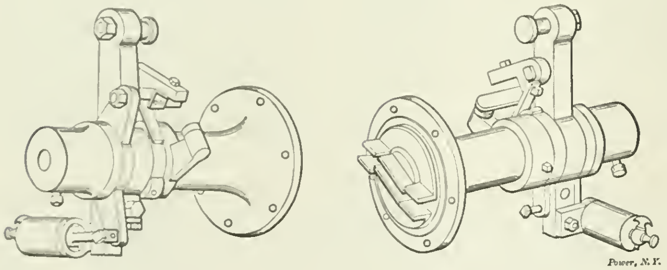

FIG. 3. SHOWING DETAILS OF VALVE GEAR

## The Bethlehem Gas Engines for the Standard Oil Plant

The Standard Oil Company recently purchased from the Bethlehem Steel Company, two 750-horsepower double-acting gas engines, to run on oil distillate gas at the Bay Way refinery, driving alternators in parallel. These conditions have been given considerable study and experiment by C. H. Haupt and Warren H. Miller, the Standard Oil engineers. They have four large gas engines of other make running in parallel at the Philadelphia refineries, the engines being of 550 horsepower, direct-connected to 360-kilowatt 25-cycle three-phase alternators. These engines, after much alteration, run in parallel on distillate gas and do about as well as the average producer-gas 60-cycle plants. The gas is violently explosive, developing about 700 pounds initial pressure per square inch, and is subject to frequent backfires, and to occasional pre-ignitions of such violence as to shear off crank pins 11 inches in diameter and twist the main shafts off short at the revolving field magnets. These disturbances have been of late eliminated by a careful selection of the gases allowed in the power-house gasometer, but, aside from them, parallel operation at Philadelphia is not altogether satisfactory, principally because the governors have the same defect usually found in natural-gas and producer-gas engines driving alternators in parallel—they are too sluggish. If any disturbance occurs, such as a backfire or a premature, the engine has instantly a powerful retarding force imposed upon it. As it is in parallel with the other machines, it cannot easily fall out of step, and the result is that it not only passes its whole load over to the other generators, but itself becomes the recipient of enormous "synchronizing" currents, making it, for the time being, a vast motor dragging on the other engine Its governor is subject to no such ele trical restraint and so it goes right ahe and opens both the air and gas por wide—far too wide to counteract the di turbance. Meanwhile the other engines parallel have had this extra load sudde ly thrust on them, and one of them sure to backfire and create a second di turbance. The original engine, with i governor thrown wide open, gets probab four or five full-charge explosions, a stores most of the energy in the flywhe since it cannot accelerate without draggi the whole plant with it electrically. Tl shows up in the other machines in t form of heavy cross currents which over to them from the temporarily f machine. As the second machine h backfired and is following along with t same sequence of disturbances, the sur ing in the whole plant may be ve violent, and may or may not quiet dow

In order to handle such a gas, the fore, the governor must be very prom powerful and exact, with no tendency overtravel, and sensitive enough to f low promptly and check the various for tending to change the speed. A furt desideratum is to minimize the tende to wire-draw on light loads possessed a mixing valve with ports which gradually closed by the governor as load decreases. We are informed that Bethlehem engines are equipped with governor mechanism which meets th requirements.

In general design the new engine d not differ much from the prevailing t of American large horizontal gas engi The distance piece between cylind however, has been designed with a vi to the easy removal of either the f ward or the rear piston, which in t engine is only a matter of a few ho time. The cylinders are of cast st and the piston is also of cast steel machined all over, inside and out; piston rings are of cast iron.

The governor is positively driven fr the lay shaft, and has a travel of ab 7 inches from full load to no load. T is of advantage in obtaining close reg tion because the selection of the cor position for a given load is much m accurate where the governor has 7 inc to travel over than when it has only inch, or less; a difference of ⅛ inch m or less on either side of the true p tion for a given load will not make m difference in a seven-inch range, whe it makes an enormous difference if whole travel of the governor rod is an inch.

The greatest improvement of Bethlehem engine, however, lies in mixing valve. The mixture is adju by the governor, of course, right at inlet valves of the cylinders. The mi valve is so constructed and contr that the quantity of mixture and the of admission are varied simultaneo the governor to suit varying loads, this by an extremely simple device utting the inlet ports so as to utilize horizontal component to vary the during which the valve is full open. full load the port is open wide and pen during the entire downstroke of inlet valve. At half load it is open ¼ of the time and the opening is ¼ of the maximum at each stroke. ght loads the port is still open con- able, thus avoiding wiredrawing, he time it is open is but a fraction e stroke. The Bethlehem engine is alone in this time feature of the ng valve, as the Westinghouse Ma- Company has lately introduced a ar device, of which the first is on 27x36-inch engine at the Standard rground Cable Company's plant at Amboy, N. J. Here the ports are quare and the time of opening is by eccentrics on a shaft actuated by vernor.

ng the minor improvements in the hem engine may be mentioned a s of pressure lubrication applied to ving parts; means for automatically g the proportion of gas to air from ntral point; and means for varying me of ignition to suit varying pro- ns of mixtures. This latter consists xed plate on which are plotted em- ly these points, and then a slot is assing through the curve of the The end of the timer rod has a nd wing-nut by which it can be at any desired point in the slot. well known, there is a one best f ignition for every possible mix- d the economy resulting from hav- timing and mixture exactly suited worth providing for.

O g to the general simplicity and number of the moving parts, an e in the speed over usual practice en found feasible. The Standard gines are 23½x32 inches and run revolutions per minute. Because rtia stresses increase as the square speed, 150 revolutions per minute n considered the limit for such an with a 40,000-pound flywheel. The ry engine runs at 185 revolutions te with the same cylinders and a flywheel, and it is a very quiet h-running machine.

enerators for the Standard Oil are General Electric three-phase rs, rated at 700 kilovolt-amperes. uency is 25 cycles. In selecting rs of a kilovolt-ampere rating nately equal to the engine horse- he Standard Oil engineers were y the results of long experience rial plant alternators. Their rea- be summed up as follows: The eing far more expensive than the r, the generator should be large o utilize the full capacity of the including overload, without ex- eating. As the engine has a capacity of 20 per cent. overload and the power factor of an industrial plant seldom exceeds 85 per cent., the generator should be fully as large in kilovolt-amperes as the engine is in horsepower or else it will get hot long before the engine gets tired.

With gas engines in parallel a motor-generator exciter is an extremely unstable factor to introduce into the chain of power production, because it fluctuates in unison with the disturbances in the power house at the very time when it should remain fixed and stable. The exciter unit at Bay Way is a 100-horsepower Harrisburg simple engine, direct-connected to a 62½-kilowatt, 125-volt Westinghouse compound-wound dynamo. As an emergency spare there is a 65-kilowatt motor-generator exciter.

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# Too Much Cooling Water on a Steam Condenser

By H. Wiegand

An abundance of cooling water certainly is a desirable asset in an ice plant, as it gives a chance for economy in operating the compressor; but I have noticed an instance where this advantage was turned into a source of loss and trouble. Looking over a well equipped and otherwise well managed 60-ton plant connected with cold storage, I found that the ammonia condenser was placed lower than the steam condenser, and two streams of water were pumped from the adjoining creek. I was further surprised at the amount of water flowing from the steam condenser and, dipping a finger into the stream, found it to be at about blood heat, or well below 110 degrees Fahrenheit. This caused me to do some figuring:

Sixty tons equals 120,000 pounds, requiring about 1000 B.t.u. per pound to be condensed and cooled down to a safe temperature of about 190 degrees, or a total of 120,000,000 B.t.u. per day. Suppose the cooling water enters the condenser at a temperature of 70 degrees and leaves it at 180 degrees, carrying away 110 B.t.u. per pound. It will take

$$\frac{120,000,000}{110} = 1,090,909$$

pounds of cooling water in twenty-four hours. In this condenser it was raised to only 110 degrees, and consequently the distilled water cooled down to about 120 degrees, requiring 1070 B.t.u. per pound or

$$120,000 \times 1070 = 128,400,000$$

B.t.u. per day. The cooling water could be used only through a range of 40 degrees, and

$$\frac{128,400,000}{40} = 3,210,000$$

pounds of it was needed in twenty-four hours, or an excess of 2,119,101 pounds. This quantity of water had to be pumped to a hight of 60 feet needlessly.

Dividing

$$\frac{2,119,101}{1440 \times 8} = 183.8$$

reduces to to gallons per minute. To raise 184 gallons of water per minute 60 feet requires nearly 3 horsepower, theoretically, and as pumps are not economical in steam consumption this might amount to about 500 pounds of coal per day. The distilled water flows from the condenser to the reboiler and needs here, as it has been cooled down 70 degrees more than necessary,

$$120,000 \times 70 = 8,400,000$$

B.t.u. of additional heat. To supply this,

$$\frac{8,400,000}{960} = 8750$$

pounds of live steam will be required, at an expense of about 1100 pounds of coal per day.

The waste of coal due to the excess of cooling water used on the steam condenser counts up to about 1600 pounds of coal per day and must be considered a total loss, as cold storage is connected with the ice plant and all the distilled water from the exhaust steam cannot be frozen. If the overflow from the ammonia condenser could be used and only an adequate amount of it turned on the steam condenser, so as to raise the water leaving it to 180 degrees, a saving of more than a ton a day could be effected.

Water coming from the steam condenser was used for thawing the ice cakes from the cans in two tilting and sprinkling devices. These did not work well, as the sprinkling water was too cold. Eight or nine 300-pound cakes had to be dumped by each outfit every hour, and whenever a can did not release its cake on time the ice pullers would help with kicks, clubs and crowbars. The ice in the storeroom was clear and almost free from cores, but I noticed a number of cakes which showed signs of salt water, due to leaks in the cans which most likely were caused by abuses on the dumping stand.

Considering that this negative result had been obtained at the expense of about one ton of coal a day, it will be evident that the reasonable use of cooling water on the steam condenser is an important item in the management of an ice plant.

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In his forthcoming message, the President will make several definite suggestions for the continuance and extension of the Administration's conservation and reclamation policy. He will recommend relief for some of the projects that have been suspended because of the illegality of the undertakings. His conservation program also will include continued control by the Government of its water-power sites and of the coal, oil and phosphate lands in such a way as to prevent the use of these natural resources by monopolies.

# The Operation of Inclosed Arc Lamps

## Multiple, Series and Series-Multiple Types. Their Construction, Method of Operation, How to Care for Them and Troubles to Be Expected

### BY R. H. FENKHAUSEN

There are six general types of inclosed arc lamps in use, namely: multiple or constant-potential, series or constant current and series-multiple or power circuit lamps, all three types being made for operation on either direct or alternating-current circuits. The type of lamp selected will naturally be governed by the current available, but owing to the superior efficiency and illumination given by direct-current arc lamps, their use is advisable wherever continuous current is available.

The principal difference in the various types of lamp above mentioned is in the coils and resistances, and several of the large manufacturers have so designed their various types of lamp that one type may be converted to another, simply by the substitution of a few interchangeable parts.

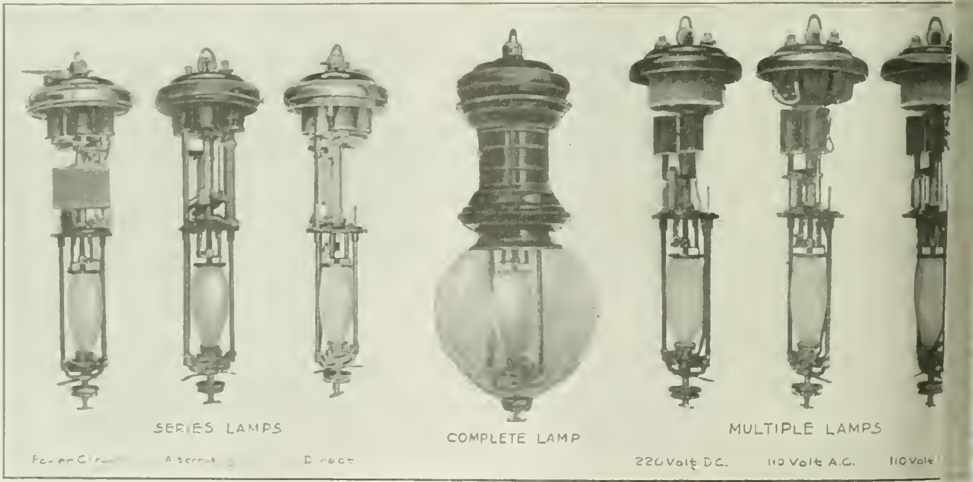

FIG. I. TYPES OF INTERCHANGEABLE LAMP MECHANISM

The direct-current multiple lamp is shown diagrammatically in Fig. 2 and the alternating-current multiple lamp in Fig. 3. The principal differences between direct- and alternating-current lamps are in the resistance, magnet coils and armature. The direct-current lamp has ohmic resistance for regulating the arc voltage, the armature is solid and the coils usually wound on metallic spools. The alternating-current lamp has a reactive coil for its voltage adjustment, by which the lamp may also be adjusted for use on either 60- or 133-cycle circuits; its armature is laminated and the magnet coils are wound on nonmetallic spools, for reasons which will be explained later on in this article.

### The Multiple Lamp

This type has but one magnet coil, which is connected in series with the arc, and the operation of this lamp is as follows: When the current is first turned on, the magnet coil is energized and attracts its armature, which rises, causing the clutch C to raise the upper carbon and strike the arc. The carbon continues to rise and the arc to lengthen until sufficient resistance is introduced into the magnetic circuit, to so weaken it that it cannot cause further separation of the carbons. The mechanism remains in equilibrium until the consumption of the carbons by the arcs lengthens the arc still further, weakening the magnet and allowing the armature to drop until the former current value is reached. The armature continues to lower the carbon as it burns away until the limit of its travel is reached; the arc will then be broken, the armature will drop and the arc be reestablished just as it was when the current was first turned on. This cycle of operation occurs once in every ten or fifteen minutes and is the cause periodical "jump" given by arc la

### Series Lamps

The direct current series lan shown in Fig. 4 and the alternatin rent lamp in Fig. 5. The series operates on a constant-current and the length of the arc can the have no effect on the magnet st which is proportional to the turns coil times the amperes, both of quantities are fixed. The series therefore has a series coil tend separate the carbons, and in addi fine-wire shunt coil connected ac arc and opposing the series co

When the current is turned carbons are in contact and the sh short-circuited, which allows th coil to attract its armature and th to raise the upper carbon and st arc. As the carbons are separa drop across the arc increases, ening the shunt coil until at th point the pulls of the opposite c ance each other, and the mecha mains in a state of equilibrium the consumption of the carbon l the arc, the shunt coil overpow series coil and brings the carbo together until the former lengt

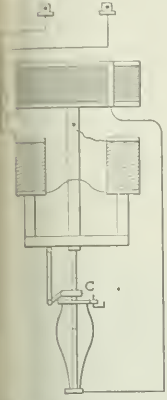

FIG. 2. RECT-CURRENT MULTIPLE LAMP

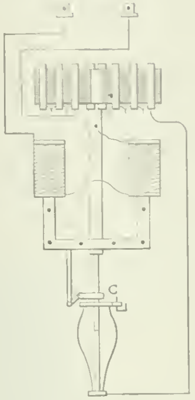

FIG. 3. ALTERNATING-CURRENT MULTIPLE LAMP

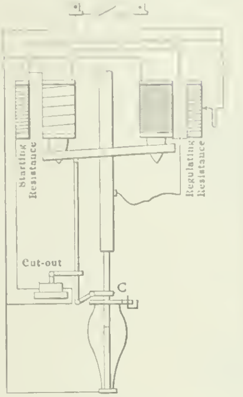

FIG. 4. DIRECT-CURRENT SERIES LAMP

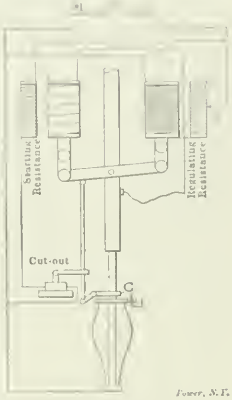

FIG. 5. ALTERNATING-CURRENT SERIES LAMP

is reached. The shunt coil continues to fe the carbon until the limit of travel e armature is reached, at which the arc is broken and reestablished re. All series lamps must have a t-t device which short-circuits the n case of trouble and thus pre- terruption of the circuit.

### THE POWER-CIRCUIT LAMP

power-circuit lamp the same as the series e main difference being that the t does not short-circuit the lamp, itches in a resistance instead, lds the current value constant other lamps in circuit. These re used whenever it is necessary rate two lamps in series on 220-, 440-, or five on 550-volt con- ential circuits.

n lamps must be operated in series tant-potential alternating-current this is best accomplished by rnating-current multiple lamps ation with a three-, five- or six- transformer.

### POINTERS ON INSTALLATION

A ating-current lamps may be con- to the circuit without regard to . as both carbons are consumed same rate and burn to similar Fig. 6. The carbons of direct-cur- imps are consumed at different rates he positive being consumed twice as fast as the negative, and burning to a crater like end, whereas the negative burns to a point, Fig. 7. Direct-current lamps must therefore always be connected so that the upper carbon will be positive; otherwise the carbon holder is liable to be destroyed due to the abnormal consumption of the lower carbon, and the formation of a crater thereon will result in most of the light being reflected up against the ceiling instead of down where it is needed. Where means for determining the polarity of the circuit are not at hand, place the two lines in a glass of salt water. The largest number of bubbles will arise from the negative wire.

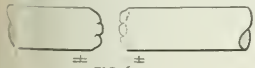

FIG. 6

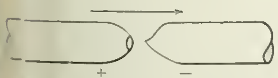

FIG. 7

Arc lamps should have an insulator on the suspension wire in addition to the one at the top of the lamp, and each lamp should be protected by an inclosed fuse of the proper capacity when used on constant-potential circuits. If dependence is placed on the main fuse supplying a large group of lamps, it is possible for one lamp to be completely destroyed without the fuse blowing. Two approved methods of arc-lamp suspension are shown in Fig. 8.

### CARE OF LAMP

The successful operation of an arc-lamp installation lies largely in the hands of the trimmer, as there are many little details which will cause trouble unless carefully attended to. The inner globe must be carefully cleaned at each trimming and inspected for nicks or cracks, because the arc is supposed to burn in a practically air-tight inclosure and even a small leakage of air will materially decrease the life of the carbons and also make the operation of the lamp noisy. This is best shown by the fact that a lamp having 150 to 200 hours' life with an inclosing globe, will burn out in about ten hours without it.

All globes are ground where contact is made with the gas check plate, but if this plate is not cleaned at each trimming, dirt will soon prevent the globe from making a tight joint. In lamps having an open base inner globe, it is unnecessary to remove the globe from the lower holder when trimming the lamp, but if the globe is removed a new asbestos washer should be placed under the globe to insure a tight joint at the bottom. In lamps having closed base inner globes, and fitted with bails, care must be used and these should be carefully on the globe and without too much pressure; otherwise the globe will crack as soon as it heats up.

Only the best grade of carbon should be used and these should be carefully inspected, and all showing hard spots, blisters, crooked places or other inequalities, rejected. Direct-current lamps use solid carbons, but alternating-current lamps use one cored and one solid carbon, the short stub of the upper carbon forming the lower carbon for the next run in all types of lamp. Each manufacturer of arc lamps sends full instruc-

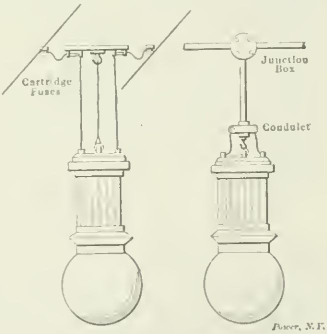

FIG. 8. METHODS OF SUSPENDING LAMPS

tions for the operation of his lamp with each shipment, and these instructions should be carefully followed, particularly as regards the proper length of carbons to use. Too long a lower carbon will result in burning of the gas-check plate, due to the abnormal hight of the arc, and too short a lower carbon or too long an upper carbon will result in the destruction of the lower carbon holder unless noticed in time.

Carbons should be firmly screwed into the holders, especially in alternating-current lamps, for the vibration may loosen them enough to allow their slipping through the holders and resulting in serious damage to the lamp.

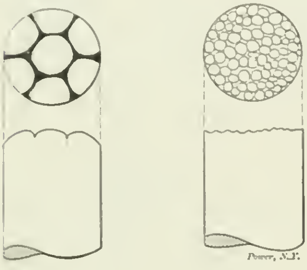

FIG. 9 FIG. 10

CARBONS

When the arc reaches a hard spot in the carbon, the arc will shorten and the carbons will give off sulphurous smoke which will stain the inner globe a dirty brown. Figs. 9 and 10 show enlarged views of the ends of good and hard carbons. The good carbon will burn to a little group of seven convex pads, having a dull appearing surface, but the hard carbon will burn into innumerable little pits, and the surface will be glossy and of a metallic tinge due to the impurities. This condition is not as noticeable on direct- as on alternating-current lamps, and it is to the latter that the above description refers.

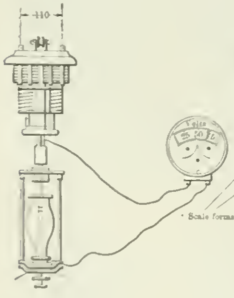

FIG. 11

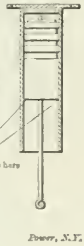

FIG. 12

The globe equipment of a lamp will naturally be governed by its location, but for general use the light opal inner globe is used, an opal outer globe being added for indoor service, and a clear outer globe, either with or without reflector, for out of doors.

## Troubles Common to the Arc Lamp

Most of the troubles encountered in the operation of inclosed arc lamps will be found due to improper adjustment, badly fitted globes, poor carbons or loose dashpots and defective clutches. Before installation all arc lamps should be adjusted for the proper arc voltage. This usually is from 70 to 75, and should be measured directly across the arc, as shown in Fig. 11, no reading being taken until the lamp has burned at least ten minutes to allow the carbons to burn to shape.

The dashpot is to keep the arc steady under sudden voltage fluctuations, and also to prevent the lamp from "jumping" violently when first turned on. Dashpots are made in both the compression and vacuum types and are one of the greatest sources of trouble in an arc lamp. They should be wiped with a clean dry rag occasionally and never given the slightest particle of oil under any circumstances. If a lamp "jumps" and cannot be stopped by extinguishing and relighting, the dashpot should be removed, wiped clean, and the little check valve inspected. This will probably be stuck and should be cleaned in gasolene, but if the valve is all right, the piston has probably worn loose and a new one should be supplied.

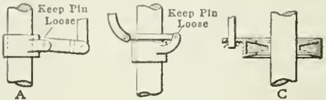

FIG. 13. TYPES OF CLUTCH

In blacksmith shops, foundries, etc., where arc lamps are burned only for overtime work but must be kept ready for immediate use, it is a good idea to light each lamp every day and allow it to burn for one or two minutes. This will prevent the gases from the fires forming scale on the mechanism to interfere with its operation. The dashpot especially is benefited by this system, as any scale forming inside the cylinder will be wiped out daily by the piston, before it has a chance to harden and prevent its motion, see Fig. 12.

Another source of trouble is the clutch, several types of which are shown in Fig. 13. Two-part metal clutches are shown at *A* and *B*, and the porcelain washer type at *C*. If the two parts of the metal clutch do not operate freely, due to dirt or to burning caused by the breaking of the upper carbon lead and the consequent carrying of current by the clutch, the carbons may fail to separate, and as a result the lamp will burn out. The porcelain washer clutch is not subject to this trouble, but is often broken when a defective dashpot causes severe "jump g" of the lamp.

Trouble from the windings burning out is steadily decreasing, due to the us of asbestos-covered wire or edgewise-w l coils with fireproof insulation, and n makers guarantee their lamps will burn out even with the carbons cla together.

The coils of alternating-current l p are always wound on insulating sp which become brittle if the coil burn and cannot be rewound. If the r man does not understand some about alternating currents, he is liab replace the original spools with ones, which would act as a short-circ secondary to the coils and generate cient heat to burn them out in a short time.

Arc lamps should not be relighte mediately after they have been guished, unless it is absolutely nece as an explosive mixture often exis the globe a few moments after the is extinguished, due to the mixtu gas and air. The writer has noted s instances in which every inner glol the circuit has been shattered fron cause.

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We have received from the Wisc Engine Company a bulletin devot Heavy Duty Corliss Engines of Belted Type, which describes their put in this line in such detail tha engineer who has one will thoro understand how his engine is pu gether and what it looks like when The bulletin is handsomely print two colors upon supercalendered and in addition to the finely illus description of their engine contains power tables; tables giving the dimensions of horizontal, simple, ta and cross-compound heavy-duty en for belted service, rules and formul finding approximate size of com engines, indicated horsepower of a gine for direct-connected electric erator, condensing water, etc. Th letin is inclosed in a heavy "cloister" cover of artistic desig clever execution so arranged as t ceive additional numbers of the b and with broad white spaces upo binding to permit the possessor to it with his individual filing mark. be sent gratis to engineers and thos are really interested in the pur placing and operation of steam engi

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It is said that there are two indepe nt investigations of the explosion a the Pabst brewery in progress: One l the Hartford Steam Boiler Inspectio and Insurance Company, which carrie the risk, and the other by the mayor pon the request of the engineers' associ ons of Milwaukee.

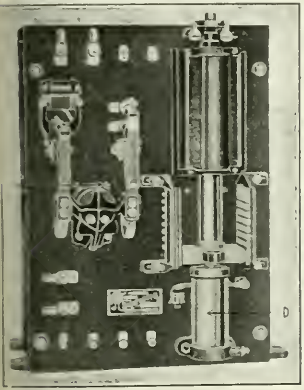
# Controllers for Electric Elevators

## Mechanical Control Apparatus with Automatic Motor Starter. A Complete Explanation of Its Operation and Wiring Connections

### BY WILLIAM BAXTER, JR.

### ONTROLLERS USED WITH HAUGHTON MECHANICAL CONTROL ELEVATORS

The controllers shown in the halftone strations of Haughton elevator maines last described are not all of the e design. One of them (shown in 31) is the same as that which was wn in Fig. 22 in connection with the description of the Nock & Garside single-belt elevator machines; this controller is built by the J. L. Schureman Company, Chicago. The controller shown in the illustration of the hack-geared machine (Fig. 32) is the type that is generally used at the present time by the Haughton company with all mechanically controlled machines. This is also a Schureman apparatus, and its appearance is better shown in Fig. 56, illustrating the rheostat switch and the main-line switch, both mounted on one slate panel, and Fig. 57, illustrating the reversing switch. This latter switch is so constructed that when it is thrown to either one of the running positions it is firmly locked and cannot be jarred out of position. The way in which the locking part of the apparatus works will be clear from an inspection of the drawing Fig. 58. This drawing shows the switch lever to consist of two separate parts attached to the casting *E*. Each one of these parts carries contact brushes that lap over from the outer contacts *A* to the inner ones *B*, and the two brush mounts are thoroughly insulated from the central portion *L*.



56. MAIN AND STARTING SWITCHES

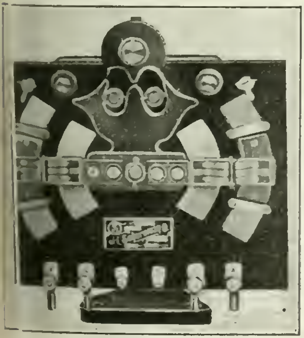


FIG. 57. REVERSING SWITCH

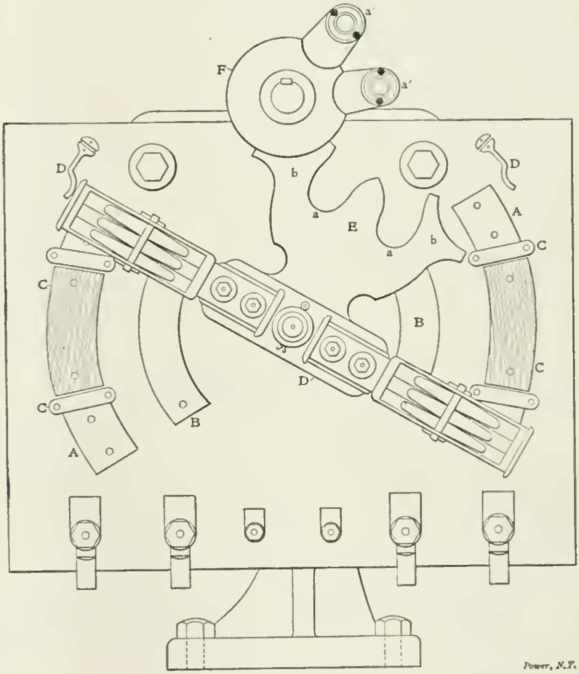


FIG. 58. DETAILS OF REVERSING SWITCH CONSTRUCTION

The switch is moved by the rotation of the disk *F*, which carries on the ends of two arms, rollers *a'* that work into grooves *a a* in the casting *E*. When the switch is in the central, or stop position, as in Fig. 57, the rollers *a' a'* rest in the grooves *a a*. When *F* is rotated by the sprocket-wheel connection with the operating sheave shaft, as was shown in Fig. 32, one of the rollers *a'* swings the switch lever into the position in which it is shown in Fig. 58, and the continued rotation of *F* carries it into the position shown, where it fits into the curved end *b* of the casting *E* and locks the switch in the running position. To throw the reversing switch lever *L* into the running position does not require a very great movement of the disk *F*, but, as can be seen from the drawing, the disk *F* can be rotated as far beyond this point as may be desired without injuring the switch in any way. This relieves the switch lever *L* from liability to strains by jamming it against a stop.

For the motor to start, it is necessary

[illegible] contact. When the current is to be stopped the lever T is moving from the running to the off position it first breaks the contact at B, and then the main line switch M opens and cuts the current off from the motor. This cutting off of the current through the motor also breaks it because the reversing switch, so that when the brushes arrive on the ends of the large J some of the contacts A A, there is no current flowing, and there can be no spark. All the sparking occurs at the contacts of the main line switch, and these are made of carbon and copper, that is, a carbon contact against a copper contact.

The rheostat switch consists of a solenoid magnet, the plunger of which raises a crosshead carrying contact brushes which slide up between two rows of contacts, and, as they move upward, gradually cut out the starting resistance in the armature circuit. The velocity which this plunger moves upward is co trolled by the dashpot D in Fig. 56. Wh the rheostat switch has moved to uppermost position and has cut out the starting resistance a stem projecti upward from the upper end of t solenoid plunger opens a switch, there cutting a resistance into the circuit of t solenoid coil. At about the same ti another projection on the crossh strikes and opens a switch that cuts high resistance into the circuit of t main-line switch magnet M, thus red ing the strength of the current that pas through these magnet coils while the e vator is running. The current requi to hold the switches in the running p tion is much less than that necessary move them to it, and advantage is tak of this fact to economize current by troducing the resistances after switches have reached the running p tions. There is also an interlock mechanism between the main-line sw M and the rheostat switch of such kind that when the rheostat switch is in the lowest position, the main switch cannot be closed, even if curr passes through its magnetizing coil. T interlocking device is provided so that motor cannot be put in circuit unless

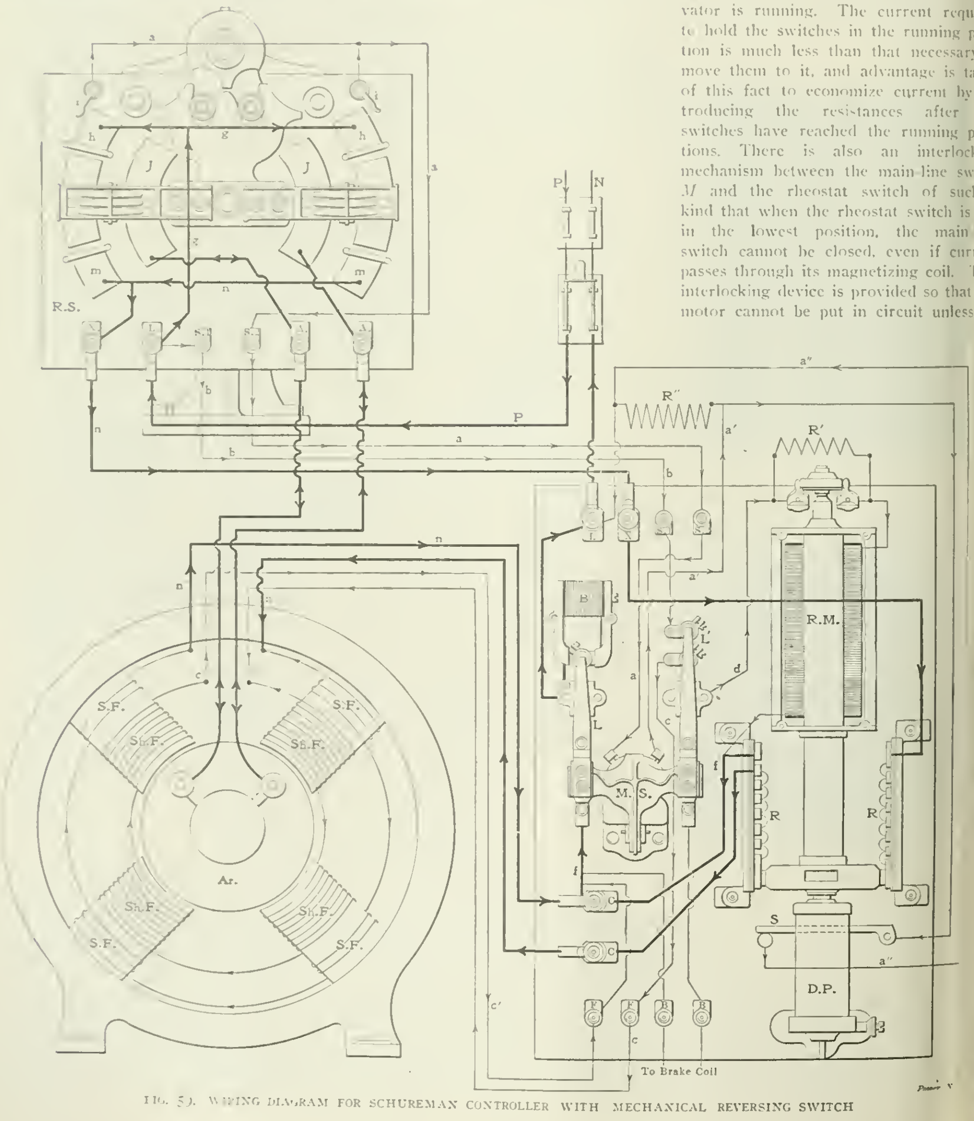
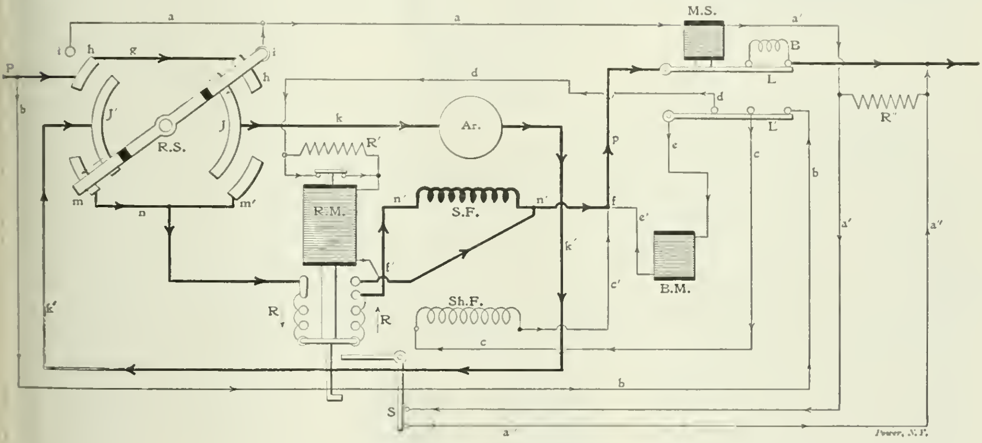


FIG. 59. WIRING DIAGRAM FOR SCHUREMAN CONTROLLER WITH MECHANICAL REVERSING SWITCH

starting resistance is in the armature uit.

All the wiring connections between the tor, the controller and the line are ly shown in the diagram, Fig. 59, and the purpose of facilitating the study it, the direction of the current in each the wires is indicated by arrow heads. all the wires, except those that con- t the reversing-switch contacts *J J'* the armature, the current always ws in the same direction, but in the ture connections it flows in one di n for forward rotation and the re direction for backward rotation; , on these wires the arrow heads are wn to point in both directions.

r the purpose of avoiding any diffi- that may be experienced in tracing he connections in this diagram a ied wiring diagram is presented in 60. In this drawing the switches their actuating magnets, as well as rmature and the field windings, are sented diagrammatically to show action more clearly, and located so simplify the wiring connections as as possible. All the switch contacts vers, and all the wires are marked ame as in Fig. 59, so that the simpli- gram is a key to the other one. reversing switch lever is shown in f the running positions, and it will ticed that the current from the line *P* passes through the wire *g* to the t *h* and thence through the switch to the contact *i* and the wire *a*; gh the magnet of the main-line h to the wire *a'* and on to one of the cts connected by the switch *S* and gh this to the wire *a''* and to the vire *N*. Unless this circuit is closed, ain-line switch levers *L L'* will not ised, and the circuit will not be closed through the motor, so that the latter will not start up.



Power, N.Y.

FIG. 60. SCHEMATIC DIAGRAM CORRESPONDING TO FIG. 59

In stopping, as already explained, the circuit is opened only at the main line switch, and the sparking all takes place at the contacts on that switch. The sparking there is reduced to a very small degree by the action of a magnetic blowout that in the diagram is indicated at *B*. When the motor is running no current flows through the blowout coil, but in the act of stopping, the end contact separates from lever *L* first, and from this instant until the other contact separates there is a current through coil *B* and this develops the magnetic flux that blows out the spark. In the actual switch the arrangement of contacts is not exactly as described, but the action is the same.

This diagram also shows the magnet that actuates the brake, at *B M*. In Fig. 59 no brake is shown, but the binding posts to which the wires coming from the brake magnet are to be attached are shown at the bottom of the rheostat panel board.

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The "Beagle," which is the first of 16 torpedo-boat destroyers in the British naval program for 1898-9, has just been launched at the yards of John Brown & Co., Clydebank. The "Beagle" is 269 feet long, 27 feet broad, and 16 feet 6 inches deep. She is propelled by turbine machinery of the Parsons type actuating three lines of shafting, and designed to develop 12,000 horsepower. Steam is provided by five large water-tube boilers fitted for burning coal only. The trial speed is to be 27 knots and the displacement 920 tons.

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The American Society of Agricultural Engineers will hold its third annual meeting December 28-29, 1909, at Ames, Iowa.

## Primer of Electricity

### THE ELECTROMAGNET

If you take a common wooden spool that has contained sewing thread, put a soft iron rod through the hole in the center and wind insulated wire on the spool where the thread originally was, you will have a crude electromagnet. Fig. 13 illustrates this arrangement. Now, take a longer piece of soft iron rod and bend it into the shape of the letter U, as indicated in Fig. 14; wind insulated wire on two thread spools and put them on the legs of the U, and the result will be what is commonly called a "horseshoe" electromagnet (see Fig. 15); the two coils of wire must be connected to each other in such a way that when current is passed through the coils, it will pass around one leg in one direction and around the other leg in the opposite direction. If the rod be very soft, such as a good grade of machinery steel, the magnet with two coils will be quite powerful when current is passed through the wire.

The piece of iron or steel surrounded by the spool or spools of an electromagnet is called the "core" of the magnet, merely because it is the central part, just as an apple core is the central part of an apple. The two ends of the magnet core are its "poles," no matter whether the magnet be of the horseshoe type shown in Fig. 15 or of the straight type shown in Fig. 13. The reason for this name is the same as that for calling the northernmost point of the earth the "north pole" and the other extremity of the earth the "south pole;" because at these points the "magnetism" comes to a focus, so to speak. (The north pole of the earth is not really the magnetic [illegible] when it was [illegible] it was supposed that it was.)

Magnetism is intangible and invisible, and its characteristics have been ascertained through years of experimentation and the theories now used to explain its cause and effects are largely arbitrary. Thus, magnetism itself is called a "flux," although it is nothing of the sort, simply because it is easier to consider its effects and because it behaves just as a flux would under corresponding conditions. The unit of magnetic flux is called the "magnetic line of force," which means that a mechanical force is set up by the magnetism along a line in space which is regarded as the path of the magnetic "line of force." This is not easy to grasp, but for practical everyday working with electrical machinery it is not necessary to go deep into the matter. Fig. 16 will probably give the reader as much information about magnetic lines of force as he needs. This represents a coil of wire through which a current is supposed to be flowing from the battery, dynamo or other source, at *E*. The dotted line represents one line of force set up through the coil by the current; this "line" completes a circuit outside the coil, as indicated, it being impossible to form a magnetic line of force with free ends. The current in the coil produces a magnetic pressure inside it which causes these invisible magnetic lines of force, and each of them follows a closed circuits, as represented by the single dotted line in the drawing.

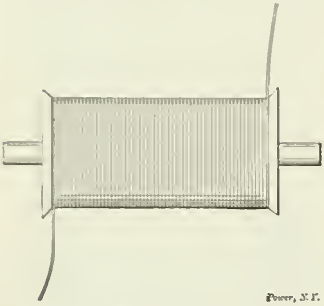

Power, N.Y.

FIG. 13. SIMPLEST FORM OF ELECTROMAGNET

Instead of one line, as shown in Fig. 16, the hole through the center of the coil is filled with magnetic flux, the number of lines of force depending on the size of the hole and on the strength of the current flowing through the coil; the number of times that the current circulates around the coil also affects the magnetic flux. The number of convolutions of wire in the coil multiplied by the current in amperes is called the "ampere-turns" of the winding, and this is the measure of magnetic pressure set up within the coil. With a simple coil, minus a core, as in Fig. 16, the magnetic flux will be exactly proportional to the ampere-turns of the coil. For example, if the coil contains ten turns of wire and a current of 50 amperes is passed through it, this will give a magnetizing force of 500 ampere-turns; now, if this produces a magnetic flux of 5000 lines of force, increasing the current to 100 amperes will produce a flux of 10,000 lines of force, because the magnetizing force has been doubled. This holds good as long as the flux passes through air only. When it passes partly through iron and partly through air, as in Figs. 13 and 15, the flux will not always increase in direct proportion with increases in the magnetizing force of the coil, because iron and steel offer varying resistance to the flux, according to how much flux there is. This will be explained more at length later.

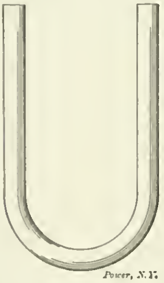

Power, N.Y.

FIG. 14. THE "HORSESHOE" MAGNET CORE

Referring again to Fig. 16, suppose that the hole through the center of the coil was of such a diameter that the area of the circle described by the inner edge of the wire was exactly 1 square inch; then the cross-section of the path followed by the magnetic lines of force within the coil would be 1 square inch, and if there were 5000 lines, the "density" of the flux would be 5000 lines per square inch; it is easier to reckon magnetic effects on the basic of flux density than total flux, because the density is proportional to the magnetizing force in ampere-turns, when there is no iron or steel included in the magnetic circuit.

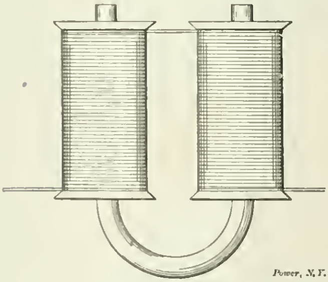
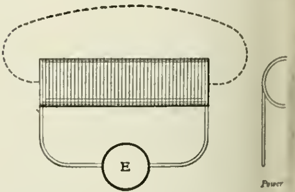

Power, N.Y.

FIG. 15. SIMPLE HORSESHOE ELECTROMAGNET

Thus, if 500 ampere-turns produced a density of 5000 magnetic lines of forc per square inch within a coil having ½-inch hole through it (and no core it would produce exactly that same den sity inside of a coil having a 3-inch ho through it, if the two coils were of tl same length from end to end. The ex planation of this is that magnetic flu follows a law exactly similar to th which applies to an electric current: tl flux produced by a given magnetizi force in ampere-turns depends entire on the magnetic resistance of the pa along which the flux "passes." This ma netic resistance is called "reluctance," a it varies directly with the length of t path, just as electrical resistance vari with the length of the conductor, a varies oppositely to the area of the pa just as electrical resistance varies c positely to the area of the conductor.

The path of magnetic flux produced a simple coil like that in Fig. 16 so wide outside the coil—consisting the whole universe—that it is not co sidered at all; only the path within coil need be considered in discussing effect of the ampere-turns in the c If the coil is 1 inch long and the c rent is such that the magnetizing fo is 3133 ampere-turns, the density of flux within the coil will be 10,000 li per square inch of path cross-secti that is to say, the reluctance of an path is 0.3133 per inch of length when cross-section is 1 square inch, if the a pere-turn be considered the unit of m netic pressure or magnetizing force; the cross-section of the path is no square inch, then the reluctance per i of length is 0.3133 ÷ the cross-sect in square inches or parts of a square i

The following examples will help to these rather complicated relations in e reader's mind. If a coil is 6 inches l and the hole through the center is



Power

FIG. 16. ILLUSTRATING THE MAGNETI CIRCUIT

inch in diameter, the area of the will be 0.15 square inch and the reluct e of the magnetic path will be

$$\frac{6 \times 0.3133}{0.15} = 12.532.$$

If the coil contains 4700 turns of wire, a current of 6 amperes in the oil will produce a magnetic flux within he coil of

$$\frac{28{,}200 \textit{ amp.-turns}}{12.532 \textit{ reluctance}} = 2250$$

lines of force; and as the area of he

ath inside the coil is 0.15 square inch, ie magnetic density will be

$$\frac{2250}{0.15} = 15{,}000$$

ies per square inch.

Now suppose another coil of the same imber of turns and the same length ere wound to such a diameter that the ıle in the coil was 7/8 inch instead of 16 inch in diameter. Evidently the ea of the path would be four times as eat as in the first coil and the reluctance ould therefore be one-fourth as great; isequently the same current of 6 amres would produce four times the flux it it did in the smaller coil, but as the th area is four times as great, the magic density will be the same as before. tting it in figures, the reluctance of larger coil will be

$$\frac{6 \times 0.3133}{0.6} = 3.133,$$

l as the ampere-turns are 28,200, as ore, the magnetic flux will be

$$\frac{28{,}200}{3.133} = 9000$$

l of force. The area of the path is 0 square inch, so that the density in t case will be

$$\frac{9000}{0.6} = 15{,}000$$

li per square inch, or exactly the same a the smaller coil.

both of these cases, the amperets were 28,200 and the length of the rericted path (that portion inclosed by th coil) was 6 inches; the magnetizing foe per inch length of path, therefore, w 28,200 ÷ 6 = 4700 ampere-turns. In b cases, also, the magnetic density was 15 0 lines per square inch, although the t fluxes were different. From this it wi be clear that, for a magnetic path in r, the relation between magnetizing i in ampere-turns and magnetic denit per square inch area of path is

$$\frac{\textit{Ampere-turns}}{0\;33 \times \textit{path length}} = \textit{Magnetic density},$$

the ath length being measured in inches an the density being the number of li per square inch area of path. If it desired to know how much magnet g force is needed to produce a certn density, the formula is transposed t ad

$$3133 \times \textit{path length} \times \textit{magnetic density} = \textit{ampere-turns}.$$

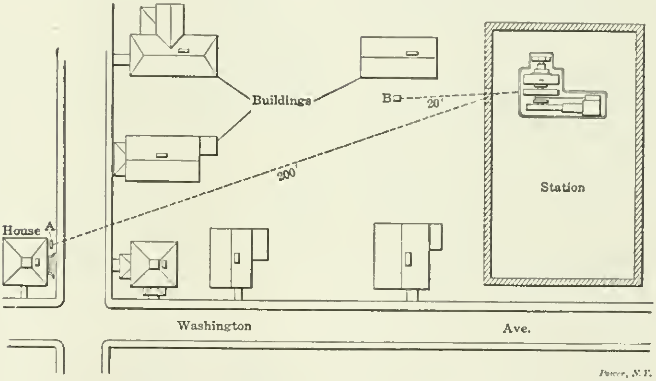
T Engineers Exchange, 413 West Fay e street, Baltimore, Md., pursuant t t plan of making the organization f nefit to its members, has arranged t r series of interesting and instructive lectu s to be delivered on each Monday nigh during the month of November. Thes lectures are free to members and frien .

# Flywheel Explosion at Scranton

By Charles J. Mason

At 6:45 o'clock on the morning of November 2, a flywheel exploded in the Washington avenue power plant of the Scranton Electric Light Company, injuring the night dynamo tender, who was just about to turn the watch over to the day man, and damaging the building and nearby machinery to the extent of several hundred dollars. The flywheel belonged to a 50-horsepower exciter set consisting of a 10x12-inch Fleming engine direct-connected to a Bullock generator, with a speed of 275 revolutions per minute. The dynamo was a 125-volt direct-current machine, generating 320 amperes.

The flywheel was 5 feet in diameter, with a 10-inch face. At the time of the explosion the rim of the wheel broke in several pieces. One of these pieces weighing about 100 pounds was blown through the 18-inch brick wall of the station, making a hole about 18 inches in diameter and landing a distance of 20 feet outside the station wall. A larger piece flew through the roof of the station, making a rent about 10 feet in length and 2 feet wide. In its flight it passed between two nearby houses, and after bringing down a couple of wires strung on a street pole landed on a grass plot just inside a picket fence. The fence was smashed and the piece of metal partially buried itself in the sod, leaving about 6 inches protruding above the surface of the lawn. Had it traveled but 10 feet farther, it would have crashed into a house directly in its path and probably would have injured some of the inmates. The distance from the engine to the lawn is about 200 feet. In the station the steam pipe supplying the engine was carried away, and several wires were cut through by the flying fragments.



PATHS FOLLOWED BY THE FRAGMENTS OF THE WHEEL

At the present writing it is not known what caused the wheel to explode, but it is thought by some that a short-circuit "plugged" the generator and the flywheel kept on going. Others think that the engine tried to race and that the governor failed to respond quickly enough.

The wheel had six spokes elliptical in cross-section, and four of these broke off at the hub; the other two breaking about the middle. The hub remained on the shaft, and as far as could be seen no cracks or flaws were present, but the metal showed a very coarse structure. Two pieces of the wheel, smaller than those previously mentioned, were found, and these showed blowholes in the casting.

# Massive Gas Engines

The Snow Pump Works, Buffalo, have just completed the last casting for 24 gas-engine frames of 115 tons each, which are building for installation at the Duquesne and Youngstown plants of the Carnegie Steel Company and the South Chicago plant of the Illinois Steel Company.

These engines are all twin-tandem, double-acting, and 3600 horsepower. Six of the lot are equipped for power service, and six are fitted with blowing apparatus. The blowing engines weigh about 2,000,000 pounds, and the power engines about 1,700,000 pounds.

The flywheels weigh 180,000 pounds each and are made in eight segments. The cylinders are 43 inches in diameter and 60-inch stroke and are of cast steel. The cranks, two on each shaft, weigh 25,000 pounds, and each crankshaft 100,000 pounds.

Harrington Emerson is authority for the statement that a firefly converts the hydrocarbon of its food into light with an efficiency of 40 per cent., while rarely is as much as 10 per cent. of the energy of coal transformed into electrical energy.

# Practical Letters from Practical Me

Don't Bother About the Style, but Write Just What You Think,
Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

## Water Level in Boilers

In order to determine what effect, if any, the level of the water in a boiler has upon the quality of the steam given off by the boiler, the writer made the following simple experiment.

The boiler upon which the experiment was performed, was a 30-inch by 11-foot return-tube type, having neither steam dome nor dry pipe. The apparatus used consisted of a throttling calorimeter connected to the main steam pipe near the boiler in the usual manner. A scale was placed back of the water column so that the hight of the water could be determined.

The boiler was filled to within two or three inches of the top. The water was then shut off, and the boiler allowed to steam for a few minutes so that the temperatures could become constant. Readings were then taken from the calorimeter and the water column every four minutes. This was continued until the level of the water in the boiler had fallen about seven inches lower than it was when the experiment was begun.

The moisture in the steam was then calculated for each reading. From the results shown below it will be seen that the level of the water in the boiler had no effect whatever upon the quality of the steam.

In the near future the writer expects to make some experiments in order to determine what effect the rate of steaming has upon the quality of the steam given off by the boiler.

HERBERT B. REYNOLDS.

Ithaca, N. Y.

DATA AND RESULTS.

| Time. | Pressures. |  | Temperatures. |  | Water Level. Inches. | Moisture in % in Steam. |
|---|---|---|---|---|---|---|
|  | Steam. Pounds. | Calorimeter. Inches of Mercury. | Steam. | Calorimeter. |  |  |
| 5-02 | 63 | 0.5 | 308 | 256 | 26.6 | 0.992 |
| 5-06 | 66 | 0.5 | 310 | 261 | 25.7 | 0.992 |
| 5-10 | 66 | 0.5 | 310 | 263 | 25.0 | 0.994 |
| 5-14 | 66 | 0.5 | 310 | 264 | 24.4 | 0.994 |
| 5-18 | 68 | 0.5 | 311 | 264 | 23.6 | 0.994 |
| 5-22 | 67 | 0.5 | 310 | 264 | 23.0 | 0.994 |
| 5-26 | 70 | 0.5 | 313 | 266 | 22.3 | 0.994 |
| 5-30 | 69 | 0.5 | 312 | 266 | 21.7 | 0.994 |
| 5-34 | 69 | 0.5 | 312 | 266 | 21.0 | 0.994 |
| 5-38 | 69 | 0.5 | 312 | 265 | 20.5 | 0.994 |
| 5-42 | 69 | 0.5 | 312 | 265 | 20.0 | 0.994 |
| 5-46 | 68 | 0.5 | 311 | 266 | 19.5 | 0.995 |

Reading of Barometer, 29.58".

## Veteran Engineers at the Columbus Convention

At the national convention held at Columbus, nothing gave me so much real pleasure as the remarkable number of members of the N. A. S. E. in attendance who have passed the three-score mile stone of life's journey. I can not say that I met all of the veterans who attended the convention, but feel a sense of pride to know that I was fortunate enough to meet and grasp the hand of the following veteran brothers:

Thomas Winship, age 78 years, of Toledo, O.; district examiner of engineers of the second district of the State of Ohio.

Uncle Jim Beckerleg, age 76 years, of Chicago; member of the N. A. S. E. for 27 years, first national treasurer, served two terms as national president, also president of the Life and Accident department since its organization; has attended all national conventions.

C. M. Janes, age 71 years, financial secretary Boston No. 1 and also the oldest living member of the N. A. S. E. in Boston.

William Tompkins, age 73 years, member No. 28 of Yonkers, N. Y.

William H. Cronley (Bill Taft's double), age 70 years, of Jersey City; at present holding down the position of chief engineer at city hall of his city; has not only been an active operating engineer during the past 47 years but has attended 24 of the national conventions.

Harry Knowlton, age 70 years, of Detroit, Mich.; has attended 25 of the national conventions as a representative the Hartford Inspection and Insuran Company.

Reinhard Baumgarten, age 70 years, Kentucky No. 2; past president of Ke tucky State association; has attended national and five State conventions, a is the oldest living member of the N. S. E. in his native State.

E. Caldwell, age 70 years, of Phi delphia, Penn.; member of No. 12 Pennsylvania; has been interested in gineering organizations during the p 41 years, a member of the N. A. S. for 19 years and has attended six tional conventions.

James G. Dallas, age 69 years; mem of Sharon No. 6 of Pennsylvania; been a member of the N. A. S. E. for years and has attended 15 convention

A. Brogden, age 66 years, a cha member of Oshkosh No. 9 of Wiscons has been an active operating engin for 45 years and attended four of national conventions.

F. E. Brammer, age 64 years, mem of Ironton No. 17 of Ohio; delegat the Ohio State convention and at pre employed as superintendent and c engineer of the Ironton city water w

O. W. Cutler, age 63 years, hono member of Niagara Falls No. 37 of York.

George A. Barbee, age 61 years, m ber of Ohio No. 38; for 24 years c man of the Ohio State license law c mittee, and familiarly known as father of the engineers' license law in State of Ohio.

Worth Park, age 61 years, membe Ohio No. 38; has served his ass tion as secretary during the past six y

I also met a Mr. Rolf, age 61 years was called away at the moment and not meet him again during the con tion, and am unable to give his add

Should not this remarkable showin these old veterans awake the you members of our beloved organizati a just sense of duty, that they owe themselves, to their employer an those depending upon them to e themselves to the highest possible of efficiency in their chosen profes From personal observation it seen to be an unfortunate fact that a fa oo large majority of the members wh attend the meetings, and who take the most active part in the elevation o the engineer, are just these old veterans ho have for years been carrying the g ter

.rt of the load necessary to keep up in rest in their association But ask any f them and they will tell you that they ave been well repaid in knowledge ined, which made them better engiers and enabled them to command a rket for their increased ability with a rresponding increase in salary

To be honest, don't you think you ng fellows better wake up and examine your bearings?

F. M. ZIMMERMAN.

Pittsburg, Penn.

## low One Engineer Got His Price

was in a small mill on the Pacific st. The plant was old and much out repair. The engine was a 16x18-inch n slide valve running at 125 revolus per minute, with a throttling gov r The boiler was of the return -tube variety burning wood fuel and rying a steam pressure of 70 pounds. proprietor said that he could not enough power and that the engine s too slow. That the job was worth per month, but if the new man could more power out of the engine, he ld pay a better wage. The new man s obtained.

The boiler had a large steam dome d to the shell, which leaked so y that it was removed, and with red l putty and sheet asbestos a tight was made. A tube expander and a pump were rented for $1.50. With expander a few leaks were stopped, h this apparatus was used as little as sible. Then the grates, which had alst disappeared, were rebuilt and a k arch put in. After thoroughly cleannd examining the boiler inside and it was tested and found tight at 130 nds cold-water pressure. The safety e was now set at 85 pounds. The r appeared to be in fine shape, but feed pump was a little too small. The r had no gage glass and the owner not buy one, saying that the r had run seven years so and was all r.

ving first taken some diagrams, the e was then given attention. Strange y the slide valve required not only tting, but ¼ inch had to be added ch outside face to give sufficient le lap. To get the power required ngineer had decided to increase both speed and the pressure. The speed increased from 125 to 150 revolus per minute. The engine being of a hvy design and of a good foundation, only doubt was as to whether the heel could safely withstand the inse of speed, but as the rim velocity he new speed would only be 4200 feet minute, even the flywheel appeared be well on the safe side.

he plant was started up with the enture and running 20 per cent faster, which meant a 20 per cent increase in output of the mill, and the engine had sufficient reserve power at all times to hold up to the new speed at all loads. After the month was up the engineer got his $90 per month.

WILFRED TWINCH.

Glendale, Arizona.

## A Dangerous Blowoff

In the accompanying sketch, Fig. 1 shows the blowoff on one of the return-tubular boilers in a battery of three. The pipe from the boiler to the 5-inch tee was 5 inches standard with a standard ell. The tee was bushed from 5 inches to 2 inches and plugged on top. The blowoff cock was an ordinary 2-inch plug cock A. Two of these cocks were of brass and one was of cast iron and not very heavy at that. One night when the fireman was blowing the boilers down he could not open the iron cock as it was stuck. When he attempted to slack the nut on the end of the plug to loosen it, the stud broke off, and as the fireman must have been born under a lucky star, the plug did not loosen and fly out.

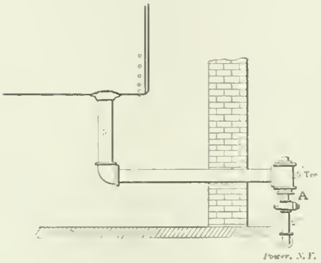


FIG. 1

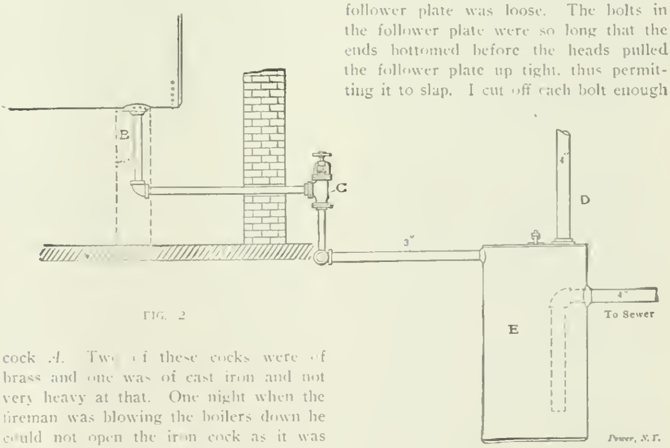


FIG. 2

These boilers carried 125 pounds of steam and at one time one of the 5 inch ells in the combustion chamber split and stirred things up in the boiler room, though no one was hurt. When the block was repaired, it was done with the same size fitting as the one that broke.

The job was eventually put in as shown in Fig. 2, the piping being all extra heavy with extra heavy fittings and a well known make of blowoff valve; a brick pier was built up at B to protect the pipe, the blowoff was run into a blowoff tank E which was buried in the ground outside of the boiler room, and which had a manhole in the top for cleaning when necessary. D is a vent pipe with a 4 inch pipe to the sewer, as shown, and extending to near the bottom of tank which prevents the steam from entering the sewer. As this plant was situated in a residence district there had always been some complaint when the boilers were blown down at night. After putting in the blowoff tank all such complaints ceased, as the blowoff was practically noiseless.

R. L. MOSSMAN.

Tampa, Fla.

## Some Causes of Engine Knocks and Their Remedies

An engine that had done but six months of service developed a loud knock in the cylinder, and I removed the cylinder head and took out the piston. After going over the rings and everything I could think of and not finding the cause of the trouble, I placed the piston in position to get the rings ready to go in the cylinder and tapped the piston with a block to drive it in until the rings were well entered, when I discovered that the follower plate was loose. The bolts in the follower plate were so long that the ends bottomed before the heads pulled the follower plate up tight, thus permitting it to slap. I cut off each bolt enough to let it draw the follower plate home, and when the engine went to work again the knock was missing.

Another engine of good make had a knock that I found to be due to one of the exhaust valves being ⅛ inch shorter than the valve pocket, allowing the valve to slap sidewise; I chipped a small groove in the top of each end of the valve so that the piston could get to the ends and the knock disappeared.

On one occasion a heavy knock developed in a York ice machine, and I discovered that the flywheel was loose on the shaft. The wheel was of the split type, and had been hammering long enough to wear the key away on the sides and batter the key seats, so that new key seats in the shaft and the pulley, and a new key to fit them, were required.

Crank-pin boxes that are so loose that the box adjustment will not tighten them, cause a knock, of course, and they should be refitted before the pounding wears an oblong hole in the crosshead box.

Too much compression will cause the steam valves to lift and hammer. The indicator will show up this trouble, and the remedy is obvious.

When piston rings are too narrow for the ring grooves, they will knock and continue to do so until they are fixed properly. The sides of the grooves should be trued up and new rings fitted to them.

Many times the wedge on the crosshead end of the connecting rod is tight and at the same time the box knocks. In this case the brasses need filing open at the joints to let the brasses hug the pin.

When the crosshead is too low it causes the piston to rise when the crank is on the head end center and allows it to fall when it goes to the other end of the cylinder; this, of course, will produce thumping.

An engine considerably overloaded will knock all over and at all times. About the only relief possible in such a case is to increase the boiler pressure until the load can be reduced to the proper amount.

John S. Van Pelt.

Augusta, Ga.

## Stopping Vibration of Motor

I recently witnessed some puzzling gyroscopic actions of a motor armature, the cause of which was not easily removed. It was necessary to substitute a 50-horsepower for a 30-horsepower motor to permit speeding up several machine tools. The original motor bracket was reinforced for the larger motor and was stiff enough to prevent any undue vibration, but a countershaft that was hung on the same span of iron work was increased in speed about fifty per cent and set up excessive vibration throughout the surrounding iron work. The vibration of the motor bracket was endwise of the armature shaft and sufficient to bump the bearings at each end. The brushes sparked so badly it was necessary to take the armature out and turn down the commutator.

Looking at the motor from the floor, all the movement appeared to be in the armature, but by setting a surface gage on top of a nearby planer housing, with an extended pointer to reach the center of the armature shaft, it was found that the armature moved less than 1/16 inch endwise, and had a very small vertical movement. The proper bracing of the motor bracket and iron work and balancing of the countershaft pulleys ended the trouble.

J. A. Mawhinney.

Franklin, Penn.

## Pumping Problems

I had rather a strange experience with a 5½x7-inch power pump driven by a 5-horsepower motor. The duty of this pump is to fill a tank situated 550 feet from the pump house at an elevation of 95 feet to the top of the water when the tank is full. When the pump was started it worked finely for some four or five weeks; then the trouble commenced. The packing in the water chamber was blown out, the cast-iron plunger broken and the teeth stripped off the rawhide pinion. When repaired a pressure gage was put on the water chamber, which showed the pressure to vary from 45 to 140 pounds. The pump would run one, two or three hours before building up a pressure, and the next day it would take 30 minutes. A vacuum gage on the suction showed 15 inches at all times. The pump draws from five driven wells, the water rising within 6 feet of the surface. When the tank is shut off and two hydrants are opened, so that there are four 2½-inch openings with hose attached, the pressure will build up to from 20 to 85 pounds. What causes the trouble?

V. D. Edwards.

Wilmington, Mass.

## Lost Motion in Pump

In the plant where I am working we have a small duplex pump that is used for boiler feeding, and as it has been in use for two years the joints have become somewhat worn, so that there is quite a bit of lost motion other than that furnished by the space on each side of the valve jamb nuts. This wear is not enough to permit of babbitting, and as the proprietor did not wish to have the bearings rebored and new pins turned, I had to resort to some expedient to get the pump to run slowly enough to keep a continuous stream of water going into the boiler.

I hit on the plan of putting an iron washer on each side of the jamb nuts in the valves, reducing the lost motion in the valve and utilizing the lost motion caused by the wear of the pins. The pump will now run at any old speed desired, and by the time the wear has become great enough to again cause trouble there will then be room for babbitt to be run in the bearings and the washers can be dispensed with until the babbitt becomes worn, when the washers can l
used again and so on.

E. D. Rice.

Wheeling, W. Va.

## Electric Drives for Factories

One great claim for electric motors i
that by their use individual drives ma
be obtained and long lines of shaftir
may be eliminated, the power used beir
only that which is necessary to drive tl
particular machine being used. Agai
where there is much dust, the claim
advanced that only induction moto
should be used, due to the danger fro
explosions caused by sparking on tl
commutator of a direct-current moto
Often managers of a factory operatii
on steam power think they are way b
hind the times and make a change l
substituting motors to drive the old li
of shafting. In this way many ve
poor arrangements of factory drives a
installed, which require much more pow
at the switchboard than was anticipate

For ordinary factory work, where tl
machines are being used a great part
the time, individual drives should l
eliminated. If possible, one motor f
a floor should be installed and line shaf
ing driven from this. A case in mind
a linseed-oil factory illustrates this poi

A change was made from engine a
shafting to electric drives. Where b
fore there was an engine and a comp
cated system of shafting, now somethi
like 10 or 12 motors are used. It seem
best to install the induction motor b
cause of the lack of care necessary
keep it going, and because of inflammab
dust present. The power necessary
drive the mill before and after tl
change was figured, and instead of
saving by use of electric motors it w
found that there was a very apprecial
loss.

With induction motors installed t
power factor was low—from 0.65 to 0.
—and this meant that often when tl
motor was apparently groaning und
overload, it was really not up to h
load. The feeders were calculated f
only enough current for the normal loa
and no account was made of wattle
current, which will heat up the wires
motors just as readily as the useful cu
rent. The feeders were always ove
loaded, and even the circuit breake
switchboard and generators. It was
continual fight to keep the circuit co

To remedy this condition it might
suggested to put capacity into the ci
cuit and increase the power factor
0.90 or 0.95. This, however, cannot
done as easily as it may seem, as pow
is used elsewhere besides in the oil mi
A synchronous motor will do the job b
it must be arranged to take about
per cent. of the load to make any gre
improvement in the power factor.

stalling the synchronous motor would impossible in this case, the only other ty to improve the condition would be rearrange the drives. This could be ne by using two large motors instead the 10 or 12 independent machines, ien by means of a carefully planned stem of shafting, with suitable clutches d a good form of chain belt instead leather belts for short drives, a de- ed gain could be made in the amount power used, and some gain in the wer factor.

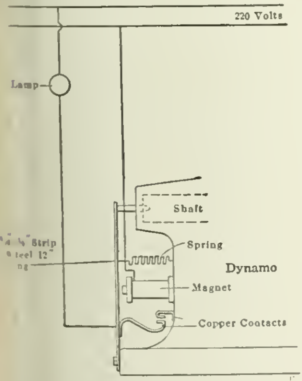
A great amount of the trouble could l eliminated by the use of direct-current tors, and I am in favor of this type machine where it is at all possible to tall it. Often, by a little care and fore- ught, the motor can be protected from st and still be accessible for inspec- and in a position suitable for the ve. If this can be done the direct- rent motor, in my opinion, is by far best for factory use.

H. J. Macintire.

ambridge, Mass.

## Oscillating a Dynamo Shaft

Ierewith is a sketch of a device for llating a dynamo shaft, which the er happened to see in a small factory t. Upon asking the engineer what device was for, he responded that shaft of the dynamo did not oscillate ts own accord and he had to resort something that would perform this ration automatically. The device ks excellently and without interrup- The sketch is very nearly self- anatory, but it may make things



RANGEMENT OF OSCILLATING DEVICE

cle r to add that the magnet used was n d one taken from a discarded gong. Th resistance of the magnet coil not bei enough to prevent an excessive cu nt flowing, an incandescent lamp wa nserted in series with the coil. The c r contacts come together when the sha of the dynamo forces the steel strip aw from the magnet, thus allowing current to flow through and magnetize the magnet coil. The steel strip would thus be drawn toward the magnet and in turn would force the shaft of the machine in the same direction. This movement would pull apart the copper contacts and break the electric circuit. The magnet would lose its energy, the shaft would oscillate back to its outer position and the same cycle of events would be repeated. The spring indicated on the sketch helps the magnet to perform its duty, or rather counterbalances the oscillating forces.

V. T. Kropidlowski.

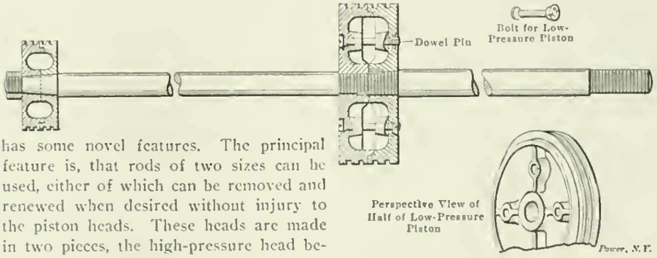
Winona, Minn.

## Novel Pistons for a Tandem Compound

Herewith is a drawing of the two pistons of a tandem-compound engine which has some novel features. The principal feature is, that rods of two sizes can be used, either of which can be removed and renewed when desired without injury to the piston heads. These heads are made in two pieces, the high-pressure head being screwed together, while the low-pressure head is joined together by a taper male and female flange and held together with four taper bolts and nuts, as shown in detail. Four ordinary cast-iron packing rings are used instead of two, and this has proved decidedly more efficient in every manner. The rods are made of tool steel, instead of the usual ordinary machine steel, which I believe will prove more economical in the long run, both in repairs and value of packing. After several months of constant service these pistons have proved efficient and reliable.

J. S. Hill.

Washington, D. C.


Dowel Pin
Bolt for Low-Pressure Piston
Perspective View of Half of Low-Pressure Piston
Power, N.Y.

SECTION THROUGH PISTONS OF TANDEM COMPOUND

## A Permanent Test Set

The set comprises three Stanley transformers, rating 2200 to 110 volts and 40 watts capacity, all of which are mounted on one base, including the switches, fuse block and rheostat.

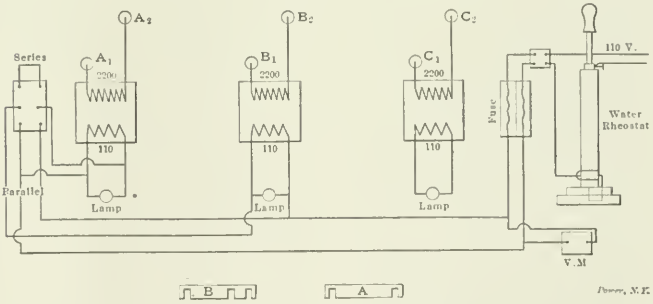
For high potential testing, remove all lamps and open all switches. Connect the 110-volt circuit to the main switch in series with the water rheostat. Attach a voltmeter. To terminals $A_1$ and $B_2$ attach the lines for high-potential testing.

To get 1100 volts, connect terminals $A_1$ and $B_1$ with connecting bar $A$, terminals $A_2$ and $B_2$ with the connecting bar $B$, and place the double-throw switch on the "series" side.

To get 2200 volts, the bars $A$ and $B$ remain as they are and the double-throw switch is thrown to the "parallel" side.

To get 4400 volts, remove the bar $A$ and change the bar $B$ so as to connect $A_2$ and $B_1$ and leave the double-throw switch on the "parallel" side.

For polarity testing, open all knife switches, remove connecting bars $A$ and $B$ from the terminals, place the 110-volt lamps in their sockets and connect terminals $A_1$ and $B_2$ across one phase, $B_1$ and $B_2$ across the second phase and $C_1$ and $C_2$ across the third phase. This makes each transformer independent.



WIRING DIAGRAM OF TEST SET

Weldy S. Yeager.

Colgate, via Dobbins, Cal.

# Subjects Under Discussio

Comment, Criticism and Debate upon Various Articles, Letters and Editorials Which Have Appeared in Previous Issues

BRING OUT YOUR IDEAS

## How Shift Changes Waste Money

I have read Mr. Whitham's letter in the September 21 number and the discussion in the October 20 number. I should like to know what kind of a chief has charge of the plant where such waste as he speaks of is allowed to go on. The chief should be held responsible for the loss. I do not think that Mr. Whitham is familiar with marine firing, where the man on watch has to have all his fires in good condition before his relief will relieve him. I have been at two plants where the firemen on watch were not allowed to leave their fires until the relief had looked at every fire and blown down every water column. This was all done by the chief's order, and there was no waste of fuel at those plants due to the changing of watches.

All twelve-hour watches are bad, but even at that no conscientious man would leave his fires in such a condition as to make it hard for the next man. I am in favor of the eight-hour shift, but I cannot agree with anybody that says a twelve-hour shift means a loss of money because any up-to-date plant will not allow it. It may mean a loss of good men, but not coal when a plant is handled right. I think that Mr. Whitham has wronged the majority of firemen and engineers.

L. W. CHADWICK.

Bridgewater, Mass.

J. M. Whitham's letter and the discussion following appears to me to be truly remarkable. If there is not a boiler or boilers that will stand from ten to fifteen minutes without the fireman at them, it would seem that it was time the boilers were cleaned, or that more boilers should be installed, or perhaps there are too many boilers for one fireman to handle. If it takes a man longer than fifteen minutes to wash up, he is not quitting work for the day—he must be dressing for a ball. If the on-coming watch cannot get into their fighting togs in five minutes and be on the job, they must be dressed like the knights of old in armor. The above periods seem like a reasonable time for change of watch, and were carried out every day in a plant burning coke, with forced draft at that, without allowing the steam pressure to drop. Of course, if there is trouble among the men, the plant is going to suffer, but a satisfied gang can work the job all right even on the twelve-hour shifts. A good deal depends on the chief.

On the tramp steamer where boiler capacity is reduced to make room for more cargo, where soft coal is the cheapest and has to be wet well with a hose to make it cake, and where the hardest steaming of any is done, the fireman can always get ready to go off watch when his relief comes on.

At present I have two boilers working to capacity on pea coal, and the fireman can get 25 minutes out of them when firing on the alternate plan.

HAROLD JAMES.

New York City.

## Some Erroneous Ideas

On page 677 of the October 19 number of POWER AND THE ENGINEER, under the above heading, J. B. Clapper properly corrected the instruction given on engine valves by the writer of the article of similar heading in the September 14 number, on page 456. The latter article, however, gives other erroneous information regarding the cylinder-head-bolt proposition.

It would be an erroneous idea if engineers thought that the cylinder-head bolts are subjected to a stress from steam pressure in the cylinder in addition to the stress which results from setting up the nuts, if the cylinder head were so heavy that the steam pressure couldn't budge it anyway, bolts or no bolts. The fact is that, no matter how tightly the nuts on the cylinder-head bolts are set up, an additional stress will be imposed on the bolts by the steam pressure as soon as that pressure becomes so great that the head would blow off were it not for the nuts on the cylinder-head bolts.

In this cylinder-head-bolt proposition the demonstration can be made with a common spring balance. Let a 5-pound weight represent the tension on the cylinder-head bolts due to setting them up; hang this weight on the hook of the spring balance and note the reading on the scale; then take a 50-pound weight and let it represent the pressure which the steam exerts against the cylinder head; hang this weight also on the hook along with the 5-pound weight and again note the reading on the scale; that w represent the total strain on the bol If you think you ought to have more less weight to represent one or b forces, change the weights at pleasu but it will not change the principle the subject in question.

OTTO JOHNSON

Boston, Mass.

## Electric Discharges through H

With reference to the trouble E. M Koy is having with electric dischar through wire-bound hose in a mine d ing electric storms, it would seem t the trouble is due to the fact that wire on the hose probably has a grea capacity than the grounds. If the min timbered, as it doubtless is, then air line is probably run along on timbers; and while the mine may dripping wet, the grounds would be imperfect that a high-tension discha would pass them by, and take the p of lesser resistance through the wire the hose and out through the drills, a incidentally, through the men handl the drills. The shock the men would from such a static discharge is, of cou quite harmless, owing to the infinitesin ly small current present, but it would anything but pleasant, and to the u itiated its seriousness would be ma fied out of all proportion to the strength of the shock.

As a possible way out of the diffic I should suggest to Mr. McKoy he thoroughly ground the air line wl each hose leaves the line, should t be more than one. This can be don thoroughly cleaning the pipe with a until bright, then wrap copper tightly around it, and solder the wir the pipe if the moisture will permit. can probably do this effectually wi gasolene torch in spite of the moist The copper wire should then be nected to an absolute ground, prefer by soldering it to a copper plate a 1 foot square, and burying the plat the wet floor of the mine. One caution that should be taken is that copper wire had better be about twice cross-section of the steel wire on hose. Under these conditions, it se to me, the wire coils on the hose sh act as a sort of a choke, effectually venting any of the discharge from ng to the men, and shunting it to ground through the copper ground wires.

If the hoisting tower is of steel, it probably rests on timber cribbing at the mouth of the shaft, in which case I would suggest that the steel- or iron framework of the hoisting tower be thoroughly grounded through about No. stranded bare copper wire, soldered firmly to a copper plate, by spreading the strands out all over the plate, and soldering each wire of the strand separately to the plate. The plate should be about 3 feet square, and be buried 4 or 5 feet deep in moist soil. I feel confident that the above precautions will absolutely overcome the difficulty.

A. P. H. Saul.

Buffalo, N. Y.

## Pound in an Engine

Le Roy Scott in the October 19 number describes a pound in an Atlas engine which reminds me of one I had to deal with once. The engine was not an old Atlas, but a new Robb-Armstrong, and when the throttle was closed it pounded badly. After doing all the stunts mentioned by Mr. Scott, such as thinking that the wristpin brasses needed keying and that there was too much play between the crosshead shoe and the guides, etc., I came to the conclusion that the piston rod had backed out of the crosshead and the piston was striking the cylinder head, although the nut appeared to be tight. Such was the case. Perhaps Mr. Scott's trouble is similar.

R. McLaren.

Berlin, Ontario.

Le Roy Scott complains of a pound in an Atlas engine and asks for suggestions. I should say that while the various causes which he thinks may produce the pound might each have its individual effect, yet the fact that the pound comes mostly when the throttle is shut, brings to my mind a similar experience with an Atlas engine and other high-speed shaft-governed engines. The pound was due to the governor weights drawing in when the engine decreased its speed, the weights striking against the stops before coming to rest. I should advise him to make rubber buffers and attach them to the stops to do away with the pound.

I recently had an experience with a high-speed shaft-governed engine which developed a pound which at first was thought to be in the centrifugal governor, but was not found there. On taking off the cylinder head the clearance was found to be entirely on the crank end and the follower bolts had made indentations in the cylinder cover, due to the engineer putting shims in the wrong side of the connecting-rod boxes to offset the wear.

A. C. Waldron.

Lynn, Mass.

Le Roy Scott in his article on page 672 of the October 19 number says "The engine in question is an old Atlas working at a pressure of 80 pounds. She knocks badly as soon as the throttle is closed, and the knock appears to be at the crosshead."

A number of years ago I had charge of an old engine that acted about the same as the engine in question. It is unnecessary for me to say that I lost several nights' sleep, but I finally discovered the trouble. In my case the brasses had been filed and taken up so often that it had shortened the connecting rod to such an extent that the piston head would strike the crank-end cylinder head when not working steam; when the engine carried full load, and working steam, the valve having lead, the steam would form a cushion between the piston and the cylinder head, so the engine would run smoothly. This may not be the case with Mr. Scott's engine, but I would advise him to make marks on the crosshead and guides and take down the connecting rod. He may find the clearance in the head end reduced to such an extent as to cause the piston head to strike as previously described.

William D. Bertschi.

Niota, Ill.

On page 672 of the October 19 number, Le Roy Scott speaks of an old Atlas engine knocking after the throttle was closed. Evidently he and the engineer have not had a wide experience with balanced valves. I presume the engine in question is of the old Atlas balanced-valve type. I remember the first time I stopped one of those engines, I thought the whole engine was going to leave the bed. Since then I have operated several balanced-valve engines and have found that all knock more or less as soon as pressure is removed from the steam chest. Several automatic engines also knock when coming up to speed. This is caused by the valve slapping against the valve seat, owing to the removal of pressure. It may be made less pronounced by stopping the engine gradually, thus allowing the valve time to adjust itself to its new conditions.

I have reduced it somewhat by taking up the lost motion between the clamps which hold the valve to the valve stem, but care must be exercised not to get them too tight, or the valve will spring the stem or will leak. The valve should be just tight enough to allow it to move enough to adjust itself to the seat.

If the crosshead or crank-pin brasses are loose, an examination of these parts will reveal this, and an engineer will have to judge for himself when these are tight enough. I think that by the time Mr. Scott and the engineer hear a few balanced valve engines stopped they will get used to the noise.

A. A. Blanchard.

Oak Harbor, O.

## New Smokestack Construction

Since the advent of the aeroplane built by the Wright Brothers, Dayton, O., has been looked upon as a place of uptodateness second to none, and while they are certainly the foremost in conquering the air they are slightly out of date regarding kinks used in constructing smokestacks, as evidenced by Mr. Zurfluh's letter on page 712 of the October 26 number, where he describes what is commonly termed shingling a stack upward as a novel method of erection. The writer has been under the impression that, the discussion of the question of relative merits in shingling upward or downward in manufacturing smokestacks, is about on a par with the question as to whether the pressure should be above or below the seat of a globe valve; both as to the length of time before the public and the unsettled state of the answer. It would be advisable for Mr. Zurfluh to get a written guarantee as to the increased length of service claimed for this form of construction.

J. E. Terman.

New Haven, Conn.

## Discoveries of Engineers

I read with interest W. H. Wakeman's article on "Discoveries of Engineers," page 649, October 19. That men who want to be called engineers will do such underhanded tricks is a condition to be deplored. We need good, broad-minded men who will work with their employer and associates in the boiler or engine rooms and not against them. Such things would be excusable were the participants school children instead of grown-up men. When we take into consideration the damage to valuable machinery and loss of life which might result from such practice, it makes it worse. If a man is discharged, would it not be better for him to show the new man all he can about the plant and start him as near right as possible? If he then failed it would show that he was really unfit for the position. Just such things as Mr. Wakeman describes have caused lack of faith between the employer and the engineer. We are all engineers, some better than others, but why not be brothers? If we are discharged from a job, we should not make it harder for the new man by doing such low down tricks, but instead help him to get along as well as possible, and even then his lot will not be any too good.

There is always room for all of us: if we fail with one employer, it's no sign we will fail with another. Some men are hard to understand, and our efforts may fail, but again we may strike a job where our leaving would not be considered. Perseverance wins, and if we fail a few times, we must try and find out where the trouble lies, examine ourselves and look at the thing from all sides, see who is to blame and sail in and do better next time. A good plan is to try to get with an employer who will talk and will plan and reason things out and be able to see things from all points of view. Let your employer know that you are really working in his interest and he will listen to you. In short, honesty is the best policy after all is said and done.

L. L. SCHEIDERER.

Marysville, O.

## A Grunting Piston

Reading the letter by A. K. Vradenburgh on "A Grunting Piston" calls to mind the experience I had a short time ago with one of my boiler-feed pumps. This pump is of the single-cylinder double-acting type. A short time ago the steam and water cylinders were rebored, new steam and water pistons put in and the steam valve was refaced. After the pump was running again, a grunting noise could be heard in the water cylinder. Thinking that the water-piston packing was too tight, it was loosened up a little, but did not cure the trouble. Then the packing was removed and the piston examined, when it was found that the piston was too tight a fit for the cylinder. There were also sharp edges on the piston, but as there was not time to send the piston to the shop, it was removed from the cylinder and the sharp edges rounded off a little. Then the cylinder walls were given a good coating of graphite mixed with a little engine oil, and the pump was started. The noise could not be heard until a few days after, when the cylinder was given another coating of graphite. This was kept up until the piston had worn to a good fit in the cylinder and no longer made the grunting noise.

H. JAHNKE.

Milwaukee, Wis.

## Mr. Kessler's Telltale Lamp

In the October 5 number, on page 582, J. E. Kessler, in describing a telltale to show condition of spark plugs, states that when batteries are the source of ignition, by short circuiting the lamps, the batteries are not pulled down so fast. This is certainly incorrect. As each light is in series with its respective plug, and in series with the spark coil and batteries, short-circuiting it would drag the batteries down faster, because the circuit resistance would be lower and more current would flow.

L. C. SPIVEY.

Rio Vista, Cal.

## Kerosene in Boilers

Referring to the letters of J. A. Mawhinney and John H. Hieber on page 714 of the October 26 number, according to my own observations, if they had omitted the kerosene and soda ash, they would have gotten rid of the scale just the same. It was the frequent alternate heating and cooling of the plates that loosened the scale, although I am not sure about the oil.

In this connection I might relate a story told me by an engineer who was my assistant at one time. My friend was night engineer in a plant in Indiana, where the water has a reputation for scale forming. They had fought scale for years with everything from crude oil and rain water to tannin and caustic soda with the same result—the satisfaction of seeing the scale grow thicker and their fuel bill grow larger every time they cleaned.

My friend's duties included cooling down and blowing off the boiler to be cleaned. One night he was not very busy, so he blew off the boiler with about 30 pounds of steam showing on the gage, and as soon as it was empty he filled it with cold water to the dome. After emptying the boiler he opened a small valve and allowed steam to enter until the gage showed pressure. Allowing the pressure to remain a few moments, he again filled the boiler with cold water, then emptied it and left the boiler for the day crew to handle.

The result of his exertions was to keep two boiler washers busy all one day cleaning out scale and two boilermakers busy all the next day rolling tubes, although none of the seams showed any leaks. As no one knew what had happened, except my friend, I suppose it is still an unexplained mystery at that plant.

When I worked on the lake marine-freight service, the boilers there were always laid up from two to three months. Before laying them up we always washed the boilers, filled them up with water and raised steam, afterward blowing them off and leaving the boilers closed all winter. The first thing in the spring we would get some straw and burn a little in each furnace to warm up the shell and tubes. We then filled the boiler with water and slowly heated it up to working pressure. After blowing off we would clean the boilers. This method was invariably successful.

A. A. BLANCHARD.

Oak Harbor, O.

In regard to using kerosene in boile allow me to say that the Ohio and India crude oil is just as good and will h lubricate the engine as well, but do use oil if you go around the boiler w a torch. Following is a recipe that w knock scale of the worst kind: Take t or three pecks of potatoes and chop fi After the potatoes have been in the boi five or six days clean it out, and if t same operation is repeated two or th times, the boiler will be clean.

GEORGE B. MEYERS

Douglas, Wyo.

## Oil Data

I have charge of the Urbana H Light and Power Company's plant, wh contains one engine, 25x42 inches, r ning noncondensing at 120 revoluti per minute with 100 pounds of ste The load varies from 20 to 300 kilowa There are also two feed-water pumps. Pennsylvania oil called special pow house valve oil is used, and running hours per day, except eight hours Sunday, I use on an average of 15 lons of oil per month.

J. BURCHA

Urbana, Ill.

## Reducing Load on Exciter

I desire to take exception to Utley's article in POWER for October in which he criticizes Mr. Westerfie method of reducing the load on his citer. Mr. Utley explains that cut in resistance in the generator field creases the current in the field, the reducing the load on the exciter. would be true if that was all there to it, but when the current in the erator field is reduced, the voltage the alternating current is reduced, to restore it, the current through generator field must be restored to previous value. To do this the vol of the exciter must be raised, which creases the load on the exciter, beca as Mr. Utley states, the product of volts and amperes equals the loa watts. So I believe with Mr. We field that cutting out resistance in generator field reduces the load on exciter.

C. E. HOWLA

Washington, O.

I note on page 716 of the Octobe 26 number, Mr. Utley calls attention t an error in my article "Simple Ki " which appeared in the August 31 num r. My impression is that this error is ue to a misprint or a "slip of the pen."

My practice and advice in such es is, to be more plain, to keep as much ad as possible off the exciter. This he merest novice understands is done by it-ng in resistance in the exciter-field eostat. What I intended to advise was cut out all resistance in the generator-ld rheostat and leave as much in on e exciter-field rheostat as possible. Pos-ly I myself, or the compositor, used word generator where the word ex-er should have been used, and the sub-tution was passed unnoticed.

William Westerfield.

Lincoln, Neb.

## Flake or Powdered Graphite?

have taken an interest in the dis-sion of the question as to which is better, the flake or finely powdered phite for lubrication. I have used phite for about fourteen years for all poses that it can be used for in a ver plant. I well remember the first te I used graphite to cool the main ring on a small slide-valve engine, ich had been rebabbitted. After a rt time the bearing got hot and it impossible to make it run cool with I then sent for some graphite, but y order I did not state that I wanted flake, and the powdered graphite was This was used with oil on the ing for a short time, but still the ing kept on getting hotter. Finally bearing was washed out thoroughly the powdered graphite and oil used n, but with no better results. I then led to get flake graphite. After mix-n this with some oil and using it on bearing for a few hours, the bearing cooled so that the hand could be n it without burning. I have tried lered graphite on a hot bearing many since, but in most cases with no results.

am under the impression that the n why the flake graphite gives bet-tisfaction on a hot bearing than owdered, is because the powdered ite washes out with the oil more ly than the flake graphite. The only use I have found for the powdered ite is on manhole and flange gas- For lubricating purpose I prefer ake at all times.

H. Jahnke.

Mwaukee, Wis.

## Cylinder Lubrication

wing are the sizes and speeds of ngines, and the amount of oil used ch for a 12-hour run:

16 and 30 by 24 Russell cross-ound, 150 revolutions per minute, in-d horsepower 490, 3 pints.

18 and 30 by 36 Corliss cross-com-, 84 revolutions per minute, indi- horsepower 500, 5 pints.

13 and 20½ by 20 Russell tandem-com und, 210 revolutions per minute, indi ed horsepower 230, 1 quart each.

18 and 30 by 24 Ingersoll cross-compound, 100 revolutions per minute, indicated horsepower 450, 1 quart.

One 12 and 21 by 21 Buckeye tandem-compound, 200 revolutions per minute, indicated horsepower 225, 3 pints.

One 8 and 12 by 12 Ingersoll cross-compound, 150 revolutions per minute, indicated horsepower 80, 1 pint.

I am using "600 W" oil.

W. D. Ranney.

Columbus, O.

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I note that few who express their views on graphite as a lubricant distinguish between the product of nature and the product of the electric furnace, whereas all should know that when it comes to lubrication the electric-furnace graphite is far superior to natural graphite. This is so because all natural graphite is mined, having been made by the unwatched, unknown process of nature from indiscriminate materials, while in the making of all electric-furnace graphite there is full control of all raw materials, as well as of the process, so that the makers are enabled to improve on nature's output.

I very much fear your correspondents have not reached the advanced class in lubrication when they claim flake graphite to equal amorphous electric-furnace graphite. Flake graphite is crystalline and hard. The claim is made that it becomes impaled on metal points. Unctuous, electric-furnace graphite is very fine and soft. In use as a lubricant, it fills in the hollows and buries the uneven surface points, giving a veneer or polish that results in lubrication far superior to that afforded by oil or grease alone, or by flake graphite.

J. M. Willitts, in the September 7 number, writes understandingly when he makes reference to the difficulties in refining flake and other natural graphites. It is, indeed, a very difficult matter to get the grit—the sand—separated from the mined graphite, but as difficult as this is, just as great as is the failure to accomplish this, we must recognize the advantages of the electric-furnace process, which vaporizes all the known elements except graphite, driving them out of the furnace under a temperature of over 7000 degrees Fahrenheit, and making it possible to obtain graphite of remarkable unctuousness, purity and lubricating qualities.

I feel that engineers of today have many advantages over those who labored in the same field a few years ago, particularly in having practically pure graphite as an assistant to fight friction. To all such I would say that no matter what their past experience has been in the use of natural graphite, they will find electric-furnace graphite the best lubricant they have ever used.

Orrin E. Dunlap.

Niagara Falls, N. Y.

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Two points must always be kept clearly in mind, viz., lubrication is a question of degree, and an oil will reduce friction and consequently is to a greater or lesser degree a lubricant.

In regard to the first point, we all know that any engineer, whose engine gives no apparent trouble, will tell you that his lubrication is satisfactory, and yet another engineer would point to many factors that indicate poor lubrication; it is all a question of opinion and in most cases opinion based on little knowledge. No groaning, no scoring of the cylinder nor rapid wear means to most engineers good lubrication. They may of course be right in many cases, but it too often happens that the same oil, same quantity and the same methods fail to lubricate other engines and even similar engines, so a mere statement of fact is not of much use. Other conditions have a lot to do with the best use of an oil.

In regard to the second point, one must always remember that when we say such and such an oil is a poor lubricant we don't mean that it does not reduce friction, but that it reduces a smaller proportion of the friction than we think possible. With this in mind we can easily understand that in an engine where conditions are such that there is very little friction, a so-called inferior oil may work satisfactorily and an engineer, using such an oil, would call it an excellent lubricant. In other words, a poor lubricant for one set of conditions may be a good lubricant for a different set of conditions. In a general sense, conditions play a very important part in this question of cylinder lubrication, and this discussion will be valuable or otherwise according to the clearness of the conditions under which any experience has been acquired.

One of your contributors advocates "allowing the oil to run on the inside of steam pipe to the cylinder." Unfortunately this is done much too often; it appears to me, from many years' experience, that it is responsible for a great many of the 90 per cent. of cylinder (and valve) troubles traceable to lubrication. I have adopted the strict rule of "keep oil at all costs from the inside surface of the steam pipe." In many engines the oil, running along the steam pipe, would have to pass through the stop valve, and in all engines the oil must pass through the engine valves to reach the cylinder; moreover, the oil must be fed into the steam pipe at a higher point than the entrance to the cylinder, for steam will not drive oil upward along a pipe surface. Further, when the oil reaches the cylinder it often flows over the cylinder ends to the lowest part of the cylinder and so out through the exhaust, without having had an opportunity of lubricating anything. It has naturally filled up any pockets in valves, etc., on the way, and deposits are formed, [illegible] of the [illegible] followed the one I have outlined and one practiced most [illegible] is "The Accident" however, causes this method to be successful occasionally. Oil in passing along the pipe flows through a valve and has sometimes to pass over a reentrant angle, which stops the flow. To enable it to continue, the oil must form drops and fall on some other portion of the pipe, and as steam is rushing along the same we get the oil broken up and carried by the steam into the cylinder. Although Mr. Thomas objects strongly to the system of atomizing the oil, it appears to me it is solely by this system that his own method proves sometimes successful. At the best, his accidental method is haphazard; breaking the oil up and even vaporizing it is either directly or indirectly responsible for all the best lubricated steam engines. Even Mr. Thomas will admit that a second and third cylinder, if not lubricated by admitting oil direct to the cylinder, receive their oil through the steam from the first cylinder spraying the oil as it hangs about the exhaust port and valve, and so carrying it forward to the other cylinders.

In drop-valve engines, direct lubrication of the cylinders, if done correctly, is probably the best method, but in other types of engine the valves cannot very well be lubricated in this manner, and oil-sprayed steam is the best and simplest, the oil being carried to all valve surfaces and cylinders. In this connection the character of the oil must be taken into consideration. Some oils, when atomized, pass through a cylinder as vapor and do not condense or deposit on the cylinder walls, other oils deposit almost entirely in the first cylinders. From this it will be seen that oils must possess other qualities in addition to their lubricating quality, and this is especially necessary in oils for superheated steam.

A good method of testing the carrying of oil by steam is to prepare a flat board, covered with white blotting paper, and hold it near to the pipe on which the indicator is fixed. Blow steam through for a few seconds and then let it impinge on the blotting paper. A brown color will be shown on the paper after a few strokes of the engine if sufficient oil is being carried by the steam.

William Scott Taggart.

[illegible], England.

We have a 26-inch diameter by 24-inch stroke Atlas four-valve engine, 135 revolutions per minute direct current to 200-kilowatt direct current generator, steam pressure 120 pounds, valves 7½ inches diameter by 32 inches long, double ported circular, situated in the cylinder heads; a straight oil way is cut in the valve seat between the ports and nearly the entire length of the valve. On one end of the seat of the steam valves a connection is made with an oil pump directly into the groove mentioned, a discharge from the oil pump also feeds directly into the throttle situated on top of steam cylinder. We use in 11 hours' run 4 gallons of 600W straight mineral cylinder oil and are unable to get along on less; we have tried a number of oils and various quantities but this gives the best results and is 50 per cent too much.

G. McFon.

Philadelphia, Penn.

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My engine is an 18x42-inch Wright Corliss, running at 70 revolutions per minute with 85 pounds boiler pressure and an average load of about 125 horsepower. There is no separator in the steam pipe. I use a sight feed lubricator of a good make and feed oil at the rate of a drop in about 25 revolutions. In 237 days have used 37 gallons of Capitol cylinder oil, about 1¼ pints per ten-hour day. The 6 and 4 by 6-inch duplex feed pump gets about ½ pint of oil per week.

James H. Campbell.

Detroit, Mich.

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The folowing cylinder-lubrication data are submitted in the discussion now going on in Power. One 20x30-inch slide-valve engine running 80 revolutions per minute, nine hours per day, six days per week; steam pressure 80 pounds gage, developing an average of 175 horsepower. A one-pint Nathan up-drop lubricator, connected behind the throttle, filled on Monday morning will last until Saturday night. The engines show every sign of perfect lubrication.

One pair of 16x36-inch hoisting engines, making an average of 35 revolutions per minute, ten hours per day, six days per week, steam pressure 80 pounds gage, developing an average of 150 horsepower. A one-quart Detroit lubricator filled will last for a run of two weeks. The engines handle easily, and receive perfect lubrication.

One 18x12x18-inch Jeansville duplex pump making an average of 130 strokes per minute, twenty three hours per day, seven days per week; pumping against a 200-foot head, 80-pound steam pressure, developing an average of 150 horsepower. A one pint Detroit lubricator is used, and one filling will last forty-eight hours, and gives satisfactory lubrication.

One 24x16x18-inch Cameron pump making an average of 65 strokes per minute, twenty-three hours per day, seven days per week; steam pressure 80 pounds gage, pumping against 140-foot head, and developing an average of 50 horsepower. A one-pint Detroit lubricator is used, and one filling will last two hundred and thirty hours, and give perfect lubrication.

Chas. J. Halloran.

Avoca, Penn.

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In my experience for the last eightee
years in marine practice, I have been
only one ship where oil was used in cy
inders.

On this one ship we used one quart
twenty-four hours, and the condition t
boilers were in, when we arrived at R
Janeiro, a twenty-one-day trip, and open
them for cleaning, was a disgrace. The
were two Scotch boilers with three fu
naces in each equipped with Howdens p
ent force draft. The tubes were cover
with oil about one-eighth of an inch thi
and even the tops of the furnaces w
covered with oil. I have wondered ma
a time since that the furnaces did not b
Pity the two firemen on watch who
to work like demons to keep the steam
150 pounds.

Of course, I don't mean to say that
oil is harmful to the cylinders, but
harm it does to the coal bunkers and
danger to the boilers and the extra sw
it extracts from the fireman, make
think it is better not to use it in st
cylinders. Even with the best oil sep
tors in the market some of the oil finds
way into the boilers.

I spent eight years in Uncle Sa
navy, and on none of the ships I was
during that time was oil used in any st
cylinders. In fact, on one ship the c
engineer had a bill posted in the en
room to the effect that if any machi
or oiler put oil in the cylinders, he w
have him court martialed, which m
the losing of from one to three mo
pay. Now, this ship was fitted with
triple-expansion engines of 1700 indic
horsepower each, placed horizontally,
they ran so smoothly at 90 revolut
per minute that one could not hear t
when standing on the upper deck.

On another of Uncle Sam's ships,
dynamo engine caused trouble by ta
the oil through the stuffing boxes
sending it into the condenser; the oil
rator did not extract all the oil from
condensed steam and quite a little
into the boilers. The trouble was rem
to some extent by having distance p
cast and put between the crank c
and the cylinder. A plate with st
boxes was secured on top of the
case. The new piston rods and
stems were made longer and p
through both stuffing boxes; still w
some oil in the condenser, and ha
clean the oil separator once a month
renew the filtering material. In my
ion it is better not to use any oil in
cylinders where the condensed wate
to be used for feed water. The savi
coal which is effected by having no
the boilers is much greater then the
ing would be by using oil in the cyli
to reduce a little friction. I have n yet
seen any scored cylinders because ere
was no oil used in them.

Gustave Klein.

Newport, R. I.

## North Dakota"—World's Fastest and Most Powerful Battleship

n the "North Dakota" the United tes has the fastest battleship afloat. with her sister ship the "Delaware," two most powerful battleships in the rld.

On November 4 the screw-standardiza n test of the "North Dakota" over Rockland measured-mile course de ped a maximum speed of 22.25 knots hour, and an average speed of 21.833 s. The first of the five trials over mile course was the fastest, as ap s in the record following: 22.25, , 22.13, 21.505 and 22.133. The ximum speed of 22.25 knots per hour nsiderably in excess of the best per ances of either the "Delaware," 8 or the "Bellerophon" (22.1), the g dreadnaught of the British navy. ng the five trials a maximum of 50 horsepower was recorded, and a of 33,875 horsepower. The maxi number of revolutions of the pro rs was 286 per minute, and it was d that 263 revolutions per minute sufficient to maintain the contract of 21 knots.

he "North Dakota," which is 510 feet , 85 feet wide, draws 27 feet of water s a displacement of 20,000 tons, is first American battleship of the first- type to install turbines, the equip t consisting of Curtis marine re sible turbines, driving twin screws. boilers are of the Babcock & Wilcox and carry a steam pressure of 265 ds gage and 50 degrees superheat.

A four-hour endurance run at top speed made on November 5, but the aver speed was somewhat lower than ex d, due to a crack 7½ inches long ping in one of the 4 inch boiler s, which necessitated cutting out four e boilers during the fourth hour of run. The record made was as fol For the first hour, 21.71 knots; d hour, 21.71; third hour, 21.64; and fourth hour, 21 knots flat. As a re f the accident one of the coal pass dead, three others were severely d and 12 were injured to a lesser nt

November 6 the "North Dakota" e a 24-hour run at 12 knots, the aged tube having been replaced im iately after the four-hour run. Few are available on this test, but it is fficially reported that the coal con iption for the 24 hours was 196.2 which is about five tons less than required by the reciprocating engines he sister ship "Delaware" when re ly making a similar test. The eller speed during this run was a more than 143 revolutions per ute.

n the day following, November 7, an r 24-hour run was made at 19 knots. The coal consumption was 295 tons, as compared to 315 for the "Delaware." There is also a possibility that there will be another four hour full speed test to satisfy the builders as to exactly what record can be made with the entire 14 boilers supplying steam to the turbines.

## To Head Off Trust Control of Water Powers

The position of the Government in regard to granting water power concessions is outlined by Gifford Pinchot, United States forester, in a letter written to Col. Henry L. Higginson of Boston, a director of the General Electric Company. The letter takes the form of a public statement, and is significant at this time because of the widespread interest in the water-power question. Mr. Pinchot seeks to emphasize particularly that he does not wish to retard the development of water powers by private capital.

Summarizing the conditions imposed on all power permits, the Government forester makes clear the point that the renewal of a permit at the end of fifty years is at the option of the Government; that it is by statute, revocable by the Secretary of the Interior, but unless revoked continues fifty years, when it terminates without any special revocation, but may then be renewed at the option of and on conditions to be fixed by the Government.

"I have no desire," Mr. Pinchot writes, "to prevent or retard the development of water powers by private capital. They should be developed by private capital, in my judgment, under proper Government control, and not by the Nation or the States.

"I have not said, either privately or publicly, that the General Electric Company or any other single existing corporation, controls, or is now seeking to control, all the water powers in the country. But no one can deny that there is a marked tendency toward practical concentration and control of the hydroelectric development over a very wide area. In some cases this concentration may be a mere 'community of interests,' evidenced and made effective by directorates in several legally distinct corporations held by the representatives of the same interests or of friendly interests. In other cases it appears to be brought about by a closer intercorporate relation, and in still others, as, for instance in central California, there seems to be a single corporate control of a large and populous territory.

"The increasing radius of practicable electric transmission and the recent financial history of the country as to consolidation of other kinds of business seems to justify the belief that there is a strong tendency toward concentrated control of hydroelectric development in the United States. I do not say that a single trust has yet been formed. As an outsider, I have not the information which would warrant my saying that such a trust has been planned, but it is apparent that present tendencies favor such a trust and will produce it if they continue.

"I therefore think that it is of the utmost importance for the people of the Nation to understand these tendencies, realize their import, and take effective steps now while there is yet time to retain and effectively exercise public control of this vital necessity of life. This may be done by giving concessions limited in time, requiring a fair rental, and imposing conditions to prevent the evils which experience has taught us to expect from unregulated monopoly. I am very glad indeed to have your statement that the 'United States should not part with this kind of property without fair leases.' That is precisely the position that the Forest Service has always taken."

## A Rule for Stairways

By A. E. Dixon

In the building of stairways and ladders there is a simple little rule that is of general application and makes the most comfortable and practicable affair to climb. It is:

*2 × the riser + the tread = 24 to 25 inches.*

For a ladder this gives a vertical distance between rungs of 1 foot, and the rule is based on the common-sense principle that it is more than twice as hard to lift as it is to go on the level but there is less of it to do.

In a power plant the stairs should be straight in order to permit of handling long lengths of pipe, etc. In regard to width, 2 feet 9 inches is about the minimum, but the stairs are sometimes cut a little narrower; where room is available it is better to make the stairs 5 feet wide, which gives plenty of room for two to pass without crowding.

## A New Steel Corporation

The Western Steel Corporation with headquarters at Seattle, has been formed with a capital of $20,000,000. The new company will take over the Irondale works and expects to extend its operations to the development of the iron deposits of British Columbia. In that province there are known deposits of iron within easy distance of tide-water, which assay as high as 66 per cent. G. M. Gibbs and C. S. Faulkner, of Vancouver, James A. Moore, of Irondale, and H. E. Law, of San Francisco, are prominent promoters of the company.

POWER
AND THE ENGINEER

DEVOTED TO THE GENERATION AND
TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.
355 Dearborn Street, Chicago.
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of POWER solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "POWPUB," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During 1908 we printed and circulated 1,836,000 copies of* POWER.

*Our circulation for October, 1909, was (weekly and monthly)* 135,000.

| | |
|---|---|
| *November 2* | 42,000 |
| *November 9* | 30,000 |
| *November 16* | 30,000 |

*This paper reaches 42,000 separate readers each month and 30,000 each week.*

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*

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# The Debt of Modern Civilization to Mechanical Power

In September-October of 1909 the Hudson river district of New York State has been celebrating the three hundredth anniversary of the Dutch discovery of the river; and New York City has been reminded of the one-hundredth anniversary of the first trip of a Fulton passenger steamboat. The new "Half Moon," and the replica of the "Clermont" have been object lessons to bring these facts home.

It may fairly be questioned, however, if to many observers of this pageantry, the thought has been emphasized how very modern all the consequences are which have followed from these historic events.

In 1609 when Hudson came, the Marquis of Worcester was still a boy. His book which describes his steam-pumping plant came out in 1663. Savery, whose engine embodied the germ of the pulsometer type of wrecking or contractor's pump without pistons, belongs at the end of that century, and Newcomen and Turpold appear at the opening of the next. Hudson was in the era of wind and water power, and of animal and human muscles as sources of industrial energy. Fulton, in 1807, had the achievements of James Watt only twenty years behind him, and Stephenson's triumph with the locomotive in 1829 was about as far away ahead of him. Hence, to grasp the full significance of the achievement of the marine engineer of 1807, and the incalculable debt of our modern civilization to the work of these pioneers it may be helpful to imagine the city of New York or any great modern city built up on the service of mechanical power as it would now be if such power were not present in it.

In the first place, its size or population would be rigidly limited. No more persons can live there than can be supplied with food by wagon and team over roads which are none too good. The railway is not at hand to bring farm products, milk, grain, vegetables and cattle from any distance overland; and only cities by a water side can be served by sloop or ship, which must be subject to delay by storm or calm or by ice. The highways will not be up to a modern standard, because no power-driven stone crusher or massive road roller is available to build them.

The city would be poor, in the second place, because all its citizens were. The only wealth is in an ownership of land, because no commerce on any large scale exists, and manufacturing is by the individual who uses or makes his own power, and production is on so small a scale that large returns are impossible because the area for market is so small. It follows, therefore, that anything like large investments are impossible in extensive water works to secure the hea of the community; there is no call rapid transit or for subways, and capital to build them if they were co ceived. The tax list as late as 1820 ca ries only ten names assessed as prope holders in excess of $100,000.

In the third place, America is not the land of opportunity nor can it be The cities are small, there are no dustrial or producing concerns to furn work and wages on any large scale no the sea coast, and no means to get produ to the seaports to send by sailing ship the crowded but poor old world. Farmi in the large and fertile inland, territo is not attractive, because cheap transpor tion is not provided, except by canal, a the number of these canals is limit because of the difficulty of financing th Emigration from the old world is sm because of the limited number of shi and costly, because so many days' sup of food must be carried for each voya across the sea. The frontier is rea only a few miles inland, because of sacrifice of life and labor and treasure carry it further; and there are few m who seek to do this. Even so late as middle of the nineteenth century, N York and all American cities were in days of small things.*

In the fourth place, the modern c has no tall buildings. The land values not very great; still structural shapes only rolled in small sizes in mills driv by water power. Transportation structural material is costly and slo there are no passenger elevators design because there is no power to drive th But, more potent than these in its eff on the growth of the business centers the fact that no one may live furth from his office or store or shop than represented by the distance he may w or ride by horse or stage. If he elect suburban residence across a ferry he m await the manufacturer of steel for bridge, of the air compressor on a la scale for his tunnel; or he must cr by horse-driven or sail-propelled boat. is impossible to state what effect steam-propelled ferryboat has had up the prosperity of an island city, such Manhattan or Brooklyn.

It would take our thought into wide a field to do more than glance the consequences which have flowed fr the conversion and transmission of pow by means of electrical devices. The ge erated or liberated power is brought home and office, to street and factory the manifold forms of light and pow and production and wealth and comf and convenience spring as by the rubb of an Aladdin lamp. Communication al by telegraph and telephone, all belong the electrical age, a modern one in ev sense. Let everyone, then, who thr to contemplate an achievement pregn h the most far-reaching consequences, ognize in the quaint "Clermont" and in deed it celebrates, the first steps in triumphant progress of the last hun- d years.

---

*"The Debt of the Modern Steam Engine Charles T. Porter," POWER, May, 1909.

## fety the Essential Factor in Boiler Rules

he Board of Boiler Rules of Massa- setts was formed after that State had n visited by the Brockton explosion, which 58 were killed, which ex- n was followed by that at Lynn, in ch 17 were injured, and it is natural that under those circum- ces they should formulate rules more gent than as if the commission were le up of one man from Massachusetts, from Missouri, one from California, o from Texas, and one from Minne- a, instead of all five from the scene he two great explosions. In way s this bias appear more conspicuous th in the chronologically graduated i rs of safety. One does not reduce sure because a boiler is ten years old, b rather, because of the *wear and tear* *ated with that period of time*. Why n then, deal directly with the wear and t and not with the ten years? This is t the Government does, and, as far a we know, is what is done by every r similar governing body. According t his practice the factor of safety is, w might say, automatically apportioned by he boiler itself. To illustrate, let us a the case of a boiler one-quarter inch th, allowed 100 pounds at a factor of 4. At the end of say fifteen years we the metal has wasted away. Mani- fe, the pressure should be reduced. find out how much it should be re- d, the sheet is drilled and is found e three-sixteenths inch thick, the de- te ration having been 25 per cent.; a fa r of 4.5 is applied and the resulting pr sure is found to be 75 pounds, or 25 p ds less than in the beginning. This s rrect, for the metal has wasted 25 per cent., but if it had not de- te rated at all, one would not be justi- n reducing the pressure 25 per cent., r reducing it only 25 per cent. if the pl had deteriorated 40 per cent.

e condition of the boiler is not re gnized. This should be done. We mi have a boiler of the water-tube ty in which, at the end of ten years, all he tubes were replaced with new n Such a boiler is practically as go as new, yet, according to this for- m, the pressure would be reduced just the same as if the tubes had not been re ed. The same would apply to an int nally fired boiler, where they had re- ne d the furnace, or to a locomotive- ty boiler, where they had renewed the fir x. Again, we have some boilers that run practically twelve hours a day, under a light, even load; other boilers run twenty four hours a day, under severe ring, forced draft, and with a constantly fluctuating load. Then, too, some boilers are not operated over four months in the year and such boilers, at the end of three years, have seen only one year of service. This difference in condition of operation must be recognized.

Is it not unfair to steam users to reduce their pressure every five years, because of the age of the boiler *only*? In general, the factor of safety should be increased as the boiler increases in age, but the factor must be apportioned according to the judgment of a skilled inspector, and cannot be set arbitrarily by a rule, unless that rule contains so many variables that by the time the proper factor is computed one has defeated the object that he wished to obtain—namely to derive a factor which is independent of the personal equation of the inspector.

## Wishbones versus Backbones

Don't wear your wishbone where your backbone ought to be. The bony framework of some engineers is very much misplaced. We don't want to sermonize and won't, but it is one of the functions of a journal of this character to be critical when criticism may do some good.

Some men succeed while others fail in every occupation. There is always a reason, and if we inquire into the cause of failure in power-plant management, we shall find in most cases that it is a matter of bones, the wishbone being misplaced and the backbone being, perhaps, mislaid altogether.

One engineer steps out of a position and another takes his place, instituting reforms that effect wonders in economy. It may be that the first man lacked sagacity, but it is a safer guess to say that he lacked backbone.

We must illustrate our meaning. Let us go into the boiler room. We all know that this department of the power plant has hitherto been very much neglected. We also know that the place to make the big savings is where the coal is being burned, that one reform in the boiler room is usually worth, in dollars and cents, several reforms in other places.

It is one thing to realize the necessity for reforms and it is another thing to start the reformations. We would expect that a serious attempt at improvement would be made in every boiler room, but nothing more than a desultory effort in this direction is made in the most of them. Why is it? Let us examine the excuses that the average engineer offers:

"The firemen are ignorant." If this is the case, it is the fault of the engineer-in-charge. He has no more important duty than seeing to it that his men are instructed. If the fireman is too dull to learn, he should be discharged.

"The firemen won't follow instructions." If there is an equivalent for saying that the engineer has no backbone, this is it. Somebody is "boss" in every plant. It's a case of the chief commanding the men or the men under him commanding the chief. If the engineer-in-charge knows how to handle men, he can have every operative under him eating out of his hand. If he does not know how to manage them, it's a case of waste and the manager will wake up some day and place a ban on waste of every kind that is avoidable. This complaint that the men will not obey is the weakest thing that an engineer ever uttered. It's entirely too common.

When it comes to urging the importance of studying combustion subjects, more excuses are met with. "I never studied chemistry." What of it? You can begin, can't you? It is not necessary that you should compass much of the technical side of this science. There are some things, however, that you can and should know. Any engineer will tell you that he would "like to know all about it." The wishbone is in evidence. If lack of time is urged as an excuse for not knowing, we may put it down that the backbone is either absent or extremely rudimentary.

We would like to popularize the study of combustion among engineers and the use of the flue-gas-analysis instrument. The proposition is not a mysterious one. It should have no terrors for anybody. We shall discuss it frequently hereafter.

We hold that the most ignorant fireman, if possessed of a willingness to learn, can be made over into an efficient operative and that it should be the duty of some competent person in every power plant to superintend the education of the boiler-room operatives.

We believe that a proper instrument for the analysis of the flue gases is an important if not a necessary apparatus and that every engineer should be supplied with one of them.

Readers of POWER are asked to submit their combustion problems to us. We may, perhaps, be able to offer some helpful suggestions. If you have tried the work of gas analysis and succeeded, tell us about it. Tell us what you did and what you accomplished. If you have tried without results, by all means tell us about it. If requested, we will not use names and addresses.

The Roché Engineering Company, 812 Weightman building, Philadelphia, has undertaken the agency for the New England Roller Grate Company for New Jersey, Pennsylvania, Delaware, Maryland, Virginia and the District of Columbia.

# Power Plant Machinery and Appliance

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

## Recent Improvements in the Green Fuel Economizer

We illustrate herewith three new features lately introduced by the Green Fuel Economizer Company, Matteawan, N. Y.

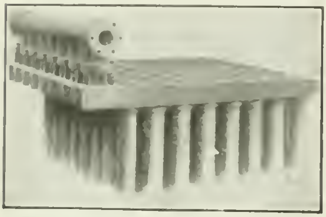


FIG. 1. SHOWING NEW TOP HEADER WITH BRANCH PIPE

Fig. 1 shows the new "extended" top header. Formerly the openings through which the hot water flowed out to the top branch pipe were placed directly over the last row of tubes and were made large enough for the introduction of the lids. This construction, however, made it necessary when washing out, either to leave the last row unwashed, or to remove the branch pipe in order to wash it, or else the branch pipe was fitted with handholes, being known in that case as an "access" branch pipe.

In the new design, the necessity of removing or opening the branch pipe has been done away with by extending the header out beyond the last row of tubes, thus permitting of getting at every pipe, by the removal of the corresponding lid. To permit of taking out the lids from the header, one, called the "master-lid," is made larger than all the others, so that the others can be removed through the master-hole. If it becomes necessary, for any reason, to remove the master-lid from the header, the branch pipe can be taken off, the opening to the branch pipe being made large enough for the removal of the lid. The sides of these improved headers fit closely together, thereby making a gas-tight joint. Where the extra width would be objectionable, a header with an access branch pipe placed directly over the last row of tubes is supplied.

Another improvement along somewhat the same lines is a new bottom header, shown in Fig. 2. Formerly it was customary to make the bottom headers of a circular section and the space between the headers was only an inch or so. Occasionally it was found that soot scraped from the tubes by the automatic scrapers would bridge over this narrow opening, resulting in the clogging up of the economizer. In order to avoid this, a header was designed having a cross-section of which the depth was about 50 per cent. greater than the width, the latter dimension being considerably less than in the old circular section. This change left plenty of room, not only for the soot to fall through, but also for the introduction of a man's arm, for the replacing or adjusting of scrapers. This bottom header is extended sufficiently far beyond the last row of tubes to carry the joint where the bottom branch pipe is attached, well outside of the economizer chamber so that it is not affected by hot gases; the joint is always subject to inspection, metal-to-metal joints only bei used in the economizer chamber.

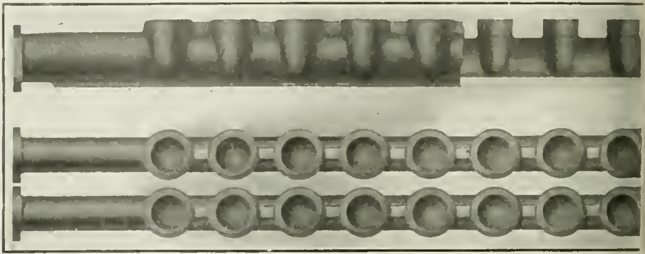


FIG. 2. NEW STYLE OF BOTTOM HEADER

An automatic soot-pit cleaner is shov in Fig. 3. The soot-pit chamber is ma with a trough from which the soot c be conveniently removed at one end, t bottom of the chamber being smooth. either end of the chamber drums, mount on horizontal shafts, one of which tends outside of the chamber are fitt and are driven by a chain from scraper-driving mechanism above. Endl chains running on these drums carr brush and scraper which, alternat pass over the bottom floor of the ch ber, carrying the soot to the trough pit at the end. With this apparatus in eration there should be no possibilit soot piling up in the soot chamber. though it would seem that the econon itself would deserve inspection at ciently frequent intervals to make unnoticed accumulation of such amount of soot improbable.

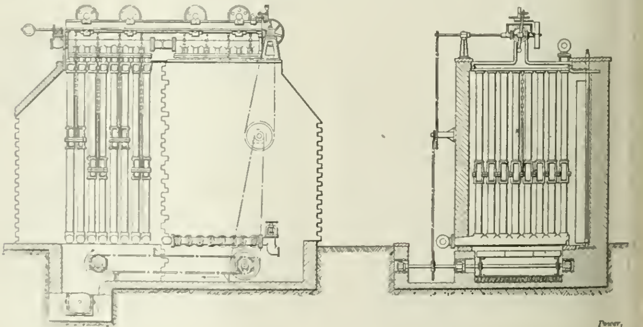


FIG. 3. SHOWING NEW SOOT-POT CLEANER

# New York" Gas Producer and Engine

The New York Engine Company, suc- sor to the Watertown Engine Com- ny, has added to its product a line of hracite gas producers and single-act- gas engines. Fig. 1 is a sectional vation of the complete producer and s. 2 to 5 illustrate the construction of hit-and-miss type of engine. The pany also builds throttling engines for ce requiring very close speed regula-

he producer is so simple in construc- that the drawing is almost self- natory. It is of the straight, updraft n type, with a stationary grate and aporizing top in the generator. The er to make steam is discharged from supply pipe through a faucet *m* into open pan, whence it flows through ll inclined tube into an open funnel This forms the mouth of a U-tube g into the vaporizer which seals the rizer from the atmosphere. The r in the vaporizer (*R*) is maintained constant level by an overflow pipe *a* ng down to the sump *Z*. Steam passes the vaporizer to the ashpit by way of the pipe *P*, and mingles there with the air for combustion.

The gases leaving the generator pass into a U shaped cooling pipe which also serves as a separator to take out the heavier particles of dirt, depositing them in the sump *Z*. From the cooler, the gases pass to the wet scrubber *H*, and

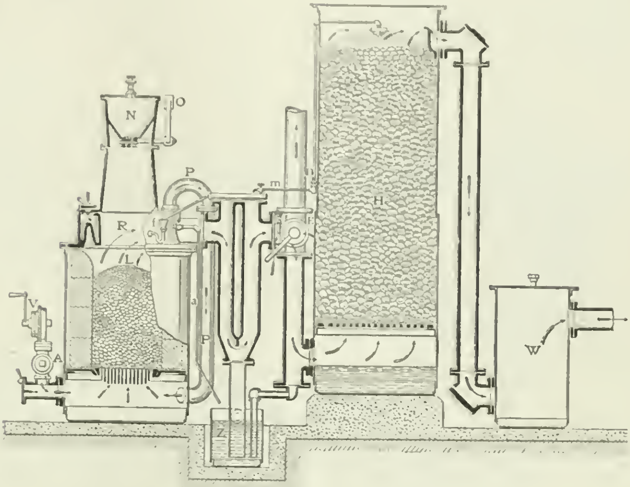


FIG. 1. SECTIONAL ELEVATION OF "NEW YORK" GAS PRODUCER

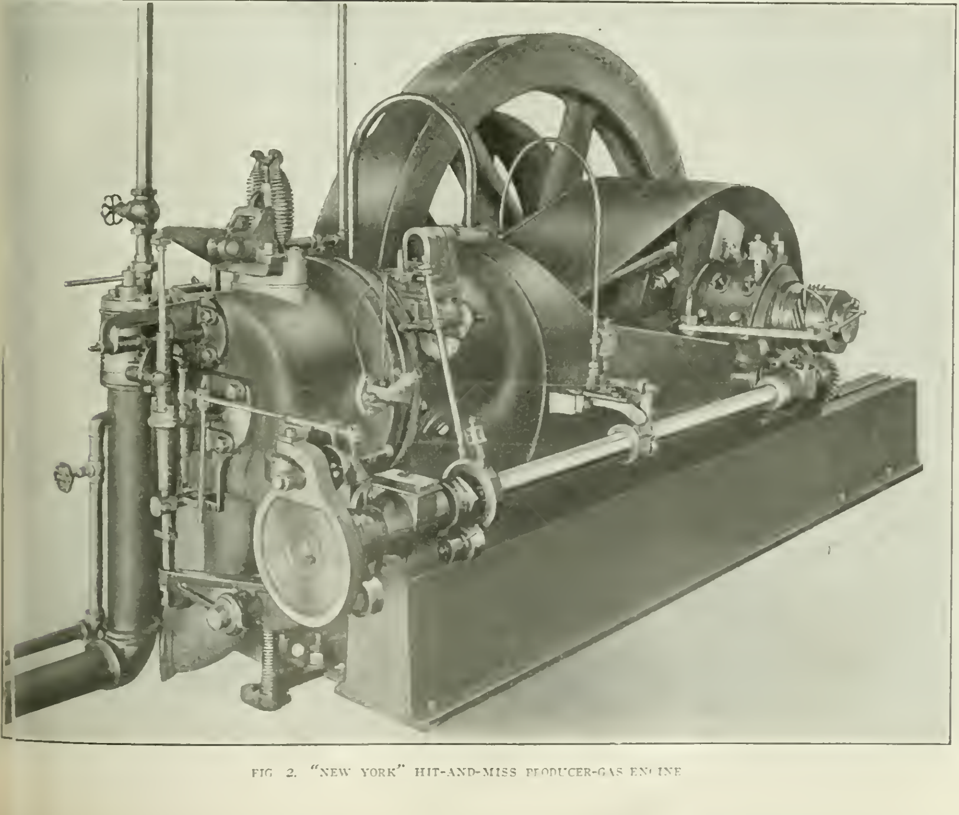


FIG. 2. "NEW YORK" HIT-AND-MISS PRODUCER-GAS ENGINE

through an expansion tank H to the final outlet. A small tank I is provided for blowing up the fire when starting the generator up. The other features of construction are perfectly obvious from the drawing.

Fig. 2 gives a view of the engine on the valve-gear side, and Fig. 3 shows most of

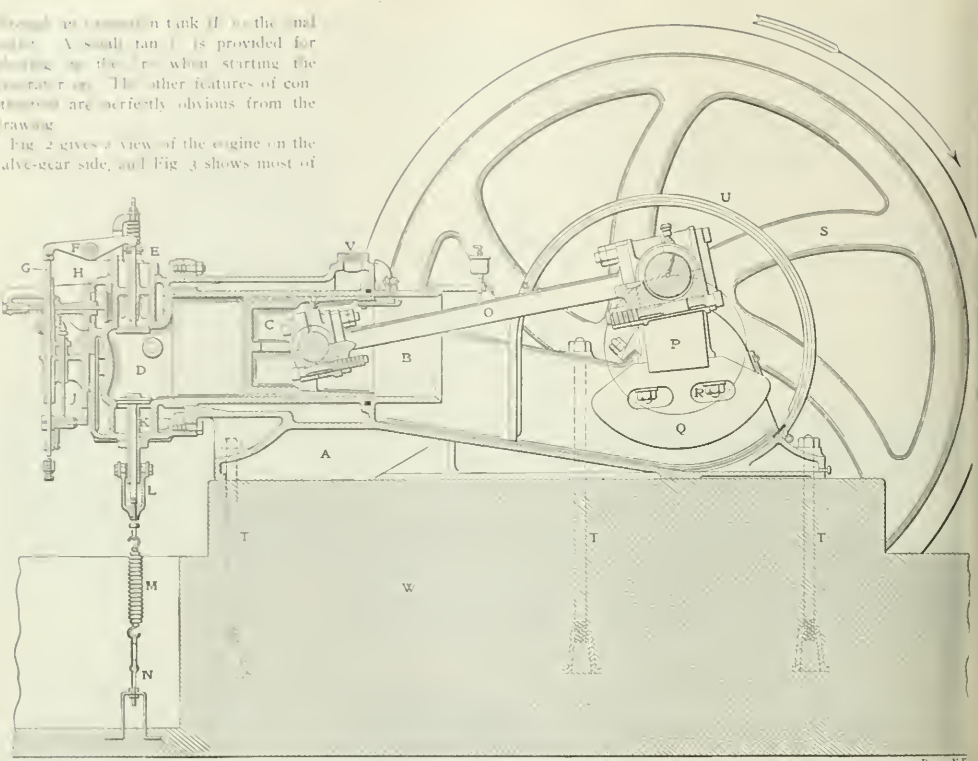


FIG. 3. GENERAL DETAILS OF CONSTRUCTION; NEW YORK GAS ENGINE

the constructional features. The frame, cylinder, piston, connecting rod and crank shaft are all of familiar forms. The valves, too, are conventional as to type. The exhaust valve *K* is opened by a cam and rocker-arm and seated by a long helical spring *M* in tension. There are two inlet valves, one at *H* controlling the admission of gas to the cage of the main valve *E*, which controls the mixture of gas and air. This latter valve *E* is opened regularly at every suction stroke by a cam and main rocker-arm acting through the push-rod *G* and the small rocker *F*. The gas valve *H* is opened by a bell-crank *I* which is actuated by the push-rod *J* which receives its motion from the push-rod *G* through a sort of pick-blade buffer controlled by the governor. long as the speed is normal or below mal, the buffer is in working position the gas valve is opened for every su stroke. If the speed exceeds the n rate, the governor pulls the buffer o position and the gas valve remains cl It will be noticed from Fig. 3 tha gas valve opens outward; consequentl suction of the piston cannot affe except to hold it more tightly closed

The piston is lubricated with oi by a little pump mounted on the si

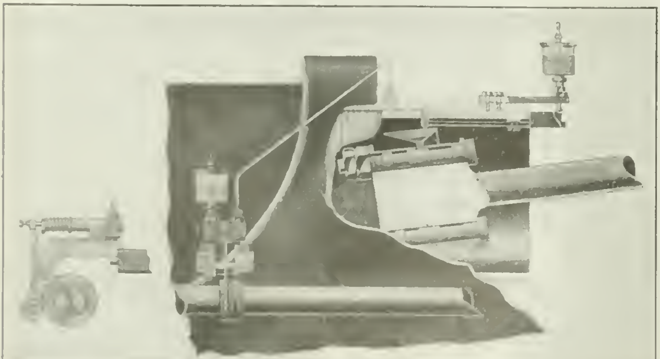


FIG. 4. OILING ARRANGEMENTS FOR PISTON AND GUDGEON PIN

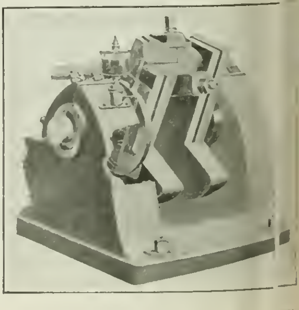


FIG. 5. LUBRICATION OF CRANK AND
BEARINGS

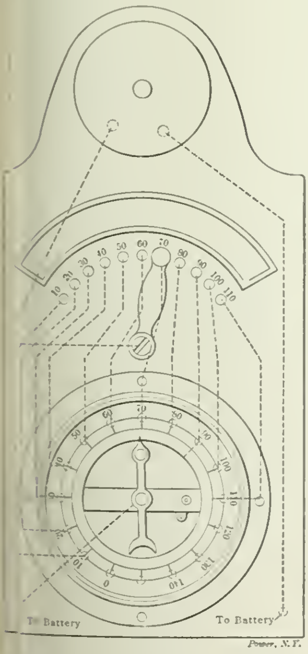
e frame, as shown in Figs. 2 and 4. he wristpin is lubricated by gravity feed m a sight feed cup into a trough car- d on the end of the connecting rod, shown in Fig. 4. Fig. 5 shows plainly method of feeding oil to the main rings and crank pin.

gnition is effected by means of a recip- ting magneto and a make-and-break ter, as indicated in Fig. 2.

These engines are built in sizes ranging m 17 horsepower (9x16-inch cylinder) to 150 horsepower (24x30) in the gle-cylinder form. For larger outputs ticylinder and double-acting engines built up to 1000 brake horsepower.

## Pressure Gage Alarm

n the accompanying illustration is wn an ordinary pressure gage and tric bell, which by means of the con- ns shown in the drawing may be ring at intervals of 10 pounds ure on the gage. On the underside the face of the gage is mounted a ring, which supports a series of pins sated from the gage and connected he terminals above. These pins are t intervals of 10 pounds on the scale f e gage, and when it is desired to ha the bell ring at, say, 70 pounds, it is ly necessary to place the lever on this particular stud, and when the hand of the gage reaches 70 pounds on the scale, the bell will ring.



Power, N.Y.

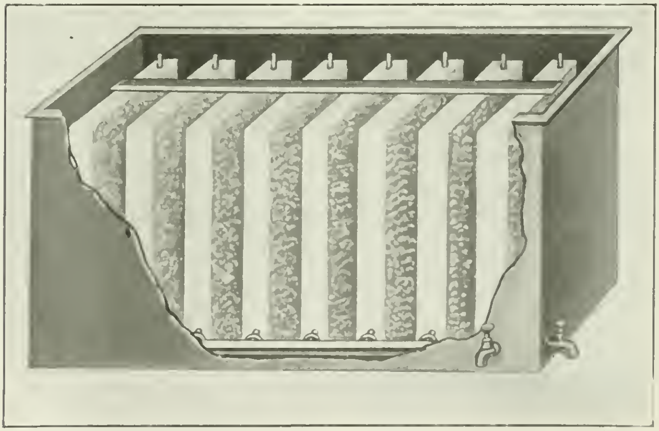
PRESSURE-GAGE ALARM

The alarm was designed by A. C. Scribner, of Gloversville, N. Y., especially for automatic sprinkler systems. By using it in connection with the dry-air system, the gage can be set to a point which warns against a lower air pressure, in case of a leak, before the main valve reverses and allows water to flow into the pipe and freeze up. When a system is being pumped up it can also be set to ring at a given point and not permit the operator to overcharge or make it necessary to continually watch the pumps. It is also a valuable device for a steam gage when a fireman has other duties to perform, and may be used to advantage on gas pressure and circulating systems.

## Sucro Gravity Water Filter

The Sucro gravity water filter, a German system of filtering water for all purposes, is being introduced in this country by the Sucro Filter Company, 42 Broadway, New York City.

The Sucro filtering medium is a cell, consisting of a frame of any suitable size or shape, surrounded by a flexible filtering material. A small pipe introduced into the upper part of the cell acts as an air vent. The filtering material is produced by fusing chemically pure asbestos cloth and a porcelain-like substance into a homogeneous, infrangible mass, said to be heat- and frost-proof, and exceedingly durable, each square inch of filtering material containing approximately 195,000 pores.



SUCRO FILTRATION SYSTEM

Impurities do not enter these pores, as only a small percentage of them collects on the outer surface of the filtering material, whence they can be readily removed by a brush. As the liquid to be filtered passes through the cell horizontally, most of the impurities immediately sink to the bottom of the tank containing the cell. This, together with allowing the filtrate to pass from the inside of the cell to the outside, effectually prevents clogging of the pores. The compact form of the cell permits of its ready sterilization, and no chemicals are used to assist filtration. The illustration shows one type of filter.

The cell is designed to occupy a perpendicular position. The number of cells forming a filtration system depends entirely upon the output of filtrate required. The ordinary household or office cooler contains but one cell. A municipal, office-building, or factory filtration system differs only in that it embraces a larger number of cells.

Every one of its parts is visible and easy of access for cleaning. In small systems cleaning is done by hand. In the larger systems cleaning is done automatically, by means of long revolving brushes operated by an electric motor and suspended from a movable platform, somewhat of the nature of a crane, passing over the surfaces of the cells. In such cases, a jet of water or steam precedes and follows the path of the brushes and assists in washing the impurities from the faces of the cells. The cleaning mechanism is designed simultaneously to brush the front and back surfaces of two cells.

The National Fire Protection Association's Committee on Artificial Refrigeration recommends: That graphite be used as a lubricant in air compressors used in dense air systems and for air compression for purposes other than refrigeration, as the temperature of the compression cylinders undoubtedly rises in some air systems to a point where inflammable vapors may be generated from lubricating oil.

# Inquiries

*Questions are not answered unless they are of general interest and are accompanied by the name and address of the inquirer.*

## [illegible] of Heat to [illegible]

Will a 3-inch pipe, 50 feet long, carrying 5 pounds pressure radiate as much heat as a 2-inch pipe, 50 feet long, carrying 50 pounds pressure?

J. T. M.

The outside diameters of 2- and 3-inch standard pipes are, respectively, 2.375 and 3.5 inches. As the circumference is 3.1416 times the diameter, the surface of a 50-foot length of each size would be:

For the 2-inch,

$$\frac{2.375 \times 3.1416 \times 50}{12} = 31$$

square feet; for the 3-inch,

$$\frac{3.5 \times 3.1416 \times 50}{12} = 45.8$$

square feet. The division by 12 is to reduce the circumference in inches to feet.

The temperature of 5-pound steam (20 pounds absolute) is 227, and that of 50-pound steam (65 pounds absolute) 298 degrees Fahrenheit. Assuming the temperature of the air surrounding the two pipes to be 60 degrees, the difference between the temperature of the pipe and the air would be:

| 5 lb. | 50 lb. |
|---|---|
| 228 | 298 |
| 60 | 60 |
| 168 deg. | 238 deg. |

The radiation, other things being equal, is directly proportional to the surface involved and the difference in temperature.

In the case of the 2-inch pipe we have 31 square feet of radiating surface with 238 degrees of temperature difference, which is equal to

$$31 \times 238 = 7378$$

square feet at one degree of difference.

In the case of the 3-inch pipe we have the equivalent of

$$45.8 \times 168 = 7694$$

square feet at one degree of difference.

The larger pipe with the low-pressure steam would, therefore, radiate the most heat for equal conditions of exposure, air circulation, drainage, etc., *if the temperature surrounding it were 60 degrees.*

If the temperature surrounding the pipe were 80 degrees, the radiation would be almost equal.

| 2-inch Pipe | | 3-inch Pipe |
|---|---|---|
| 298 | Inside temp. | 228 |
| 80 | Outside temp. | 80 |
| 218 | Difference in temp. | 148 |
| 31 | Sq.ft. surface | 45.8 |
| 218 | | 1184 |
| 654 | | 740 |
| | | 592 |
| 6758 | Equiv. surface 1° | 6778.4 |

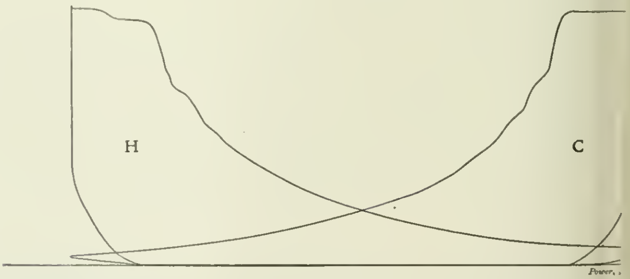
If the temperature of the air surrounding the pipe were much above 80, the smaller pipe at the higher pressure would radiate the more heat of the two, as can be seen by working an example along the line indicated.

## *Irregular Diagrams*

In the accompanying diagram, why does the indicator pencil rise higher than the steam line and what causes the steam line on the head end to drop? The engine has been running for eight months.

H. J. E.

The reason that the admission line rises higher than the steam line is the momentum of the moving parts of the indicator. They get to going and do not stop where they ought. The steam line on the head end is somewhat higher to start with than that upon the crank. This may be due to having a smaller clearance, or to the setting of the head-end valves. The best way to find out why it is so is to take a diagram from the steam chest either simultaneously with that taken from the cylinder, or, if you have but one indicator, under as nearly as possible the same load, speed and other conditions. If you will put the steam-chest diagram over the other diagram, making the atmospheric lines coincide, and draw the boiler-pressure line above the steam-chest diagram, you will have in the difference between the steam-chest diagram and the boiler-pressure line the loss of pressure at each point between the boiler and the steam chest, and in the difference between the steam line and the lower line of the steam-chest diagram, the difference of pressure between the cylinder and the steam chest and can locate in that way the point at which the pressure is lowered. The steam line upon the head end is apt to fall away more abruptly than that upon the crank on account of the faster motion of the piston in the head end of the cylinder due to the angularity of the connecting rod.



## *Cause of Pressure Rise in Ice Machine*

I am running two compression ice machines in a 50 ton ice plant, and the high pressure of one of them rises as I pump down. What is the cause?

H. G.

Without more definite knowledge of your actual running conditions, it is impossible to state definitely that an overcharge of ammonia in the machine in question is what gives rise to the r in head pressure you mention, but assu ing that other conditions are kept co stant, this is the only cause that sugge itself. You are undoubtedly pumping yo ammonia out of the expansion side the system and "storing" it in the co pression side, that is, on the conden and receiver. If there is more than enou ammonia to fill the receiver the remain goes into the condenser and when o pipe after another of the condenser f up with liquid, the remaining availa condensing surface is reduced proporti ately. Reduced condenser surface can made up for, to a certain point, by creasing the water supply, which tends reduce the head pressure, but when condenser gets filled above a certain p and the water supply is increased ab a certain quantity, further increase comparatively little additional cooling fect and the head pressure accordin rises.

Such a condition may not necessa indicate an overcharge of ammonia. far as the *expansion side* of the sys is concerned, and aside from seeing the compression side is not suffici overcharged with liquid during the pu ing-down process to occasion danger ly high head pressures, the expansion only is to be considered.

For the purpose of producing along, only just sufficient liquid is quired so that there will always be liquid at the expansion valves; tha so that there will be gas slugs to the expansion coils at any time. condition can always be readily recogn by the intermittent hissing sound duced by the passage of alternate q tities of gas and liquid. The cond in which there is just sufficient li to give a solid flow at the expansion is the minimum charge that can be ployed with economy. To provide unforeseen contingencies, such as l through leaks, trapping of liquid in of the system, etc., it is always expe to have the liquid charge some larger than this, a credit balance in bank to guard against overdrawing account if collections do not come they should.

## Book Reviews

TERNATING CURRENT MOTORS. By A. S McAllister. Published by the McGraw-Hill Book Company, New York. Cloth; 334 pages, 6x9 inches; 138 illustrations. Price, $3.

This is the third edition of Dr. McAl- ter's excellent textbook, and it has been ght up to date to a surprising degree. split pole synchronous converter, h is only about a year old, is treated this edition; a chapter on synchronous ters has been added, and the discussion sparking in single-phase commutator rs has been extended to cover motors commutating poles. About the only rse comment that can conscientiously made regarding this work is that it s not present enough of engineering ce: that is, it is restricted almost rely to principles.

MENTARY ELECTRICAL CALCULATIONS. y T. O'Conor Sloane. Published y D. Van Nostrand Company, New York, 1909. Cloth; 304 pages, 5½x9 ches; 41 illustrations. Price, $2.

covering the whole field of direct- rent calculations and giving the basis ternating-current mathematics, in ad- to introductory chapters on arith- and exponential notation, and ap- es on special subjects, the treat- is necessarily abbreviated and per- confusing by the introduction of so subjects in a limited space. The r has endeavored to make his math- l illustrations as simple as possible, to help the student numerous prob- les have been presented and the solu- s given. Some idea of the ground red by the book may be obtained the following chapter headings: s Law, Resistance, Kirchoff's Laws, A gement of Batteries, Electric En- nd Power, Bases and Relations of tric Units, Thermo-Electricity, Elec- emistry, Fields of Force, Mag-, Capacity and Inductance, Hys- and Foucault Currents, Alternating t, Networks, etc.

careful study of the book should n insight into the various subjects g to direct- and alternating-current and the simple presentation for the part does not require more than mentary knowledge of mathematics.

## Books Received

tural Sources of Power" By Robert ll. D. Van Nostrand Company, New Cloth; 348 pages, 5¼x8¼ inches; llustrations. Price, $2.

eam Power Plant Piping Systems" By William L. Morris. McGraw Hill Bo Company, New York. Cloth; 400 pag, 6x9¼ inches; 389 illustrations; indexl. Price, $5.

"Electric Power Conductors." By William A. Del Mar. D. Van Nostrand Company, New York. Cloth; 320 pages, 5x7½ inches; tables; illustrations, indexed. Price, $2.

"A Manual of Steam Engineering" is the title of an engineer's handbook prepared by W. H. Wakeman for the New York Belting and Packing Company for gratuitous distribution to their customers. The manual, exclusive of the complete index and a limited number of pages of advertising matter, contains 300 5½x2½-inch pages of reading matter, including instructions, suggestions and illustrations for engineers concerning the application of the theory of steam engineering to daily practice. There are upward of 50 useful tables which in connection with the rest of the volume provide a convenient and reliable book of reference for everyday use.

"How to Utilize Exhaust Steam" is the subtitle of a catalog of the Cochrane Open Feed Water Heaters which has just been issued by the Harrison Safety Boiler Works, Seventeenth and Clearfield streets, Philadelphia, Penn. The title is well justified by the fact that fully two-thirds of the book is occupied by discussions and illustrations of different ways of employing exhaust steam, as for heating, drying, evaporating, heating water for boiler feeding and for use in dye works, tanneries, bleacheries and paper mills, etc. In a chapter entitled "The Possibilities of a Pound of Steam" it is pointed out that at the best only 10 or 12 per cent. of the total heat energy in steam can be converted into mechanical work, and that the remainder still present in the exhaust of an engine or turbine is as good for most of the purposes for which steam is employed as is the same weight of live steam. In a chapter on "Condensing Plants," it is shown that it does not pay to install electric- or power-driven auxiliaries as long as the steam from steam-driven auxiliaries can be used for heating the feed water. The section on "Corrosion" gives the latest results, showing that air in solution in the water is a necessary condition to corrosion and pointing out that a large part of this air can be driven off from the water by spraying the latter through a steam bath, as in the Cochrane Open Heater. The book contains 104 pages, 6x9 inches, and is distributed gratis to those interested in steam-plant matters.

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The Eccentric Association of Engineers, No. 1, of New York, will hold its twenty-second annual entertainment and ball at Amsterdam Opera House, on Saturday evening, December 4. The event is for the benefit of the widows' and orphans' fund connected with the organization. A first-class vaudeville entertainment has been arranged for by the committee.

## Engineering Societies

### AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., Jesse M. Smith, New York, N. Y.; sec., Calvin W. Rice, Engineering building, 29 West 39th St., New York. Next meeting, New York, December 7-10, 1909.

### NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Wm. C. L. Eglin, Philadelphia, Pa.; sec. and treas., John F. Gilchrist, 139 Adams St., Chicago, Ill. Association headquarters, 29 W. Thirty-ninth St., New York.

### ENGINEERS' CLUB OF PHILADELPHIA

Pres., W. P. Dallett; sec., W. P. Taylor, 1317 Spruce St. Regular meetings 1st and 3d Saturdays.

### AMERICAN SOCIETY OF NAVAL ENGINEERS

Navy Dept., Washington, D. C. Pres., Rear Admiral John K. Barton (retired) U. S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N.

### AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, Cleveland, O.

### WESTERN SOCIETY OF ENGINEERS

Pres., Andrews Allen; sec., J. H. Warder, 1737 Monadnock Block, Chicago, Ill.

### ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., George T. Barnsley; sec., E. K. Hiles, 803 Fulton building, Pittsburg, Pa. Meetings 1st and 3d Tuesdays.

### AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., Louis A. Ferguson; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly, excepting July and August.

### ENGINE BUILDERS' ASSOCIATION OF THE UNITED STATES

Pres., A. L. Merriam, Oswego, N. Y.; sec., C. H. Sembower, Reading, Pa.

### UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, W. S. Cadwell, Chicago, Ill.; sec., Thomas H. Jones, 244 Eighth street, N. E., Washington, D. C. Next convention, Buffalo, N. Y., August, 1910.

### NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., William J. Reynolds, Hoboken, N. J.; sec., F. W. Raven, 325 Manhattan building, Chicago, Ill. Next convention, Rochester, N. Y., September, 1910.

### AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next convention, Philadelphia, Pa., June, 1910.

### OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS

Pres., F. W. Ballard; sec., David Gaehr, 1135 Schofield Bldg., Cleveland, O.

### MASTER STEAM BOILER MAKERS' ASSOCIATION

Pres., J. H. Smyth; sec., Geo. M. Clark, 1337 N. Maplewood Ave., Chicago, Ill.

### INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., Robert A. McKee, Peoria, Ill. Next convention, Denver, Colo., September, 1910.

## The Melville Marine Turbine Gear

In the November 9 issue it was erroneously stated that the spiral gearing used in the Melville-McAlpine marine turbine gear was cut by Shuchardt & Schutte, while as a matter of fact the cutting was done at the works of Hermann Pfauter, Chemnitz, Germany.

## Personal

Ernst J. Berg, who has for many years been closely associated with Dr. Charles P. Steinmetz at the Schenectady works of the General Electric Company, has been appointed professor of electrical engineering, in charge of the department, at the University of Illinois. Mr. Berg has been a member of the General Electric engineering staff for 17 years, during which period he has had a prominent part in the development of new types of alternating-current apparatus. His change of occupation will deprive Dr. Steinmetz of one of his most loyal and efficient assistants, and give the Urbana university an unusually well qualified head for its electrical-engineering course.

## Society Notes

The American Society of Mechanical Engineers has accepted an invitation from the Institution of Mechanical Engineers of Great Britain to hold their summer meetings jointly in England. The invitation has been accepted by the council of the American society and the joint meeting will be held from July 26 to 29, it is not yet announced whether at London or elsewhere.

At Boston the local members of the American Society of Mechanical Engineers will hold a meeting on Wednesday evening, November 17, in room 6 of the Lowell building of the Institute of Technology, with a topical discussion on Low Pressure Steam Turbines. This discussion will be participated in by W. L. R. Emmet, General Electric Company; H. G. Stott, Interborough Rapid Transit Company, New York, Richard H. Rice, General Electric Company; Prof. Edward F. Miller, Massachusetts Institute of Technology, and others.

The annual ladies night of the Brooklyn Council, No. 8, Universal Craftsmen Council of Engineers, was held at Masonic Temple, Brooklyn, N. Y., on Saturday evening, November 8. The handsome meeting rooms were comfortably filled. The entertainment was thoroughly enjoyed, the following gentlemen participating: Herbert Self, Peerless Rubber Company; Joe McKenna, Jenkins Brothers; John Lloyd Wilson, Swan & Finch Company; Frank Corbett, Ashton Valve Company; Dan Quinn, and Jack Armour, of POWER. During the evening Herbert E. Stone, of the Dearborn Drug and Chemical Works, called to the platform C. H. Palmateer, and presented him a handsome past chief's jewel. Refreshments were served, and good nights were said after a most enjoyable evening.

## Business Items

A directory of engineers and power plants of Illinois, Indiana and Wisconsin has just been issued by the Stationary Engineers Directory Company, 253 La Salle street, Chicago. An alphabeticay list of the plants is given, with their capacity and the names of the engineers in charge, also an alphabetical list of the engineers in Chicago. The price of the directory is $5.

Thurlow E. Coon, formerly with Fairbanks, Morse & Company's Detroit branch, in charge of the water-works department, has recently been appointed manager of the Ball Engine Company's Detroit office. Mr. Coon will also act as district manager for the Bundy steam traps and separators, the Buffalo Forge Company and the Buffalo Steam Pump Company, with offices at 1809 Ford building.

## New Equipment

The International Acheson Graphite Company is building another addition to its plant at Niagara Falls, N. Y.

The Butler Hospital, Providence, R. I., is building a new power house.

The Atlantic Mills, Providence, R. I., have a new power house under construction.

The Congealed Ice Company, Providence, R. I., is making preparations to erect a ne factory.

The Norwich (N. Y.) Gas and Electric Com pany expects to replace two of its boilers w a large 250-horsepower boiler.

## Help Wanted

*Advertisements under this head are serted for 25 cents per line. About six wo make a line.*

WANTED—Thoroughly competent ste specialty salesman; one that can sell hi grade goods. Address "M. M. Co.," Pow

AN ENGINEER in each town to sell t best rocking grate for steam boilers. Wr Martin Grate Co., 281 Dearborn St., Chica

AGENTS WANTED to sell Burgmann ce brated engine packings in territories not covered. See our advertisement on page

WANTED—Night engineer to take cha of boilers, engines, ice machines, pumps, e with proper assistance; give reference, sal wanted and notice required. Box 55, Pow

WANTED—First-class draftsman and e mator for high-class steam power and he ing work. Address, giving full particul references and salary wanted, Box 826, Cl lotte, N. C.

## Situations Wanted

*Advertisements under this head are serted for 25 cents per line. About six wo make a line.*

CHIEF ENGINEER operating large cen station plants and producing results, wo like to connect with a concern which des a first-class man. Box 66, POWER.

CHIEF ENGINEER; machinist by tra 14 years' experience in power and ligh plants, both steam and hydraulic; also perienced in refrigeration. Box 69, Pow

ENGINEER of 500-horsepower plant; st and gas engine experience; direct and a nating current, single or polyphase genera line work; Maine or New Hampshire ferred. Box 70, POWER.

ELECTRICAL ENGINEER with highest erences, wishes to form connection with concern, preferably in or near New Y three years' experience in Mexico, five y in Chili; speaks Spanish and German flue has had wide experience both in selling constructing electrical, steam and hydr machinery; open for immediate engagem Address "H. K. W.," Box 71, POWER.

## Miscellaneous

*Advertisements under this head are serted for 25 cents per line. About six w make a line.*

PATENTS secured. C. L. Parker, Soli of Patents, 4 McGill Bldg., Washington,

ANY FIRM or engineer in charge steam plant that is troubled with scale h boilers can get absolutely free, the best cator and reducing wheel made, with ve lined mahogany case. For particulars dress Great Lakes Chemical Works, Ma woc, Wis.

## For Sale

*Advertisements under this head are serted for 25 cents per line. About six make a line.*

ONE 13x26-INCH Buckeye engine, first condition; can be seen running at the fa of the Standard Tool Co., Cleveland.

FOR SALE—20x48 Wheelock engine two 72"x18' high pressure tubular boil good condition cheap. Address "Engi Box 2, Station A, Cincinnati, Ohio.

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Crosby Steam Gage & Val Co. ........
Curtis & Curtis Co. ........

Danubil Co. ........
Davis Regulator Co., G. M. .
Dearborn Drug & Chemi Works ........
De Laval Steam Turbine C
Detroit Lubricator Co. ....

# Public Service Corporation Power Plant

## A Modern Power Plant, Free from Frills and Built for Business. Steam Turbine Driven Auxiliaries a Feature, also Their Uniformity of Design

### BY WARREN O. ROGERS

The Marion power plant, of the Public rvice Corporation of New Jersey, is ictly a business proposition. It is loed on the low land, just west of Jersey ty Heights.

Adjacent to the power house flows the ackensack river, with its supply of salt ter for condensing purposes. The elaware, Lackawanna & Western railad is on the south, while just beyond he Erie and at one end the New York, stern & Susquehanna, all of which ce the plant in a position convenient the delivery of coal and other sup- ps.

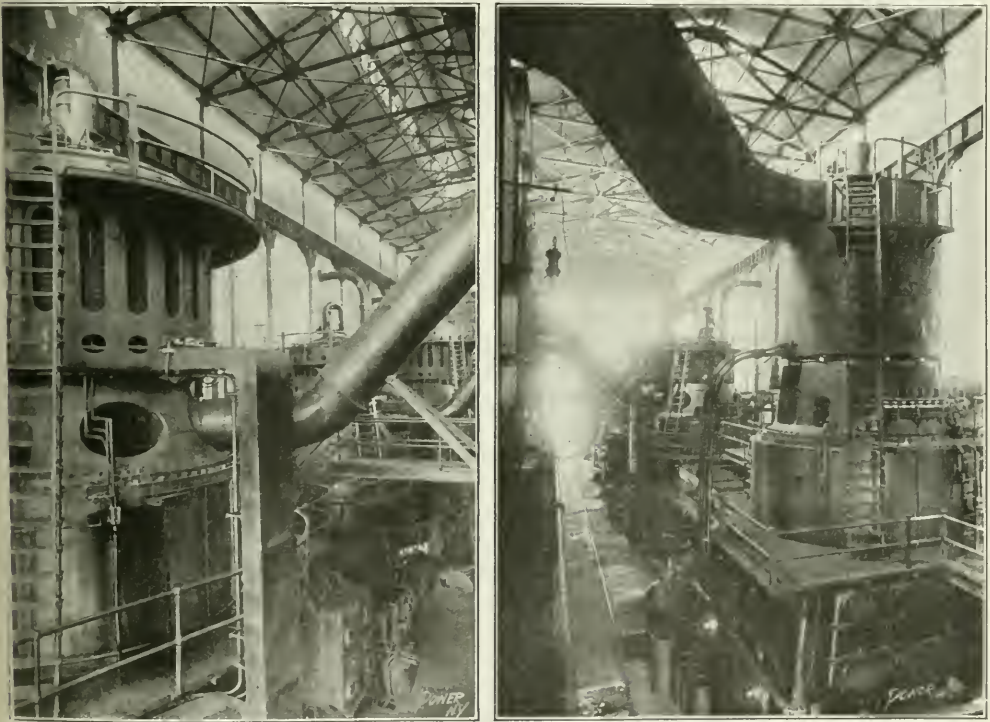


FIG. 1. TWO VIEWS OF THE TURBINE ROOM, MARION POWER PLANT

### Turbines

The turbine plant, illustrated in Fig. 1, originally consisted of four Curtis turbines: two, 3000 and two, 5000 kilowatts capacity. Today the turbine room contains turbines of 34,000 kilowatt capacity, or 45,800 horsepower, divided among the following units: Two 4200-horsepower, vertical Curtis turbines, each direct connected to a 3000-kilowatt generator, running at a speed of 720 revolutions per minute, 60-cycle, amperes 131 and voltage 13,200: two 6700-horsepower, vertical Curtis turbines, each direct connected to a 5000 kilowatt generator, running at a speed of 500 revolutions per minute, 25-cycle, amperes 215 and voltage 13,200, and two new Curtis vertical turbine units of 12,000 horsepower, each direct connected to generators of 9000 kilowatt capacity, running at a speed of 720 revolutions per minute, one 25-cycle, and one 60-cycle, amperes 393 and a voltage of 13,200.

The turbines are placed as shown in Fig. 2, the platform of one being connected to that of the next machine, which enables the operating engineers to pass from one to the other without going down on the floor. The generators are cooled by air, admitted through air ducts, which, in the case of 9000-kilowatt generators, is taken from the outside directly above the switchboard-room roof. In the case of the other four turbines, the air is supplied by means of motor-driven blowers. The auxiliaries are mostly located between, and at the back of the turbines, as shown in Figs. 2 and 3, the forms [illegible] of the entire [illegible] of the plant, while Fig. 3 shows a plan view of the piping of the first four units that were installed, the two [illegible]-kilowatt units being piped in practically the same manner.

Although the plant has been added to, the various apparatus has been kept of the same size and type wherever possible, another of the marks of business enterprise.

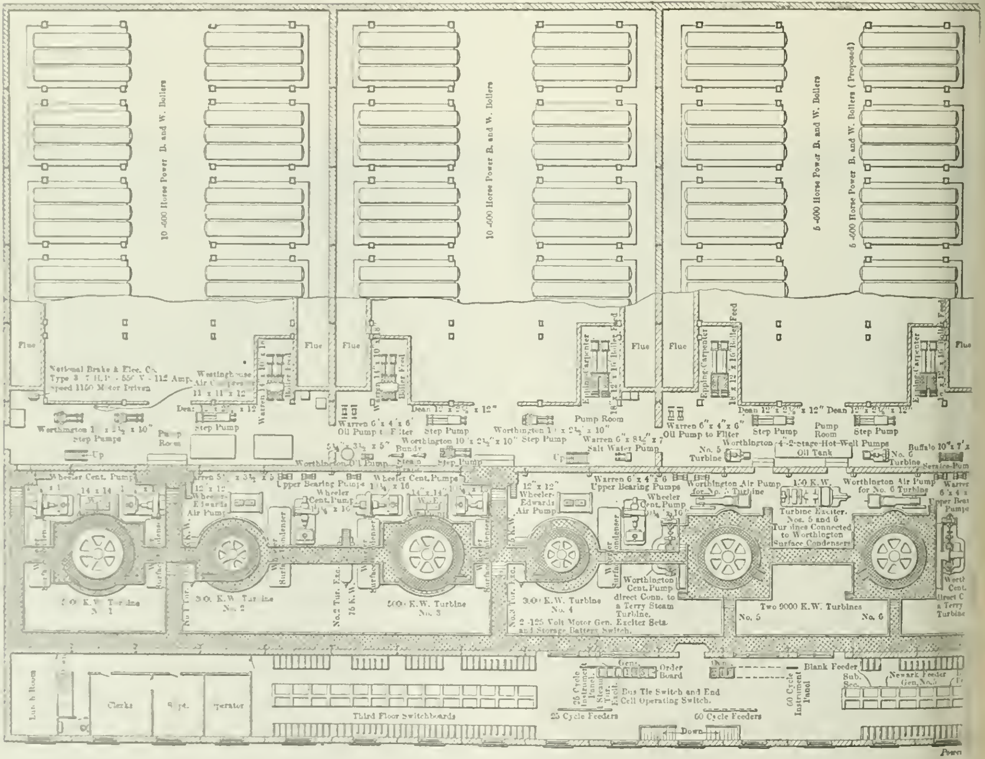

10-600 Horse Power B. and W. Boilers
10-600 Horse Power B. and W. Boilers
5-600 Horse Power B. and W. Boilers
5-600 Horse Power B. and W. Boilers (Proposed)
Flue
National Brake & Elec. Co. Type 3 7 H.P. - 550 V - 112 Amp. Speed 1150 Motor Driven
Westinghouse Air Compressor 11 x 11 x 12
Warren 14 x 10 x 16
Boiler Feed
Dean 12 x 2½ x 12
Step Pump
Worthington 1 x 2½ x 10" Step Pumps
Pump Room
Up
Warren 6" x 4" x 6" Oil Pump to Filter
Worthington 10" x 2½" x 10" Step Pump
Bundy
Steam
Worthington Oil Pump
Wheeler Cent. Pump
Warren 5" x 3½ x 5
Upper Bearing Pumps
12" x 12" Wheeler-Edwards Air Pump
Wheeler Cent. Pump 10¾ x 16
14 x 14
Surface Condenser
Wheeler
No.1 Tur. Exc.
No.2 Tur. Exc. 75 K.W.
No.3 Tur. Exc.
500 K.W. Turbine No. 1
300 K.W. Turbine No. 2
500 K.W. Turbine No. 3
300 K.W. Turbine No. 4
Epping-Carpenter
18" x 12" x 16" Boiler Feed
Warren 6" x 8¼" x 7 Salt Water Pump
Warren 6" x 4" x 6 Upper Bearing Pumps
Worthington Air Pump for No. 5 Turbine
Worthington Air Pump for No. 6 Turbine
150 K.W. Turbine Exciter.
Nos. 5 and 6 Turbines Connected to Worthington Surface Condensers
Worthington 4"-2-stage-Hot-Well Pumps
Oil Tank
No. 5 Turbine
No. 6 Turbine
Buffalo 10" x 7" x
Service-Pum
Worthington Cent. Pump direct Conn. to a Terry Steam Turbine.
2-125 Volt Motor Gen. Exciter Sets and Storage Battery Switch.
Two 9000 K.W. Turbines
No. 5
No. 6
Lunch Room
Clerks
Supt.
Operator
Third Floor Switchboards
25 Cycle Instrument Panel
Steam Tur. Excit.
Gens.
Order Board
Bus Tie Switch and End Cell Operating Switch.
25 Cycle Feeders
60 Cycle Feeders
60 Cycle Instrument Panel
Blank Feeder
Sub. Sec.
Newark Feeder Gen. No. 5
Down
Power

FIG. 2. GENERAL ARRANGEMENT OF TURBINES, AUXILIARIES AND BOILERS

### Exciters

There are four exciters for the six turbines, three being of 75 kilowatt capacity, 600 amperes and 125 volts, running at a speed of 2400 revolutions per minute; the fourth being of 150 kilowatt capacity, amperes 1200, voltage 125, and running at a speed of 2000 revolutions per minute. All exciters are of the General Electric make, and are direct connected to Curtis horizontal turbines, the three smaller units being placed between Nos. 1, 2, 3 and 4 turbines, the large 150-kilowatt exciter being placed at the rear and midway between Nos. 5 and 6 turbines.

### Condensers, Circulating and Air Pumps

A study of Fig. 2 will give, in detail, the position and general arrangement of the condensers, circulating and air pumps. Nos. 1 and 3 and Nos. 2 and 4 turbines are equipped with duplicate auxiliaries, Nos. 1 and 2 being equipped with two condensers each, and one Wheeler-Edwards air pump. Nos. 2 and 4 turbines are each connected to one Wheeler condenser, which is supplied with condensing water by Wheeler centrifugal pump, a 12x12-inch Wheeler-Edwards air pump being supplied with each turbine. Nos. 5 and 6 turbines are connected to two Worthington condensers, each of which is supplied with cooling water by a Worthington centrifugal pump. Each condenser is also piped to a Worthington air pump.

An end elevation of the turbine room is shown in Fig. 4, also the convenience with which cooling water is obtained. As the water duct connects directly with the river, which flows by the end of the building, the condenser-water supply is always available, the lift varying with the rise and fall of the tide, the difference being designated by the mean high- and mean low-water mark shown.

### Boilers

The present boiler plant consists of twenty-five Babcock & Wilcox water-tube boilers, of 600 horsepower each, and equipped with superheaters which supe heat the steam 125 degrees, on the ave age. These boilers are located in thr distinct boiler rooms, as shown in F 5. The lower view shows ten of t boilers which are hand-fired, when use the coal being delivered to the firem through the coal chutes shown. Only few of these boilers are in use at t present time. The center view sho ten 600-horsepower boilers set in t batteries. These boilers are equipped w Roney mechanical stokers, driven Westinghouse stoker engines. The c is delivered to the hopper through c chutes from the coal bin above, wh is shown in Fig. 6. The upper vi shows the latest installation of bo five in number, of 600 horsepower and are placed in No. 3 boiler roo which space has been provided for more additional boilers of the same when required, see Fig. 2, which make this boiler room a duplicat No. 2.

Each boiler is equipped with a s heater, has 249 tubes, 18 inches long 4 inches in diameter, carries 195 po steam pressure, 200 pounds being the maximum pressure allowed.

Above the boiler in each room a coal-storage bin with "W"-shaped b om

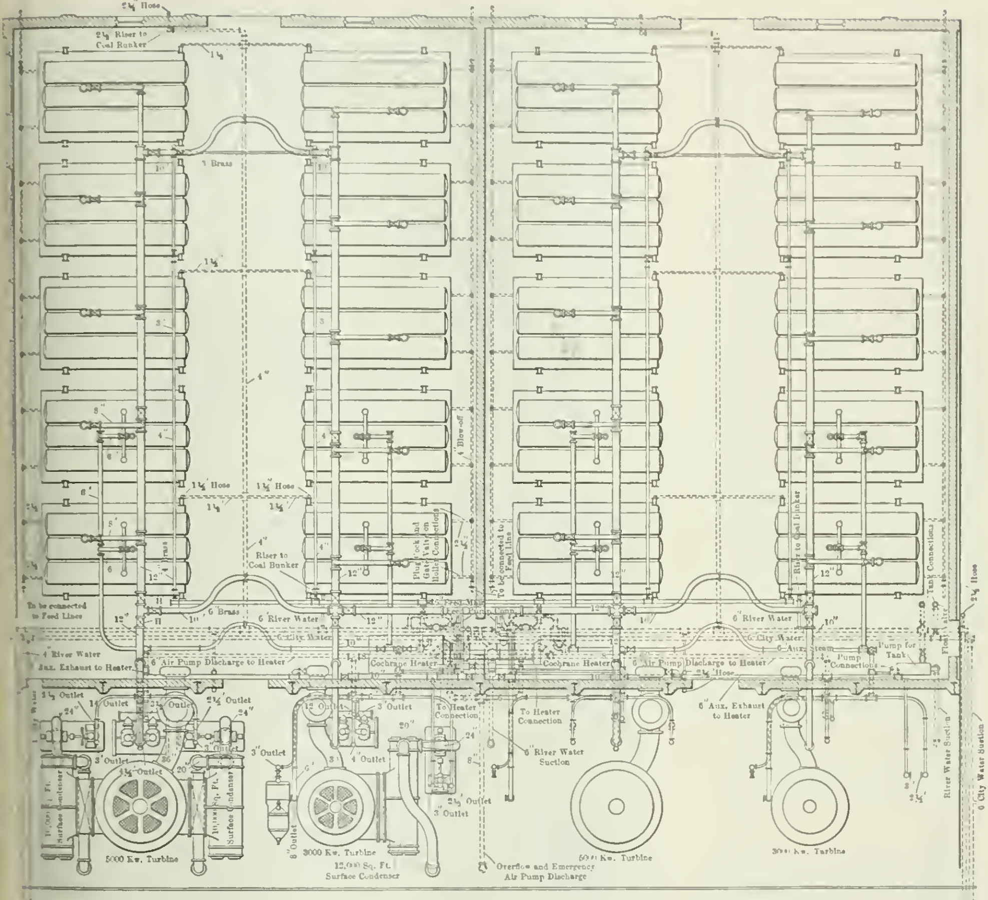
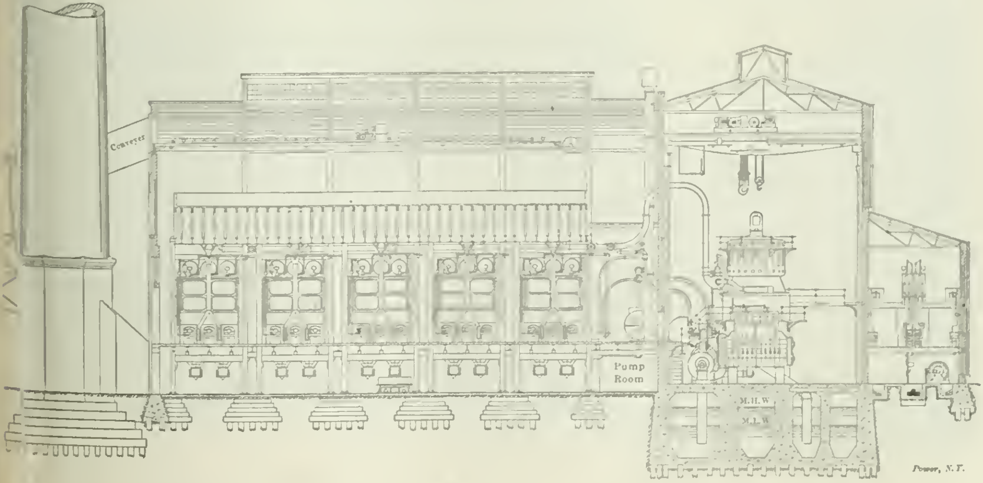


FIG. 3. SHOWING PIPING OF TURBINES, AUXILIARIES AND BOILERS

*Power, N.Y.*



*Power, N.Y.*

FIG. 4. END ELEVATION OF BOILER AND TURBINE ROOMS

and coal chutes to the hoppers of the stoker.

Under each boiler is a brick-lined ash hopper, fitted at the bottom with suitable gates. When it is desired to remove the ash an ash wagon is backed under the outlet, the gates opened and the cart filled with ashes and hauled away.

### Coal Conveyers

Above the coal bin in each boiler room is installed a Robins motor-driven belt conveyer, extending the entire length of the boiler room. As the conveyer track is placed in the center of the coal bin, the conveyer discharges the coal on either side, and for the entire length of the bin, the point of discharge being determined by the operator. The conveyers over the coal bin are fed by another belt conveyer which runs the entire length of the boiler building and extends beyond at one end to the weighing shed. Coal is delivered either from ships at the wharf, Fig. 11, or railroad cars by means of a separate belt conveyer, which passing over a coal-weighing machine weighs the coal while on the belt. After being weighed, the coal is delivered to the belt conveyer, running to the boiler room, from which it is delivered into chutes and fed to the conveyers running to the bins in the top of the boiler room.

### Pumps

The pump room, Fig. 7, is located on the ground floor next to the turbine room, as indicated in Fig. 4, the location and size being shown in Fig. 2. The three 18 and 12 by 16-inch Epping-Carpenter feed pumps are located in bays built out from the pump room proper, as shown in Fig. 2. There are also two 14 and 10 by 18-inch Warren boiler-feed pumps placed in the same manner. Oil to the step bearings of the turbines is pumped by Dean and Worthington duplex pumps, the sizes and location being shown in Fig. 2.

### Switchboard Room

The switchboard room is level with the balcony shown in Fig. 1. The two views shown in Fig. 8 are of the two ends of the room, the operating board being shown in the foreground in each instance. This board devotes two panels to two 125-volt motor generators, exciter sets and storage battery switches. One is devoted to bus-tie switches and end-battery cells operating switches, three to generators Nos. 1, 2 and 5, and the last panel is used as an order board. This order board operates a system of signaling, devised by the chief electrician, so that the operator at the switchboard can give and receive signals to and from the engineer on the turbine floor. This particular feature is of such interest that it will be treated in a separate article in another issue. The switchboard controlling generators Nos. 2, 4 and 6 is shown in front of the 60-cycle feeder board, shown in

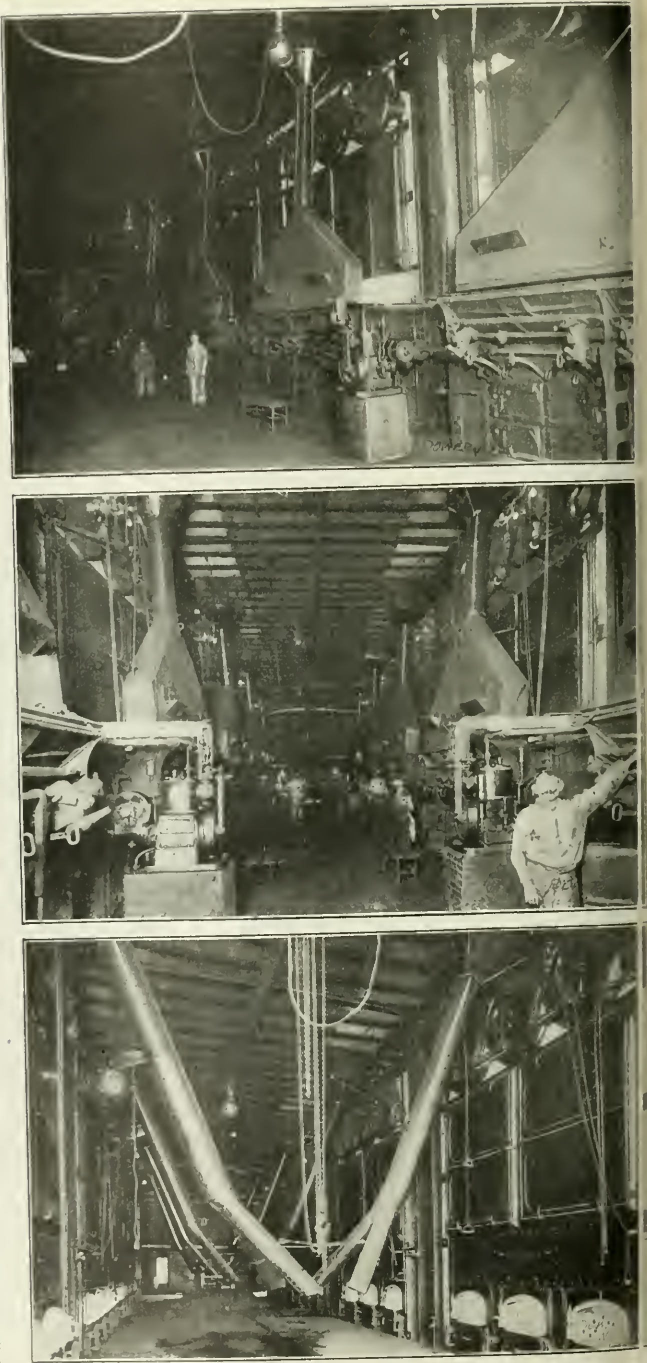


FIG. 5. VIEW OF THE THREE BOILER ROOMS

e right-hand view of Fig. 8, beyond the ble. The position of each is also shown Fig. 2. The generation panel controls l switches, which are motor operated, l all necessary operating and recording truments are found on the other panel.

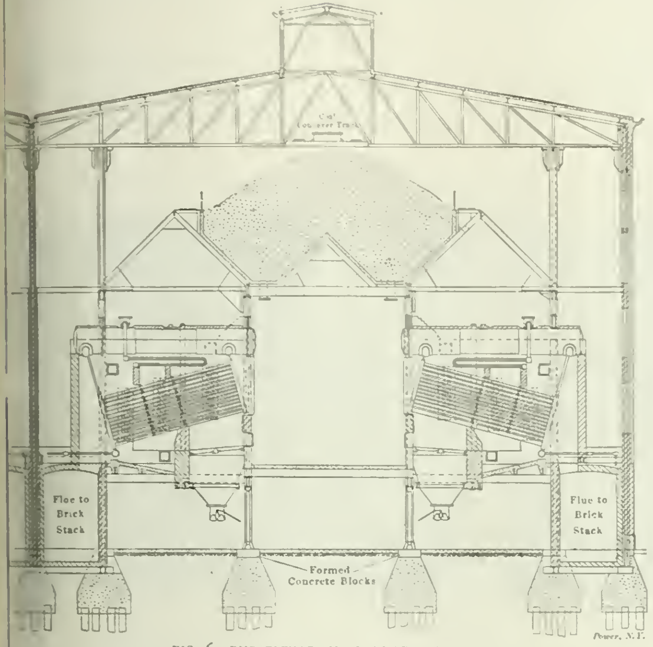


FIG. 6. END ELEVATION OF BOILER ROOM

### Load Despatcher

he Marion plant operates in conjunc- with several power plants and trans- er stations. The operation of the -tension system comes directly under pervision of the chief operator who ree assistants, one of whom is al- s on duty. These three assistants he load despatchers. In their office private telephone exchange, with ections to all stations and substations system. With the aid of the load tcher's operating board, shown in 0, the load despatcher has the en- ystem in view at all times. On this l are shown, in black squares and , all stations and substations in the m, also the generators, rotaries, transformers, switches, etc. In the r f these black spaces are small in which, when in service, a white is inserted; when available for ser- a red plug is inserted. For busbar ecting switches small brass screw are used, the position of the screw indicating an open or closed switch. he board are also shown all over- l lines and underground cables, their . and current capacity.

hen work is to be done on any of these lines or cables, the load despatcher is notified, and he orders such lines cleared from the busbar and tagged. He also has them short-circuited and grounded at the request of the foreman in charge of the repair work.

Special tags, provided for the purpose, are placed on the oil switch control on each end of the line, and one on the load despatcher's operation board. When this has been done, the line or cable is turned over to the foreman in charge of the repair work, and at the same time he is notified where the tags, etc., have been placed. The line or cable is then held off until the foreman reports "O. K" to the load despatcher, after which the tag, etc., are removed, the necessary tests made, and the line is again put in service. This rule also applies to all high-tension apparatus. No high-tension apparatus line or cables are operated without instructions from the load despatcher, except in cases of extreme emergency, and if so operated, he must be notified at once and will then assume control of the situation. This load-despatcher system was started the first of the present year and has proven a success up to the present time.

In Fig. 10 is shown a station-load curve chart, one of which is made up from the daily readings, which are taken every fifteen minutes. It contains a curve for the 25- and 60-cycle machines, a total of both and a boiler curve, shown by the heavy straight line.

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## Don'ts for Engineers

By H. E. Wood

Don't use slimy water in a boiler.

Don't forget to open your trycocks often.

Don't fail to try your safety valve every day.

Don't throw coal promiscuously all over the fires.

Don't fail to try your foundation bolts occasionally.

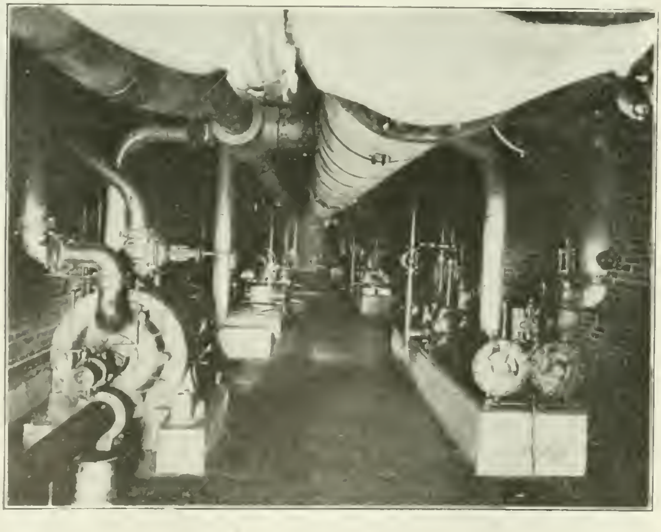


FIG. 7. VIEW OF PUMP ROOM

Don't neglect a leak in your boiler, pipes or fittings.

Don't rely altogether on your glass gage for water level.

Don't leave the blowoff cock while blowing off water.

Don't let water or dampness get on the outside of your boiler.

Don't pump very cold water directly into a boiler with steam on.

Don't close the passageway between the boiler and the steam gage.

Don't use a light hammer, or hit light blows when driving out bolts.

Don't forget that the careful and skilful fireman is a good smoke preventer.

Don't forget that it is up to the fireman to protect the lives of the people in the vicinity of his boiler.

Don't allow too much smoke to issue from the smokestack, if it lies within your power to prevent it.

Don't forget that smoke is an extra expense to the man who buys the coal.

Don't forget that the very black smoke contains a large amount of unburned carbon, which should be ignited and used.

Don't run away with the foolish idea that you are the only one who can run the plant, for someone else might want a whack at it.

Don't forget that a stationary boiler sometimes has just as many lives at its mercy as has a railroad locomotive.

Don't fail to have your steam gage tested at least once a year, as it is the instrument that talks more forcibly than the phonograph.

Don't run an engine without having the nuts on the pillow blocks marked so you can tell if they are moved, maliciou or otherwise.

Don't fail to investigate all points ab a boiler with which you are not famili because ignorance is no excuse, in case boiler explosions.

Don't screw a valve clear open, and the stem stand tight, but when it stri the stopping place, turn it back again enough to leave the stem free.

Don't use a wire or metallic rod a handle to a swab, in cleaning the wat gage glass, for it makes the glass liabl a sudden break in a short time.

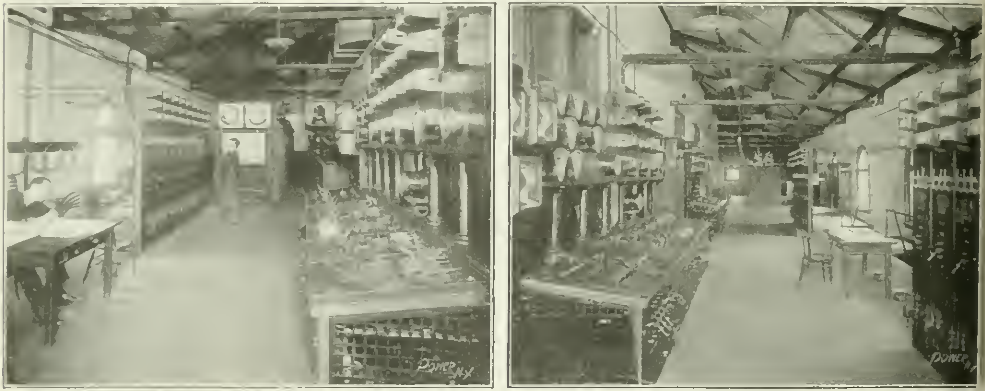


FIG. 8. SHOWING BOTH ENDS OF THE SWITCHBOARD ROOM

Don't think, because you can boil a teakettle that you are an engineer.

Don't let the boiler prime, as water does not agree with a steam cylinder.

Don't fail to keep all gages and cocks clean.

Don't fail to open the blowoff cock once a day, if the water contains a sediment.

Don't start your fire in the morning without plenty of water in your boiler.

Don't allow filth of any kind to accumulate around the boiler or engine room.

Don't forget that a steam pump requires attention.

Don't turn on the boiler feed the first thing in case low water is discovered.

Don't screw up the piston-rod gland too tight and injure the packing.

Don't fail to cover your fires the first thing in case low water is discovered.

Don't forget that more importance is to be placed on the water than on the fire.

Don't run a steam-pump piston more than 100 feet per minute except in emergency.

Don't fail to examine all cocks, valves and connections when cleaning the boiler.

Don't fail to inspect the boiler and machinery upon taking charge of a new job.

Don't do anything about an engine without a reason, but when you do it, do it well.

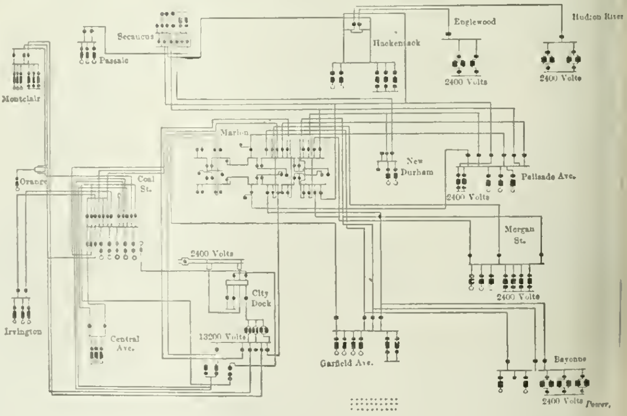


FIG. 9. DIAGRAM OF DESPATCHER'S BOARD.

Don't forget that some people b it improves the life and service crank-pin box, to peen the babbitt in bore it to size afterward. It is cla that the peening densifies the surface also makes the babbitt fill the box b

Don't bring your engine to a dead while the babbitt is melting in the box. It is better to slow down as as possible without stopping, until the babbitt cools enough to set itself a then stop for repairs.

Don't be caught in an emergency with- at a couple of cold chisels, a calking ol, a crowbar, a piece of rope, a few unds of babbitt metal, belt-mending ols, lace, extra pipe fittings, valves, c

Don't be caught without extra parts, ke nuts, set screws, bolts, delicate parts engine, gage glasses, trycocks, etc., to used for quick repairs in emergency ises.

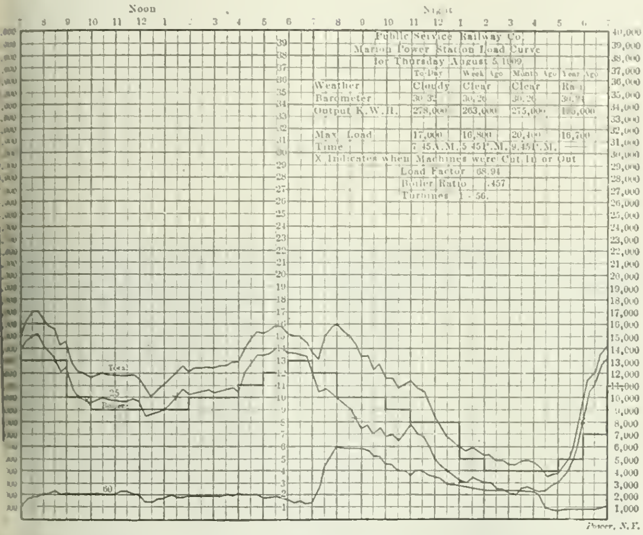


FIG. 10. STATION LOAD CURVE OF BOILERS, 25- AND 60-CYCLE CIRCUITS, ALSO TOTAL

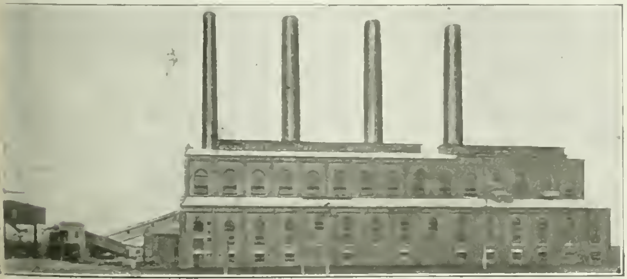


FIG. 11. VIEW OF POWER PLANT FROM THE SWITCHBOARD ROOM SIDE, ALSO SHOWING COAL UNLOADING CONVEYERS

't scratch, dent or distort in any w the crank pin or wristpin, when over- a g the engine, for they are just as ir rtant as the piston or cylinder.

n't hesitate about handling the con- ne ng rod and eccentric rods, while your en e is running, for you can feel a kn k before you can hear it.

n't take an engine apart to repair i, less there are sufficient witness marks on e parts so that anyone can tell where the go back again.

n't use emery cloth on a slide-valve sea there is danger of loose particles of emery getting into the ports and washing into the cylinder.

Don't think it is necessary for a crank box to fit tight along the cheek lines (or joint lines). Liberal clearance there is better.

Don't leave your wrench or hammer where you could not put your hand on it in case the room is full of steam or darkness.

Don't leave your climbing stools under the eccentric rods, or valve-connecting rods, after you are through oiling.

Don't admit casual visitors to the engine room when you are making repairs; your time is too valuable.

Don't neglect putting in good liberal oil channels, after repairing a crank box or pillow bearings.

Don't run away with the idea that you know all there is to be known about your engine or its valves.

Don't use oil that has any grit in it, for it is cheaper to throw it away.

Don't forget that a long-angle joint in a steam ring is far superior to a short angle joint.

Don't forget that a neatly corrugated steam ring is far better for repairs than a smooth one.

Don't rebabbitt a connecting rod and put it to work without lining it up from and to both pins.

Don't fail to be prepared for a sudden and quick shutdown, in case of accident or emergency.

Don't take a steam-chest valve out of an engine without first examining the lead and lap.

Don't repair or overhaul a steam chest without seeing that your valve lead is all right.

Don't fail to have locknuts or cotterpins, or both, on your connecting-rod bolts.

Don't get caught without cloth bandages and liniment, to use in case of accident.

Don't be stingy with oil; it is cheaper than repairs.

Don't leave your climbing stools or stepladders out of their regular places.

Don't rebabbitt a crank box without liberal liners in it, to take up wear.

Don't use cheap or low-grade babbitt in a crank-pin box; it does not pay.

Don't handle all the bright work you can reach when visiting an engine room.

Don't fail to neutralize feed water to the boiler, as it prevents scale.

Don't leave standing water in pipes that are exposed to cold weather.

Don't allow a slight knock in the engine to go unattended; look it up.

Don't allow people who visit your engine room to spit on the floor.

Don't use emery cloth to smooth up the crank box after rebabbitting.

Don't allow oil to stand in pools on the floor around the engine.

Don't allow your brass or polished parts to get dirty or rusty.

Don't fail to examine all stays in a boiler when cleaning it.

Don't fail to wash out your boiler often when using bad water.

Don't allow the feed-water 'heater to become clogged with sediment.

Don't leave the drain cocks closed when you stop the engine.

Don't neglect the cylinder-head nuts; keep them all tight.

Don't allow curious boys to be alone in an engine room.

Don't fail to look for leaky blowcocks occasionally.

Don't fail to keep water in the ashpit.

Don't screw valve wheels too tight.

Don't neglect back connections.

Don't overlook expansions.

Don't waste good steam.

Don't let steam drop.

Don't get too mad.

Please don't.

---

The death of George W. Hoffman, manufacturer of the U. S. metal polish and other specialties, occurred at his home in Indianapolis, Ind., October 22.

# Uncle Pegleg's Philosoph

## There Is Considerable Food for Thought Even in a Country Sawmill We Entertain a Salesman and I Get Started Upon a Boiler Problem

## HEATERS USEFUL EVEN IN A SAW MILL

It was due to Uncle Pegleg Maxwell that I was first roused to sit up and take notice. Ours was the lumber country up in the northern woods and we worked in a sawmill. Uncle Pegleg, going on sixty, had sacrificed a leg and most of the fingers of his right hand in the industrial warfare and had a comfortable berth as engineer. I was a young fellow and a part of my work was to help out the old man's physical deficiencies. He was kind and helpful, but full of a quiet sort of dignity that set him above the most of the men, even of the foremen. I remember once that I thoughtlessly addressed him as "Pegleg." He turned his blue eyes upon me with a quizzical sort of a look, not hurt, not offended, but which said plainly: "Sonny, I wouldn't do that again;" and I didn't.

He was always studying. There were few of the men about who interested him or who got much encouragement to come again when they looked into the engine room, so he was very much alone. I went in at first only to do such lifting and other things as he wanted, help about, and got after a while to eating my lunch there and spending some time with him.

One day when I was there he had a caller, a drummer for a concern that sold pumps and heaters. He had a nice portfolio full of pictures and tables and got off a half hour of monologue as to how many heat units we could save if we would put in one of his heaters, and how quick it would pay for itself. When he had been through it twice and was starting on a long list of letters of recommendation, the old man said:

"Did you notice that big stack as you came in with the cage over the top?"

The young man hadn't paid particular attention. Mr. Maxwell led him to the side door and pointed it out.

"It is what we call a 'destructor,'" he said. "We burn up in it what sawdust and trimmings we can't burn under the boilers to keep them from burying us up. How much do you think you could save us under those conditions?"

The drummer got off some confused remark about 'carting coal to Newcastle,' and started to make his escape.

"There are other things though," said Uncle Maxwell, "that a heater is good for even in a sawmill."

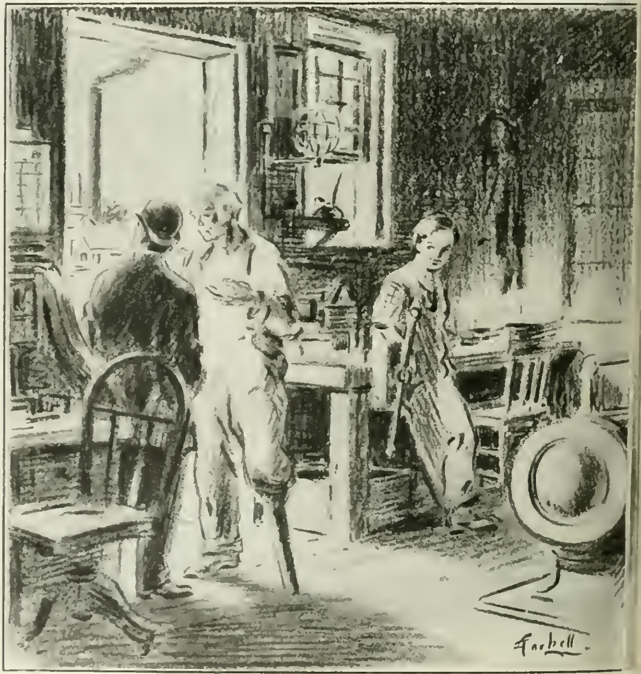
"Yes," said the drummer, brightening up, "the hot water is better for your boilers—saves contraction and expansion strains, and all that."

"Yes, and saves boilers another way. If I use hot water I can get along with fewer boilers than as though I put the water in cold. Our hardest work here is to get money to put into plant. Ever figure out how many less boilers a man would have to buy if he used a heater, how the price would compare, how much less it would cost for upkeep, whether the scale would throw down in the heater and keep the boilers in better shape, how much less it would cost to handle fuel for and keep an extra furnace in repair, and all those things?"

This was evidently a new line of thought to the salesman.

"With a good heater and all the exhaust steam I can use I can save about one boiler in six, and everything that goes with it. That would save interest on twelve or fifteen hundred dollars. It saves about a hundred dollars worth boiler a year for a boiler won't last more than fifteen years. It saves hand about one-sixth of the fuel, but that d count with us for we've got to get it of the way anyhow. It saves a lot sealing, and laying off besides being you say easier on the boilers from of contraction strains.

"Well, I don't know what boilers worth, but I can make you a good p



HOW MUCH DO YOU THINK YOU COULD SAVE US UNDER THOSE CONDITIONS?

on a heater. I'd mighty well like t one in up in this country. Our firm a reputation of being generous wit friends, and anything you could do t me land — the — of course —"

The drummer fumbled about in c fusion. The old man was looking a with that same look that he gave me I called him "Pegleg."

"No," he said. "We have bee through that long ago, and are all up. We've got a pump that's acting don't suppose you're anything of a pump loctor, are you?"

The drummer sidestepped on this by iving Uncle Pegleg the name and address f their "practical man." He didn't pretend to know anything about pumps himelf. The shop made the product and l' he knew how to do was to sell it. nd so he sailed away with an obvious nsciousness of duty done, and I watched im saunter up the yard, lighting a cigar cheerful disregard of the "No Smokg" signs, and I said:

"Gee! I wish't I had a job like that."

"Why?"

"Why? Look at the chance he has: Getg four or five times as much as I do r wearing good clothes, giving away l cigars, riding around the country, g at the best hotels, getting acquaint e with people and seeing everything t' s to be seen."

seeing nothing."

Huh?"

Did you ever hear of men who walk through the woods without seeing any trees? Well, he's one of them. Coming there into a country that is full of wte wood to save fuel. Got a lot of ot r good reasons for selling his goods if e only knew them, but all he knows is hat he gets out of his catalog. Do you think if I had been in his place I'd have gone out of this plant until I'd seen everything in it and found out if there was a possible chance for any of my stuff? He could have sold me a pump if he'd half tried. He can't get out of town until half-past four, and instead of staying here and making a friend and digging out stuff that will help him in the next place, he will go and sit around the hotel and read that picture paper he had in his bag, or make up to some of the town girls."

I thought of what a different use the old man would make of opportunities such as the drummer had, and of his limited sphere and possibilities, and said:

"Don't you ever get lonesome, stuck here in this little corner?"

"Lonesome! Why, boy, there's more to think of and study out here in this little corner than would last a man like me a dozen lives. It isn't where you are, it's what you are thinking of that makes you contented or otherwise. Pick up any one thing and think it out to a finish, and you'll be happier while you are doing it, and better when you've got it done. It's that kind of thinking that makes men get on and do things."

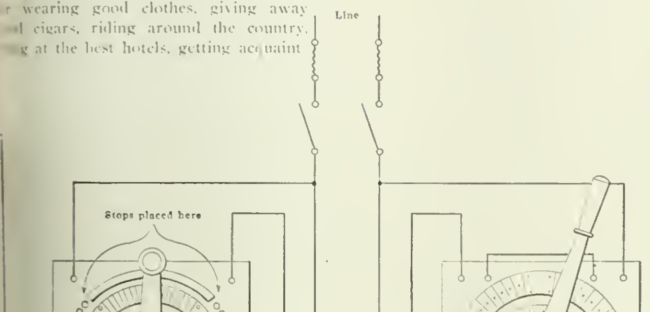


FIG. 1. EMERGENCY ARRANGEMENT FOR RUNNING A SERIES-WOUND MOTOR AT CONSTANT SPEED

I was willing enough to think, but I looked around the old accustomed scene and there was no inspiration in the too familiar surroundings.

"What, for instance?" I asked.

"See that boiler out there? Why are the girth seams single-riveted and the lengthwise seams double?"

I had never even noticed that it was so.

"Are they all that way?" I asked.

"Never saw one that wasn't."

"Then there must be some reason for it."

"There is. Think it over. It'll keep you from being homesick for a day or two."

It was starting-up time, and after I had blown the whistle and helped the old man to get her a-going, I went off to wrestle with the problem.

## Emergency Motor Connection

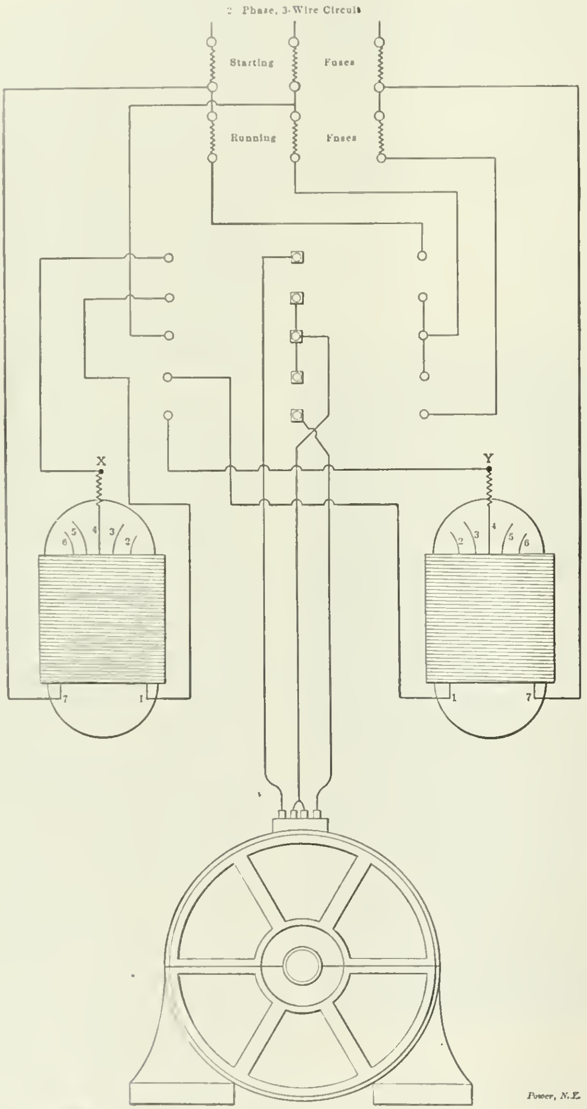
By R. H. Fenkhausen

In the operation of every large electrical installation, occasions frequently arise, due to breakdowns or excessive work, where standard apparatus is not at hand to replace that out of service. Under such conditions it is permissible to employ methods which would not be good practice under normal circumstances.

In the plant under my charge most of the motors are two phase 440-volt machines, and there are only about six direct-current motors, outside of crane service; therefore there are few direct-current motors available as spares in case of breakdown.

A 20-horsepower direct-current shunt-wound motor driving a machine tool was completely burned out, and the only motor on hand to replace it was a series-wound machine with a crane controller. The speed characteristic of the series motor prevented its use in this particular case, as close-speed regulation under varying load was essential; this had been obtained in the burned-out motor by the use of a "compound" controller with armature resistance for starting and a shunt-field resistance for speed regulation. The solution of the problem finally arrived at is shown diagrammatically in Fig. 1. The series-wound motor was installed in place of the burned-out machine, but its field winding was connected across the line in series with the grid resistance belonging to the crane controller. This was found to give the motor about the proper field strength, and as the grid resistance was proportioned for continuous duty it did not overheat. The lever of the "compound" controller was blocked as shown, so that it could not be moved past the normal speed position, and the controller was used as a starting rheostat in series with the armature.

Speed regulation was obtained by varying the resistance in series with the field winding by means of the controller *B*.



Power, N.Y.

FIG. 2. KNIFE SWITCHES AS A TEMPORARY SUBSTITUTE FOR A DRUM TYPE STARTING SWITCH

The efficiency of this outfit was, of course, extremely low, being only about 45 per cent., but the waste of power was offset many times by the amount saved by preventing a shutdown of the machine tool. Although only installed as a makeshift for a few days, this outfit gave satisfactory service for several months, as rush work prevented shutting down the machine to replace the repaired motor until that much time had elapsed.

A 75-horsepower two-phase induction motor with a drum type auto-starter switch and separate autotransformers was ordered from the factory. Upon the arrival of the motor it was found that no drum-type switch had been shipped with the autotransformers. The missing switch was of the six-point type connecting the motor successively to six different starting voltages. The motor was urgently needed so the scheme outlined in Fig was finally adopted. A three-pole doul throw switch and a two-pole double-thr switch were combined to make a f pole double-throw switch, and differ taps of the autotransformers were tr at *X* and *Y* until a tap giving enou voltage to start the motor was fou The starting current was high, beca there was but one starting point, the switch was used until the arrival the drum controller.

Another 75-horsepower motor equip with a similar type of controller direct-connected to a centrifugal pump shown in Fig. 3. The controller equipped with two sets of fuses, one starting and the other for running. If motor was started very quickly no fu were blown, but as soon as an atte was made to start up slowly the st ing fuses would blow on the second no This proved that something was wr and an investigation revealed the that the motor was wound for 440 v as ordered, but the autotransformers wound for 220 volts. There was no t to get proper coils from the factory even to rewind those on hand. Luc the motor was supplied from indivi transformers, so the transformers motor were both changed to 280 v The change was easily made at the tr formers simply by connecting the two tions of the secondary in multiple. heads were removed from the motor the winding reconnected for 220 volts connecting all the "N" poles in one se and all the "S" poles in another; two series being connected in multiple 220 volts. As the standard voltage the plant was 440, autotransformers this voltage were ordered, and the m and transformers reconnected for higher voltage upon their arrival.

## Upkeep of Parsons Turbines U. S. S. "Chester"

About six months ago considerabl tention was given in these columns to trial tests of the three United S scout cruisers, "Chester," "Salem" "Birmingham." The "Chester," it wi remembered, was equipped with Par turbines, and it will be of interes know how these machines have stood the wear and tear of actual vice. In this regard an article by A. F. H. Yates appeared in the A number of the *Journal* of the Ame Society of Naval Engineers. It ap that during the fourteen months of first commission, which ended earl July of the current year, the "Che had steamed slightly over 33,500 No repairs to her turbines had bee fected during this period, and with exception of one point to be rema upon, the machinery and boilers we excellent condition.

Throughout the greater part of the time the vessel had been in commission, e starboard low-pressure astern turbine had not started with the same ease as the rt astern turbine on occasions when he turbines were being tried preparatory getting underway. Its behavior on h occasions had been erratic and fol-wed no definite rule, though repeated rials of the same turbine appeared to ow it to run normally, and it had never iled on the very great number of oc-sions when its operation was required getting underway and coming to h r.

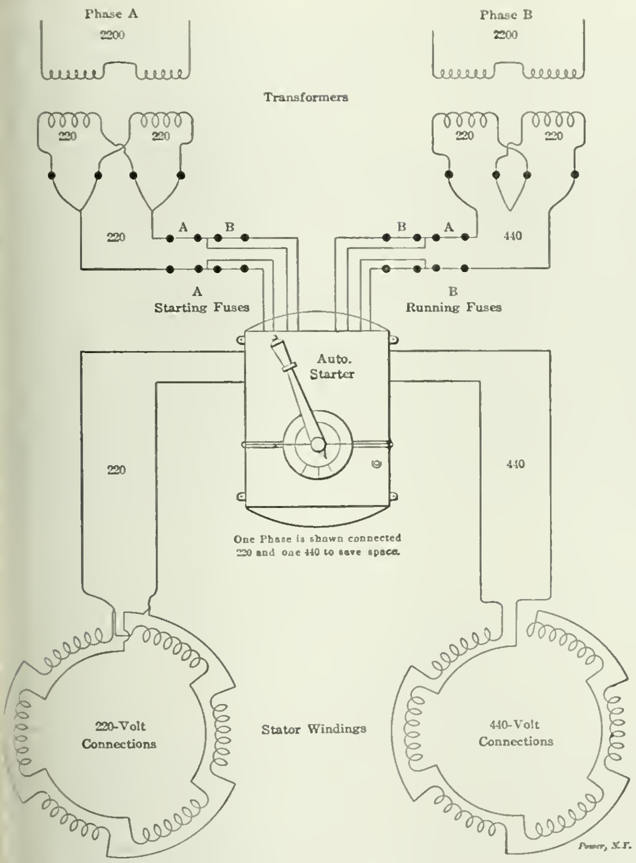


FIG. 3. ADAPTING A 440-VOLT MOTOR TO A 220-VOLT AUTOTRANSFORMER STARTER

The first intimation of any defect in this ne was given on May 26, 1908. When ing it preparatory to getting underway turbine developed a shrieking noise en worked up to 18 pounds pressure. e turbine was stopped and further ated with its throttle valve cracked to admission of steam, and after a short terval the trial was repeated and the bine worked well. After this occur-ce, the starboard turbine was always efully watched, but there appeared to be no reason for attaching particular importance to the event mentioned. As time went on, however, this turbine began to require a higher initial pressure than usual when trying it for getting it underway, but it appeared to run normally after being prepared for operation. The port astern turbine usually started under five pounds pressure when first tried, and never required more than 15 or 20 pounds. The starboard turbine had formerly acted similarly, but later it at times required 40 or 50 pounds, and frequently 75 or 100. Then again it would start under low pressures, but on one occasion in August, 1908, it required 150 pounds. These events would tend to show that blade stripping occurred at somewhere about this time, and, while minor in extent at the start, was gradually becoming worse. With the scant clearance in this type of turbine, it seems almost incredible that such an effect could be gradual, but the history of the case leaves no other conclusion.

Finally, the efficiency of this turbine dropped to a point which could not be accounted for, without thorough investigation. This was about the end of May, 1909, and early in July the vessel was docked at the New York navy yard. The casing was lifted, and the upper half of the casing and the spindle blading were open to inspection. On each of these parts nearly all blades of the first stage were stripped except in the first row. Similarly the first three rows of blades of the second stage were deformed so badly as almost to entirely blank off the passage of steam through them. In the third stage of blading a few blades were slightly damaged on their tips and some of the lacing strips cracked. On each part the first row of the first stage was nearly in tact. One blade was missing from the first row of the first stage of casing blading and but a few were missing from the first row of spindle blading. The remarkable point about the matter is the fact that, in spite of this damage, the turbine preserved as high an efficiency as it did. This appears more remarkable as the first three rows of blading in the second stage were practically blanked off to the admission of steam. When using 125 pounds steam pressure per gage in this turbine, it should develop about 390 revolutions per minute, whereas in its damaged condition it developed about 170.

The most logical explanation would appear to be that the damage was caused by water and the fact that the turbine is improperly provided with drains. There does not appear to be proper provision for draining the steam belt proper, and if a heavy charge of water appears therein when steam is admitted, it must of necessity be driven with the steam through the blading. Blading in the Parsons turbine as a rule will stand charges of water without difficulty, simply breaking it up into small particles and forming a spray with the steam, but the blades of the first stage of the astern turbines of this ship are of the weakest of all the standard sizes used, and it can be readily seen that they could not be expected successfully to stand heavy charges of water.

A close examination of the condition of the damaged blading, particularly of the first row of the first stage, showed this row to be intact except for a few blades, and indicates a strong probability that these few missing blades were the cause of the rest of the damage. Steam admitted to the steam belt first strikes the first row of fixed blades on the cylinder; it then strikes the first row of moving blades on the spindle, and so on, alternately. It is believed that on some occasion when the turbine was tried, a charge of water in the steam in striking this first row of fixed blades, dislodged the one blade which was missing, and that this blade stripped the few that are missing in the first row of moving blades. With so many blades stripped, it is easy to see how all the remaining rows of the first stage could be damaged. The blades of the second stage withstood stripping because of being of heavier material and better secured.

The [illegible] inch blading which makes up the six rows of the first stage of the astern turbines is of too scant hight to permit of being secured with a lacing strip, and has no support other than that of being firmly calked into place at its base. The second stage blades, which are 1 inch high, are of sufficient hight to permit of the use of lacing strips and benefit by this additional support. They are not sufficiently long to make use of binding wire, and it is omitted. The blades of the third stage are 2 inches high and are fitted both with lacing strips and binding wire. It can thus be seen that there is a marked difference in the relative strength of the three different stages of blading, and that the blading of the first stage is much the weakest.

Everything tends to indicate that the difficulty was of long standing, and such being the case this turbine has a remarkable record in successfully standing up under the severe tests that have been imposed upon the machinery.

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## The First Pennsylvania Electric Locomotives

The first of the electric locomotives to be used in the New York tunnel extension of the Pennsylvania railroad has been delivered at Long Island City, and will be subjected to a series of tests over the electrified lines of the Lond Island railroad. The locomotive weighs 330,000 pounds and is capable of developing 4000 horsepower. Reference to Fig. 1 will show that the new locomotive looks like two passenger coaches with huge driving wheels and rods. On each side of the steel cabins are ten square windows, and at the ends there are oblong windows similar in appearance to steamship port holes. The cabins contain the he driving motors as well as the auxiliy and control apparatus.

Fig. 2 shows the locomotive with e cabins removed. It is built in two tions; that is, there are two cabs and running gears, jointed at the middle. E section has eight wheels, four of wl are drivers, 68 inches in diameter, d the other four truck wheels 36 inches n diameter. The sections are permaney coupled back to back by a friction d t gear so arranged that the leading tion pilots the rear one. This obv the necessity of turning the engine, runs equally well in either direction, each section is provided with a com te set of manipulating levers, so that e driver simply changes ends, as in ie case of the subway and elevated trai

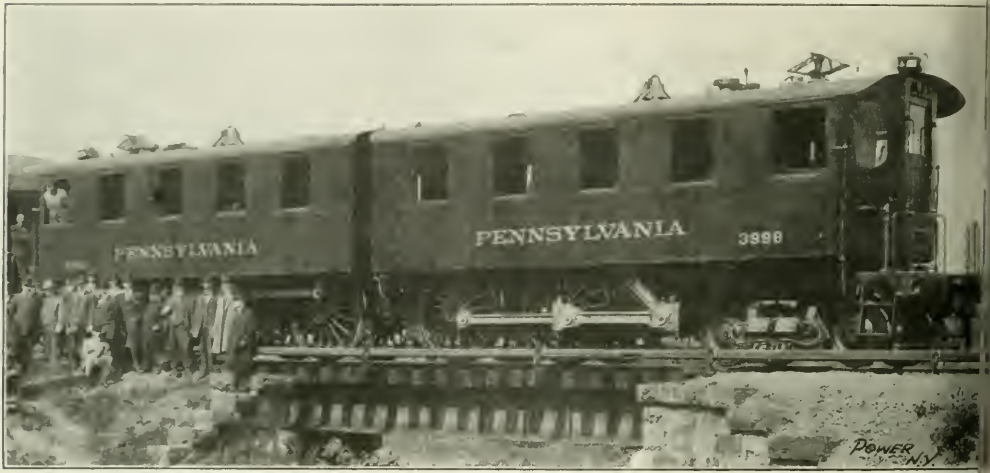

FIG. 1 THE FIRST ELECTRIC LOCOMOTIVE FOR THE PENNSYLVANIA TUNNEL

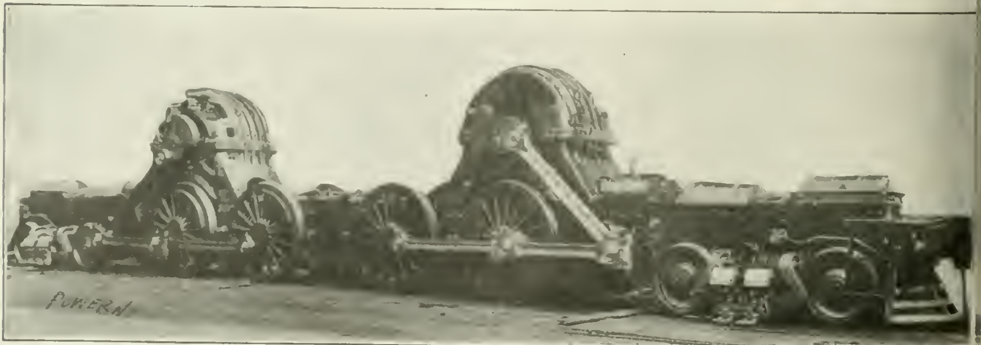

FIG. 2 PENNSYLVANIA ELECTRIC LOCOMOTIVE WITH HOUSINGS REMOVED

Two pairs of driving wheels re coupled by rods to a jack shaft parlel with the driver axles, which in tur is rod-coupled to the motor crank s ft.

e cranks are ninety degrees apart, so re can be no dead-center position. It obvious that all rods and moving parts ve only rotary motion and therefore y be correctly counterbalanced for all eeds. The motors, jack shafts and other r, excepting, of course, the side rods the driving wheels, are supported on e truck springs.

Each motor, without connecting rods, ighs 45,000 pounds, and fills a large rt of its cab. The main control ap- s is in a bulkhead sort of an ar- ment centrally located so that there e ple passageways along the sides. t e end is located an electrically ri air compressor for supplying air brakes.

ach end of the complete locomotive e is a Westinghouse brake valve for peed brake operation, and also the eng er's controller, by which all electr manipulation is effected. The contr ystem is, of course, arranged on the pilot" or relay plan, the actual -controlling apparatus being operat by electro-pneumatic mechanism controlled in turn by a small master switch manipulated by the engineer

The first twenty-four Pennsylvania electric locomotives will have the following weight, dimensions and power: Total weight, 166 tons; weight of electrical parts, 62 tons; weight of mechanical parts, 103 tons; total horsepower, 4000; maximum draw-bar pull, 60,000 pounds; maximum full-load speed, 60 to 70 miles an hour; diameter of driving wheels, 68 inches; diameter of truck wheels, 36 inches; weight on drivers, 14 tons; length over all, 65 feet; total wheel base, 56 feet.

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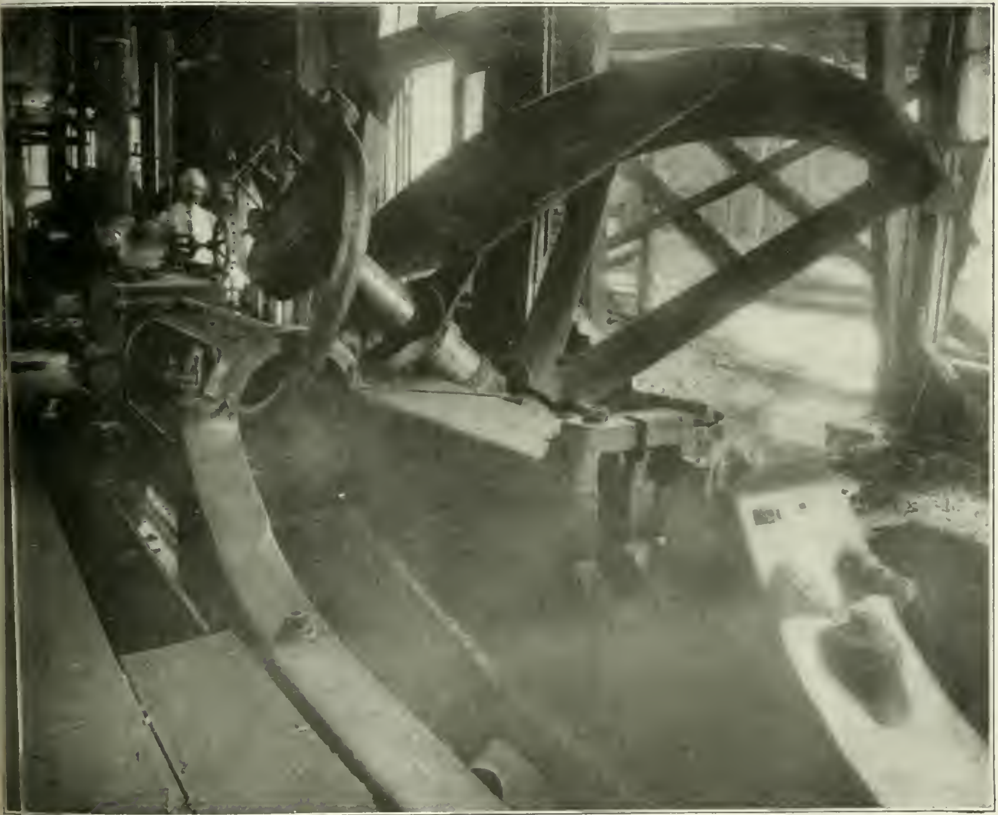
An electric railway from Ville Franche to Bourg-Madame has just been completed. The road is 34 miles long and starting at 1407 feet above sea level at Ville Franche it rises to a hight of 5220 feet and then descends to 3750 feet at Bourg-Madame. The third-rail system is used and supplies an energy of about 800 volts. The motor cars are each equipped with four 50-horsepower motors.

# Flywheel Explosion at Red Oaks, Iowa

A 14 foot flywheel, mounted on a Corliss engine, exploded on August 11 at 4 p.m., in the plant of the Red Oak Electric Company, Red Oak, Iowa. The exact cause of the accident, says *The Budget*, will probably never be known, as the engineer, who could have thrown light on the matter, was instantly killed in trying to stop the engine. The fireman saw the belts broken, the engine racing at a high rate of speed and the engineer running for the throttle. He then ran back to the boiler room to shut off the main valve. It was while doing this that the explosion occurred. Returning to the engine room he found the engineer under the débris and the throttle valve within one and a half turns of being closed.



ENGINE WRECK DUE TO A BURSTED FLYWHEEL, AT RED OAK IOWA

The main belts appear to have been in good condition before the accident. The breaks were clear cut and fresh. Some of the cemented lap joints were partly open, but showed fresh breaks. The generators were not burnt, and the circuit breakers were not thrown. The conditions after the accident indicate that the belts must have broken. The engine being relieved of its load, and under a full steam pressure, started to race. In addition to this, there are indications that something got between the wheel and the bottom of the pit, wedging the wheel upward and tearing the outward box loose, breaking the cap of the main bearing and throwing the crank shaft and wheel forward and at an angle. The governing mechanism was probably damaged, or put out of commission, when the belt broke, though the engine was so badly wrecked that it was difficult to determine this. In carefully examining the broken castings under a magnifying glass there was not the slightest evidence of a flaw or old fracture of any kind.

In addition to the wrecking of the engine, the building was badly damaged.

## Pump Troubles

By W. H. Booth

When a pump has a long suction pipe, there is apt to be trouble and the pump will often refuse to draw water, even a foot valve placed at the end of the suction pipe sometimes not effecting a remedy. If trouble of this kind is experienced, as it often will be where the hight of suction is considerable, it will usually be found very easily.

The pump should be the highest point in the run of the suction pipe. Not only should this be the case, but every part of the suction pipe should have a gradual rise to the pump, so that, from the well end to the pump, the suction pipe should have a continual, if not a uniform, upward slope. Often in pumping from a well, the suction pipe rises vertically to a point above ground and thence falls to the pump. The bend at the top of the well is about the highest point and the nearly horizontal length forms an air trap.

If the volume of trapped air is considerable, as compared to the displacement volume of the pump, and there is much clearance in the pump cylinder, it may be impossible for the pump to draw out the imprisoned air. All water in nature contains air or other gases in solution. The volume of air dissolved is proportional to the pressure. Under the partial vacuum of a pump, some of the air escapes from solution and lodges where the pressure is least. Unless suction pipes are sloped all the way to the pump, this air cannot flow to the pump, but it effectually stops the action. If a pump does not discharge all the air which enters its barrel, it may cease to work when this air, at the full stroke, fills the barrel at a pressure above that in the suction pipe. Hence the necessity of care to so design pumps that their clearance spaces will be filled with water and not with air.

In sewage pumping, especially, the escape of gases must be cared for. Sewage is often in a state of decomposition, so that it contains much gas which is freely given off when the sewage is placed under the partial vacuum of the suction. Siphons cease to act from the same cause—air accumulations at the top of the bend—and provision must be made to pump out this air or the siphon will cease to work.

There is a difference between air which is imprisoned in a suction pipe and an air vessel intentionally and designedly placed on the suction of a pump in order to allow the movement of the flowing water to be more continuous and steady. In this case, the air vessel or vacuum vessel stands on a tee from the suction and is really a vacuum vessel into which the flowing stream makes its way during the return stroke of the pump bucket. The stream of water, especially if long, must not be too suddenly checked, nor should it be too quickly started into motion. The vacuum vessel, therefore, affords a means of taking up the flow and of supplying the suction, while the long column in the suction pipe gathers way. This vacuum vessel is essentially different from an air trap on the line of the suction pipe; it should be clearly understood that such a vessel must be on a branch, off the main, and that should any air be drawn out of the vessel and escape into the suction main, there must be a clear ascent for it all the way to the pump.

Pumps often work badly because they have to deliver against too unyielding a resistance. Take, for example, an injector which will feed into a steam boiler but may fail to feed into an economizer feed heater. In the boiler, there is a large steam space filled with elastic vapor which can be reduced in volume without rapid or serious rise of pressure. In the latter, no reduction of volume is possible and feed cannot enter faster than it is let out into the boilers. There is no elasticity and an injector will fail when the boiler feed is at all restricted.

Both pumps and injectors work better when an air chamber is arranged near the point of delivery to give elasticity. Such an air vessel should be set so as to catch any air coming forward with the water and it will probably remain full because hot water does not dissolve air as does cold water. By means of a float and a small snifting valve, the vessel may be made to serve the purpose of an air eliminator, removing air from the water before it enters the boiler, such air and gas being held to be very prejudicial, causing corrosion of the boiler.

Condensing water which has been u over and over again and is well fr from air has been known to render air pump noisy, the pump drawing fr a jet condenser delivered through upper valve which opened with great v lence when the water struck it too s denly. The remedy was found in use of an air inlet to the condensing s tem. The small amount of air did appear to reduce the vacuum, for pump was of ample size, but it mi d with the water, opening the delivery v gently and with a better cushioning fect.

The failure of a centrifugal pump w it draws air into its fan is well kno the obvious reason being that air is light to exert the effect produced rapidly whirled water. It might thought that a centrifugal pump woul less efficient in suction than a bu pump, but I have known a centrif pump to lift water over 31 feet by suct True, the water was cold, about 51 grees Fahrenheit; it was from an arte well and not overcharged with gases; the lift surprised me at the time a carefully retested it with the same sult.

It is usual, of course, to say that cannot pump hot water. Hot water be pumped as well as cold water so as the suction hight properly corresp with the temperature. Cold boiled w not re-aërated might be pumped with 33 feet of lift. Water at 212 de Fahrenheit must flow by gravity int pump barrel. At still higher tem tures, water must enter the pump at pressure as will prevent any or muc it from flashing into steam. Obvi therefore, the pump must not be so above the source of the hot water the latter will not flow into it. At temperature under 212 degrees Fa heit a certain lift is possible, depe on the absolute pressure of steam a given temperature. As soon as the p lift is exceeded, the pump will bec mere vapor pump, pulling vapor o the water, which boils under the re pressure.

A very powerful pump, capab drawing away a large volume of might raise water too hot for a pump to manage, for the whole m water in the vertical suction might duce so much steam throughout its as to give rise to the effects ob in the air-lift pump where a colu foam is caused to rise higher t balancing column of solid water.

A square foot of uncovered pipe with steam at 100 pounds pressur will radiate and dissipate in a year th heat put into 3960 pounds of steam the economic combustion of 396 pou of coal. Thus, 10 square feet of ba pipe corresponds approximately to the aste of two tons of coal per annum.

# Efficiency of the Centrifugal Pump

## A Study of the Three Methods Used to Find Efficiency of Centrifugal Pumps. Correct General Equation to Use with Charts to Simplify Work

BY JOHN B. SPERRY

After a careful search through the en ecring literature pertaining to centrif gal pumps, and a thorough study of the talogs of nearly every centrifugal-pump nufacturer and their guarantees, the r er finds that what constitutes the effi cy of the centrifugal pump is a dis ed question. In the literature itself re were found no less than three dif rent methods of calculating the efficiency f the pump from the results of tests, l each had been used by prominent ineers.

e efficiency of any machine, as every neer knows, or should know, is the of the horsepower output to the sepower input. But next to the broad ry and the general application of the trifugal pump to general conditions, part comes in for so much contortion l abuse as the term "efficiency." This se of efficiency has often caused the spective purchaser to look askance on trifugal pumps as a *"bona fide"* com ial proposition, with the natural re that other types of pumps are yet uently installed where the centrifugal would serve the purpose best.

The difference in these three methods in the manner of finding the total against which the pump is working. testing centrifugal pumps two gages sed, a vacuum gage on the suction to the pump shell, unless the pump ves its supply under pressure, and ressure gage on the discharge close he pump.

e formula most frequently used is:

$$H = H_S + H_D + A. \qquad (1)$$

re

$A$ = Distance between gages in feet.
$H$ = Total head in feet.
$H_S$ = Reading of suction gage reduced to feet.
$H_D$ = Reading of discharge gage reduced to feet.

Another formula frequently used, and which was used in computing the results of a test recently published, is:

$$H = H_S + H_D + \frac{V_D^2}{2g} + A. \qquad (2)$$

Where $A$, $H$, $H_S$ *and* $H_D$ have the same meaning as in formula (1) and $\frac{V_D^2}{2g}$ is the velocity head in the discharge pipe, $V_D$ being the velocity of flow in feet per second.

The third formula stated in its general form is:

$$H = H_S + H_D + \left[\frac{V_D^2 - V_S^2}{2g}\right] + A. \qquad (3)$$

Here $A$, $H$, $H_S$ and $H_D$ are the same as used in formulas (1) and (2), and $\frac{V_D^2 - V_S^2}{2g}$ is the difference between the velocity heads in the discharge and suction pipes, $V_D$ being the velocity of flow in feet per second in the discharge pipe, while $V_S$ is the velocity in feet per second in the suction pipe. From these equations it can be seen that from the same data widely differing results can be had.

Before going further, it is best to find out and state just what part of the total head the pressure gage on the discharge records, and what part the suction gage shows. In 1738, Daniel Bernouilli deduced the following law in hydraulics:

*At any section of a tube or pipe, under steady flow without friction, the pressure head plus the velocity head is equal to the hydrostatic head that obtains when there is no flow.*

This theorem of theoretical hydraulics is of great importance in practice, and by it we can satisfy ourselves just what the pressure and vacuum gages show. Let Fig. 1 be a frictionless tube of two different diameters with a steady flow of water through it. By steady flow is meant, that a constant volume of water is passing through it. At $A$ and $B$ are U tubes, or pressure gages that record the pressures at these sections. When there is a steady flow of water through the pipe, the gage at $A$ reads $H_1$, while the gage at $B$ reads $H_2$, and when the flow is stopped by closing a valve at the end or by some other means the reading of both gages is $H$. Let $W$ equal the weight of water flowing in each second through each section of the pipe, and let $V_1$ equal the

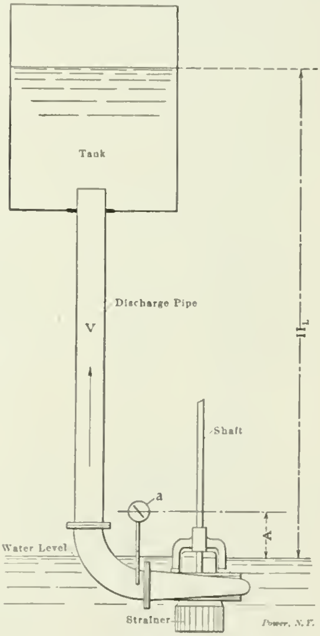


FIG. 3. SUBMERGED PUMP

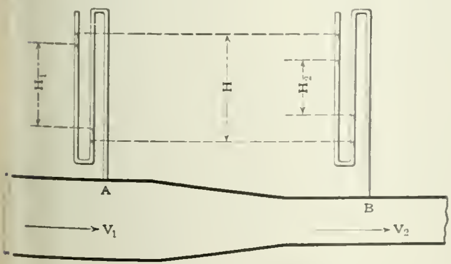


FIG. 1. FRICTIONLESS TUBE OF TWO DIAMETERS

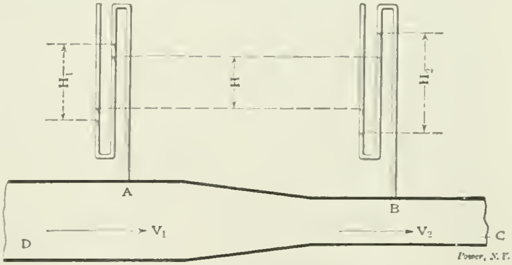


FIG. 2. INITIAL PRESSURE NEGATIVE

mean velocity of flow through section *A*, and $V_2$ the mean velocity of flow through section *B*. When the water was at rest the potential energy due to pressure at *A* and *B* equaled $WH$. When it was in motion the energy due to pressure was $WH_1$, and the kinetic energy equaled.

$$\frac{V_1^2}{2g} W,$$

making the total energy at section *A* equal to

$$WH_1 + W\frac{V_1^2}{2g}.$$

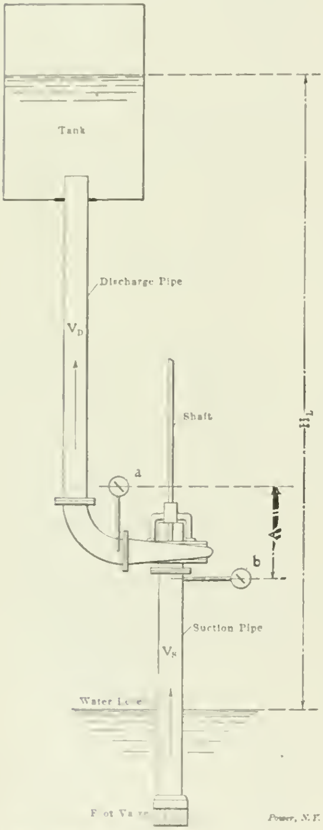


FIG. 4. SUCTION AND DISCHARGE PIPES OF EQUAL DIAMETER

Applying the Bernoulli theorem gives,

$$H = H_1 + \frac{V_1^2}{2g}. \tag{4}$$

By the same reasoning,

$$H = H_2 + \frac{V_2^2}{2g}, \tag{5}$$

or,

$$H = H_1 + \frac{V_1^2}{2g} = H_2 + \frac{V_2^2}{2g}.$$

From this it can be seen that the pressure head at any section decreases as the velocity increases. Hence the pressure gage on the discharge shows the pressure head in the water at the point of measuring, and to find the total head in the water the velocity head must be added to the pressure head, or gage reading.

Fig. 2 is an arrangement similar to that of Fig. 1, except that the initial pressure *H* is negative. Consider Fig. 2 as part of a siphon with the long leg on the side *C*, and the short or supply leg on the *D* side. Suppose that the supply leg is provided with a valve for shutting off the water. When this valve is closed the pressure in the section shown in Fig. 2 is negative and equal to *H*. When the supply valve is opened the water flows through section *A* with a velocity $V_1$, and the gage shows a pressure $H_1$, while the velocity through section *B* is $V_2$ and the pressure $H_2$. The effect of the velocity of flow is to decrease the pressure, as in Fig. 1, but a decrease in pressure increases the reading of the vacuum gage, or as it is commonly expressed, creates more vacuum. This can be shown in another way by applying Bernonilli's theorem again:

$$(33.4 - H) = (33.4 - H_1) + \frac{V_1^2}{2g}, \tag{6}$$

also

$$(33.4 - H) = (33.4 - H_2) + \frac{V_2^2}{2g}. \tag{7}$$

Then

$$(33.4 - H) = (33.4 - H_1) + \frac{V_1^2}{2g} = (33.4 - H_2) + \frac{V_2^2}{2g}.$$

$$H = H_1 - \frac{V_1^2}{2g} = H_2 - \frac{V_2^2}{2g}. \tag{8}$$

Hence, it is said that the vacuum gage shows the total head at that section, i.e., pressure head plus velocity head.

The next step is to develop an equation expressing the energy for the stream of water flowing through the pump, incorporating the gage readings. When derived, this formula will give the total head that the pump should be credited with. In considering this formula there are three cases: first, for the submerged type of pump; second, for the suction type of pump which has its suction and discharge pipes of the same diameter at the point where the gages are attached; third, for the suction type which has suction and discharge pipes of different diameters at the sections where the gages are attached.

Fig 3 is an example of case 1. Here is a submerged pump raising water from one reservoir to another at a higher level through a vertical lift equal to $H_L$. At *a* there is a pressure gage whose center is a distance *A* above the water level. The velocity of flow through the discharge equals *V* feet per second. If $H_D$ represents the reading of the pressure gage reduced to feet, and keeping in mind Bernonilli's theorem, the total lift against which the pump works can be pressed by the following:

$$H = H_D + \frac{V^2}{2g} + A.$$

To find the horsepower it is only ne sary to multiply the result from forml (9) by the total weight of the w pumped per minute, and divide by 33 foot-pounds, or:

$$H.P.\ Output = \frac{8.33 \times G}{33{,}000}\left(H_D + \frac{V^2}{2g} + A\right) = 0.0002524\, G\left(H_D + \frac{V^2}{2g} + A\right).$$

Here 8.33 equals the weight of one

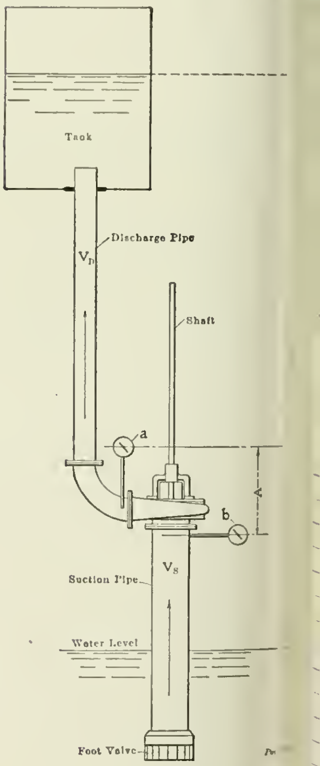


FIG. 5. SUCTION AND DISCHARGE PIP DIFFERENT DIAMETERS

lon of water and *G* equals the nu of gallons pumped per minute.

Case 2 is shown in Fig. 4. Her pump body is placed some distance the water level, and raises water th h a vertical hight of $H_L$. The diar ers of the suction and discharge pipe ar equal, consequently the velocity of w in feet per second through each m be equal, or $V_S = V_D$. The distan between gages *a* and *b* is equal to . If the vacuum and pressure-gage re ngs

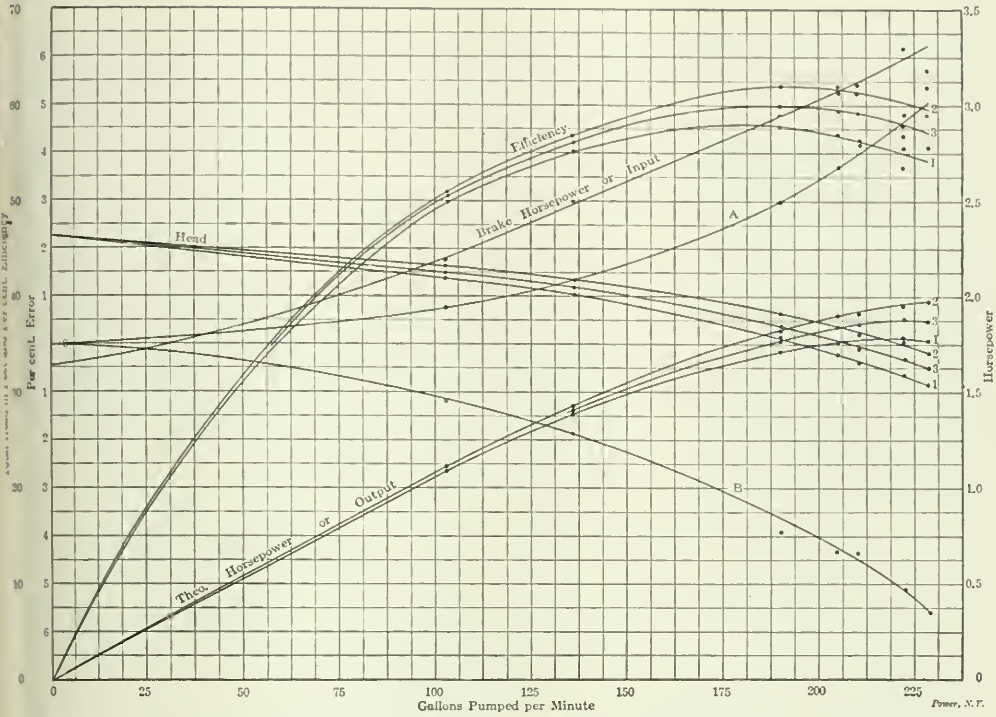


FIG. 6. DIAGRAMMATIC COMPARISON OF FORMULAS (1), (2) AND (3)

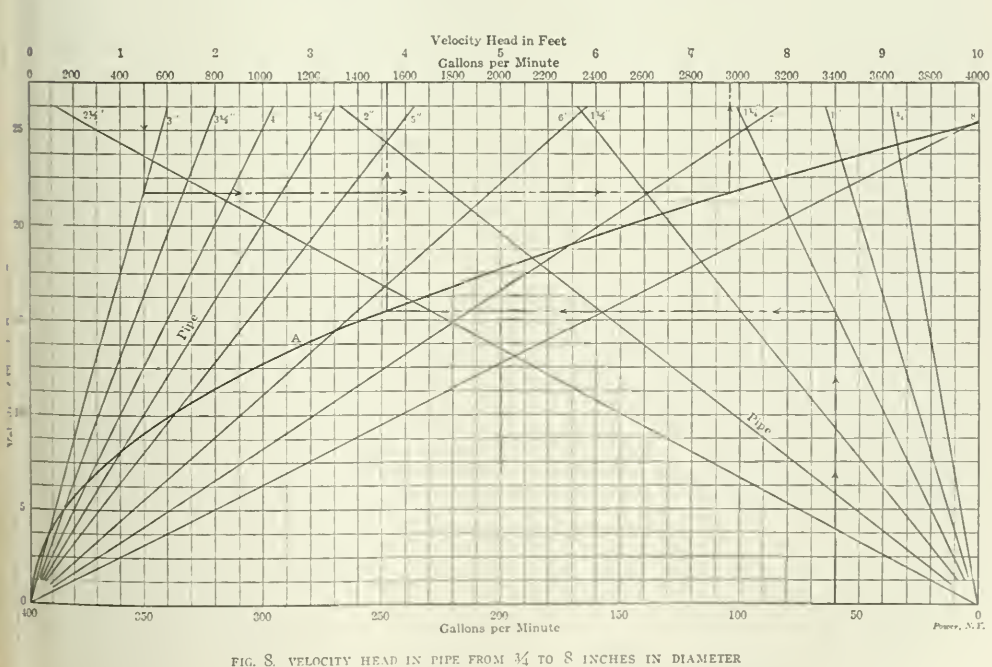


FIG. 8. VELOCITY HEAD IN PIPE FROM ¾ TO 8 INCHES IN DIAMETER

[illegible] are expressed by $H_S$ and $H_D$ respectively, and remembering what each shows, the total head against which the pump is working may be written as follows:

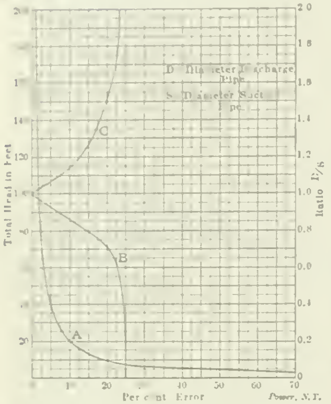


FIG. 7. ERROR IN TOTAL HEAD VARIES FOR DIFFERENT HEADS

$$H = H_D + \frac{V_D^2}{2g} + H_S - \frac{V_S^2}{2g} + A.$$

But $V_D = V_S$, then

$$H = H_D + H_S + A. \qquad (11)$$

To find the horsepower use the formula

$$H.P.\ Output = \frac{8.33 \times G}{33{,}000}\left(H_D + H_S + A\right) = 0.0002524\, G\, (H_D + H_S + A). \qquad (12)$$

The third case is shown in Fig. 5. This differs from the second case in that the suction and discharge pipes are of different diameters at the sections where the gages are attached. The total head $H$ is:

$$H = H_D + \frac{V_D^2}{2g} + H_S - \frac{V_S^2}{2g} + A;$$

or

$$H = H_D + H_S + \frac{V_D^2 - V_S^2}{2g} + A. \qquad (13)$$

Here $H_D$, $H_S$, $V_D$ and $V_S$ represent the same quantities as in the previous equations. Equation (13) can be considered as the general equation for the correct total head for any pump, while (9) and (11) are correct for special cases. For the general equation of horsepower output we have:

$$H.P.\ Output = \frac{8.33 \times G}{33{,}000}\left(H_D + H_S + \frac{V_D^2 - V_S^2}{2g} + A\right) =$$

$$0.0002524G\left(H_D + H_S + \frac{V_D^2 - V_S^2}{2g} + A\right) ()$$

Returning now to equations (1), ( and (3) and comparing them with eq tions (9), (11) and (13), it will be fo that equations (1) and (11) are identic (2) and (9) would be the same if t $H_S$ was omitted in equation (2). He equation (2) is wrong as it stands, does not give correct results except submerged pumps, when term $H_S$ appears. But equations (3) and are the same. The object of this ar is to show that, when correctly app equations (1) and (3) are correct, equation (2) when used for subme pumps, but as ordinarily used, equat (1) and (2) are wrong and (3) is rect. This can be stated in another ay by saying that equation (3) is the or- rect general equation for finding the tal head against which a pump works, ile (1) and (2) can only be used for s cial cases.

DATA OF TEST ON 2½-INCH CENTRIFUGAL PUMP.

| Test No. | Brake H.P. | Suction. | Discharge. | Gallons per Minute | Formula (1). | | | Formula (2). | | | Formula (3). | | | Per Cent. Error Formula (1). | Per C Erro Form (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Total Head. | Theo. H.P. | % Eff. | Total Head | Theo. H.P. | % Eff. | Total Head. | Theo. H.P. | % Eff. | | |
| 1 | 3.33 | 16.15 | 14.43 | 222 | 31.83 | 1.785 | 53.6 | 35.10 | 1.965 | 59 | 33.55 | 1.875 | 56.4 | —5.13 | +4 |
| 2 | 3.185 | 16.33 | 13.27 | 228 | 30.85 | 1.775 | 55.7 | 34.31 | 1.985 | 62 | 32.66 | 1.88 | 59 | —5.54 | +5 |
| 3 | 3.12 | 15.54 | 16.16 | 211 | 33.00 | 1.76 | 56.4 | 35.96 | 1.91 | 61.3 | 31.51 | 1.838 | 59 | —4.37 | +4 |
| 4 | 3.10 | 15.37 | 17.31 | 206 | 33.93 | 1.761 | 56.8 | 36.76 | 1.907 | 61.5 | 35.46 | 1.845 | 59.5 | —4.32 | +3 |
| 5 | 2.91 | 14.69 | 19.85 | 189 | 35.79 | 1.705 | 58 | 38.15 | 1.818 | 61.8 | 37.05 | 1.768 | 60 | —3.45 | +2. |
| 6 | 2.51 | 13.56 | 25.4 | 136 | 40.21 | 1.38 | 55 | 41.5 | 1.423 | 56.7 | 40.95 | 1.402 | 56 | —1.81 | +1 |
| 7 | 2.18 | 12.43 | 28.28 | 103 | 41.96 | 1.09 | 50 | 42.79 | 1.12 | 51 | 42.487 | 1.103 | 50.6 | —1.241 | +0. |
| 8 | 1.63 | 11.30 | 33.48 | 0 | 46.03 | 0 | 0 | 46.03 | 0 | 0 | 46.03 | 0 | 0 | 0 | 0 |

Add 1.25 feet for $A$ = distance between gages.

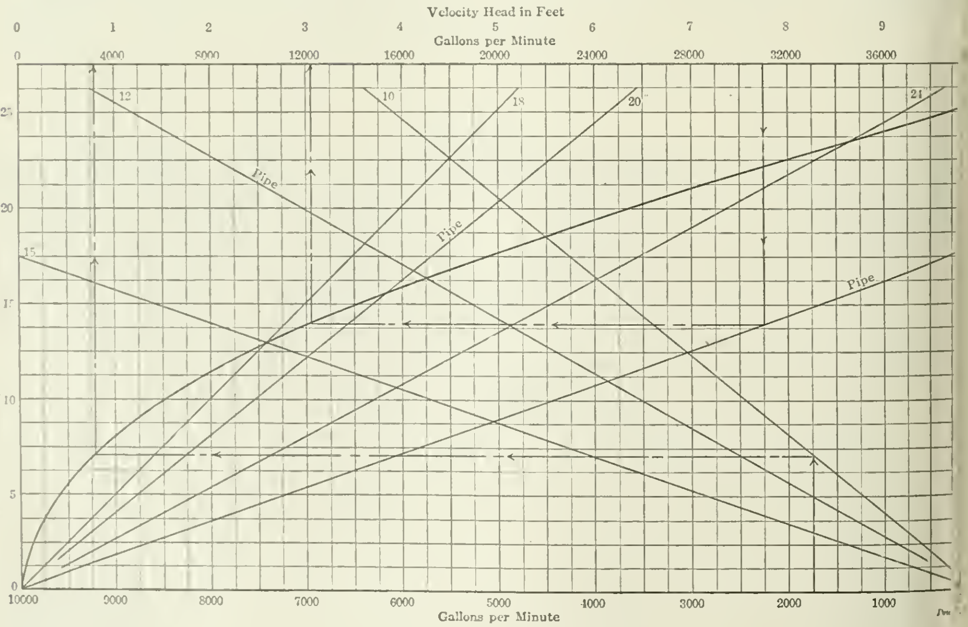


FIG. 9. VELOCITY HEAD IN 10- TO 30-INCH PIPE

### TEST DATA

The accompanying table gives the data t a test on a 2½-inch centrifugal pump. he diameter of the suction pipe is 3 ches and that of the discharge, 2½ hes. The distance A between gages 1.25 feet. The total head, theoretical r horsepower output, and per cent. effi ency were computed by each of the for- las (1), (2) and (3), and since for- la (3) is correct, (1) and (2) were pared with it to find the per cent. r involved when they were used.

g. 6 is a graphical representation of results given in the table. The num- s marked on the curves correspond to r formula number. For the total head st which the pump was working, it be noted that when pumping no water t ree formulas give the same result, that as the quantity of water pumped increased, the total heads differed. ula (1) gives the lowest results, for- (2) the highest and formula (3) t is case is about half way between. the total heads differ, the theo- l horsepower and efficiency differ Curve A represents the per cent. r in the total head involved when formula (2). Curve B represents er cent. error in the total head when la (1) is used. The error is not a nt quantity, but is a variable that ses more rapidly as the quantity water pumped is increased.

Fig. 7 curve A shows how the per c error in the total head varies for rent heads, when the velocity head in t scharge pipe is constant. In this c t is 2 feet when using formula (1) f submerged pump, or when using f la (2) for a pump of the suction t whose suction and discharge pipes a f the same diameter, or again when e r formula (1) or (2) is used and l velocity head unaccounted for is 2 f From the form of the curve it is s that the per cent. error increases sl y at first, as the total head is de- c d until about a 25-foot head is r l, when it begins to rapidly increase. it is important that the correct head should be found for low lifts, error will be great. Curves B and C re plotted to show how the per cent. r involved by using formula (1) for different ratios in the diameters suction and discharge pipes. The tes of the curves are the ratio of th meter of the discharge to the diam- et f the suction at the sections where th gages are placed. The abscissas give h er cent. error. The curves represent ven case where the total head is 10 fe the velocity head in the discharge pipe is 2 feet, and the ratio of the diameters of he suction and discharge pipes is su osed to vary. From the curves it is se that when the diameters are equal, th er cent. error is zero, and the error inc ases either way, being larger, the gr er the difference in the diameters.

Other curves could be plotted showing the per cent. error involved by using either formula (1) or (2) without first considering whether they apply to the case at hand or not, but those that have been plotted are sufficient proof that formulas (1) and (2), as ordinarily used, are wrong, and do not give the true total head that should be credited to the pump.

To sum up the foregoing, the true total head that should be credited to any centrifugal pump can be computed by using the general equation for total head, formula (3) or (13). Also, formula (1) gives the total head for a special case, that is, when the diameters of the discharge and suction pipes at points where the gages are attached are equal. Formula (2) is incorrect and should be of the form of (9) for submerged pumps.

To facilitate the finding of the velocity head in the different sizes of pipe for different capacities, the writer has devised two charts, shown in Figs. 8 and 9. Anyone having a great number of tests to compute will find these charts of great help. Fig. 8 is for pipes from ¾ inch to 8 inches in diameter, while Fig. 9 gives the velocity head in pipes ranging in size from 10 to 30 inches. Besides giving the velocity head, these charts can be used to find the velocity in feet per second, or the capacity in gallons per minute for a given velocity head and size of pipe. The charts are simple, and their method of use is made clear by the dash, dot and arrow lines.

For example, find the velocity head in a 1¼-inch pipe for 60 gallons per minute. Project up from 60 on the lower gallon scale in Fig. 8 to the 1¼-inch pipe line, then across to curve A, and from there up to the velocity-head scale at the top, where the velocity head is found to be 3.8 feet.

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## With the Breakdown Gang

By A. E. Dixon

They did not call us the "breakdown gang" on the pay roll, but in the mill they did and whistled five with the department number when we were wanted; then it was get there on the jump, and we had to get her going again as quickly as Fate would let us. The result was that we did some queer stunts once in a while in the way of repairing machines, for the boss was sort of a genius at this work and did not stick at anything. One morning we were called to No. 2, the 36-inch blooming mill, to find that the roller had tried to put a cold billet through by main force, with the result that one of the top guides on the 55x60-inch engine had gone to smash and the connecting rod was buckled.

We had a spare rod in stock, but the top guide looked like a sticker; but the boss got a few measurements and persuaded Billy on No. 1 mill to roll him a 10x12-inch bloom; he got this sheared an inch or two longer than the old guide, which did not matter as there was clearance at both ends. By the time this was done the boss was back with an order for Billy to make the bloom, and the bloom was on its way to the river behind one of the "dinkeys;" here we hooked it on to one of the cranes and sent it overboard to cool off a bit.

In the meantime, the machine shop had been getting ready and the big planer looked like a carpenter shop when we got the bloom lined up on two 12x12 inch yellow-pine blocks with some steel plate on top of them, and the table covered with 2-inch plank to protect it from the heat. A sheet-iron templet had been made for the bolt holes and they were laid off on the bloom. In the meantime another gang had rigged up an electric motor on the planer table to drive two portable drills, and by the time the planer was ready to start two holes were going into the bloom at a good rate, while the side head on the planer was trying to get the high spots off the other side. The planing was finished first and was one of the finest examples of Pittsburg finish I ever saw—deep scratches and high polish. Then we got it down under the radials, which were fortunately so placed that one could work at each end, and finished up the holes.

Next we loaded the bloom and pulled her down to the mill with a "dunkey," where some new studs had been set in the lower guide to hold her down, and with the help of the crane we soon had her in place and bolted fast. The new connecting rod had been put in and the boss got them to start up the engine easy, while a couple of men with swabs were stationed at the guide to supply the lack of an automatic oiler.

Well, she went off all right and the boss said he "guessed she'd last till the new guide and crosshead arrived."

She did last, but the next Sunday we had a job putting in a plate steel liner to take up the wear in that crosshead. That liner certainly was a peach; they just sheared it to size from a plate of the right thickness because the planers were so busy there was no chance to finish it up at all. After we had the new guide and crosshead on, we sent the temporary rig up to the open hearth to remelt, though it deserved a better fate.

---

The State Department has been informed that the president of Guatemala has directed a bronze bust of Robert Fulton to be placed in Estrada Cabrara park in Guatemala City. The Government of the United States has directed the American minister to Guatemala to express its appreciation for the honor thus accorded to the memory of an American citizen.

# Compressed Air Calculation Short Cuts

## A Chart by Which M. E. P. and Horsepower May Be Determined without Use of Complicated Formulas Involving Fractional Exponents

BY SNOWDEN B. REDFIELD

In some of the late issues of the *American Machinist* a number of articles have been presented giving curves and tables to assist in the somewhat complicated calculations relating to the compression of air. Genuine "short cuts" for such calculations as these are rare, and for this reason it is a pleasure to present the accompanying diagram, which was calculated by Ward Raymond, who is assistant chief engineer at the Phillipsburg, N. J., plant of the Ingersoll-Rand Company. By the use of this diagram the calculations of the adiabatic mean effective pressure and indicated horsepower developed by the compression of air are reduced to their simplest possible terms.

In this diagram we have the solution of the expression

$$MEP = 3.46\, P_1\, (R^{0.29} - 1).$$

$MEP$ refers to mean effective pressure developed in the air cylinders; $P_1$ is the absolute initial pressure, which in the case of an air compressor is usually atmospheric; $R$ is the ratio of compression, or the absolute discharge pressure divided by the absolute initial pressure. Owing to the fact that this formula contains a decimal exponent, namely, the 0.29 power, it is rather unwieldy, and many people shrink from using it any oftener than they can possibly help. Knowing the value of $R$ from the conditions of the problem, we find directly from the diagram the corresponding value of the rest of the expression, namely, $3.46\,(R^{0.29} - 1)$, and multiplying this factor by the absolute initial pressure, gives the mean effective pressure right away. The four following examples will serve to show the simplicity of the operation:

1. Assume single-stage compression from the atmosphere to 60 pounds gage pressure. $R$, the ratio of compression, will be $(60 + 14.7) \div 14.7$, or $74.7 \div 14.7 = 5.08$. Examining the diagram we find that the vertical line marked $A$ corresponds to the value of $R = 5.08$. From the curve at this point we find that the value of the factor for which we are looking is 2.082. In the case of the problem the initial pressure is atmospheric, or 14.7 pounds per square inch absolute. Multiplying 2.082 by 14.7 we have a mean effective pressure developed in the air-compressor cylinder of 30.6 pounds per square inch, based on adiabatic compression. This is the true theoretical adiabatic $MEP$ exerted against the piston and it is not necessary to deduct the back pressure from this as in the case of the usual steam formula.

In most compressed-air problems the mean effective pressure is not wanted so often as the indicated horsepower per 100 cubic feet piston displacement per minute, and in all cases this can be found by dividing the mean effective pressure by 2.29. For the case in point, dividing 30.6 by 2.29, we have 13.4 indicated horsepower developed in the air cylinder per 100 cubic feet of piston displacement per minute. Dividing this by 100 and multiplying by the piston displacement per minute of the compressor, we have the total indicated horsepower in the air cylinder in question.

2. If the compression had been single-stage from atmosphere to 100 pounds the value of $R$ would be

$$114.7 \div 14.7 = 7.81.$$

In looking at the diagram we find that the vertical line corresponding to $R = 7.81$, crosses the line of the diagram at the point marked $B$ corresponding to a value of the factor 2.82. Multiplying this number by the initial pressure 14.7 pounds absolute, we have an answer of 41.4 pounds per square inch $MEP$ developed in the air cylinder. Again, dividing this by 2.29 we have 18.1 indicated horsepower developed per 100 cubic feet of piston displacement per minute.

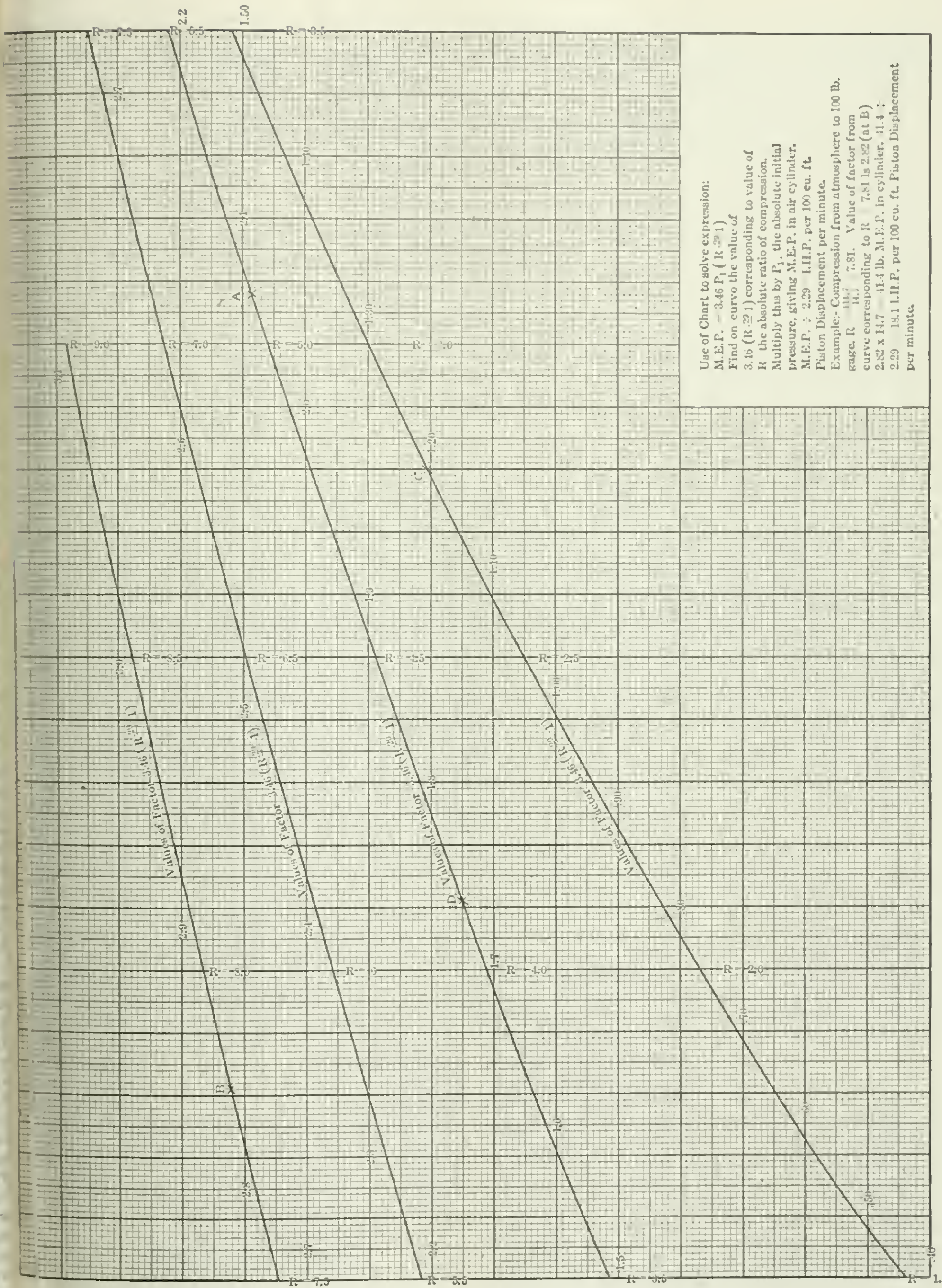
3. For compound compression all we have to do is to remember that with theoretical conditions the horsepower of the low-pressure and the high-pressure cylinders should be alike, giving the minimum total power developed. In practice air compressors are designed so that this is approximately true. The curves and all the formulas are, of course, based on the theoretical aidabatic, and, therefore, we are correct in assuming that the horsepowers in each of the two stages of compression are alike. If the horsepowers are alike this means that the ratio of compression in the two stages are also alike, and consequently the ratio of compression in each cylinder for compound compression will be the square root of the total ratio of compression.

From atmosphere to 100 pounds pressure we have already found that the total ratio of compression is 7.81. The square root of this or the ratio of compression in either the low pressure or the high-pressure cylinder is 2.8. Entering the diagram we find that the line corresponding to the value of $R =$ crosses the factor line in the diagra the point marked $C$ and correspond the value of the factor 1.204. Multipl 1.204 by the initial pressure 14.7, we the mean effective pressure in the pressure cylinder 17.7 pounds per sq inch. Dividing 17.7 by 2.29, we have power in the low-pressure cylinder indicated horsepower per 100 cubic of displacement of this low-pressure inder. As this must be half of the compressor horsepower of the comp compression, we have 15.46 indi horsepower total for the two stages 100 cubic feet of displacement per mi Dividing this by 100 and multiplyin the low-pressure cylinder displaceme cubic feet per minute we would hav indicated horsepower of the compr in question.

This process may be carried thr three, four, five or any number of s of compression. All that needs t remembered is that for multiple-compression the horsepower in all cylinders is supposed to be alike; t fore finding the horsepower in the pressure cylinder we can multiply th the number of stages or cylinders, g us the total horsepower of the com sor. In order that the horsepowers be alike, the ratios of compression in various stages must be alike and sequently for compound compre must be equal to the square root three-stage the cube root and for stage the fourth root of the total of compression.

4. Assume three-stage compressi 1000 pounds pressure. The value of ratio of compression, will be 1014.7 di by 14.7 or 69.2 compressions. With horsepower in each stage the rat compression in each stage and c quently in the low-pressure cylinder be the cube root of 69.2, or 4.11, a the diagram we find that the value corresponding to 4.11 is marked $D$. corresponds to the value of the fact 1.75. Multiplying 1.75 by 14.7 we hav pounds per square inch mean eff pressure in the low-pressure cyl Dividing this by 2.29 we have 11.22 cated horsepower per 100 cubic fee per minute displacement of the low-pr ure cylinder.

This is the horsepower in the first ge, also in each of the succeeding st es;



Use of Chart to solve expression:
M.E.P. = $3.46\ P_1\ (R^{.29} - 1)$
Find on curve the value of
$3.46\ (R^{.29} - 1)$ corresponding to value of
R the absolute ratio of compression.
Multiply this by $P_1$, the absolute initial
pressure, giving M.E.P. in air cylinder.
M.E.P. ÷ 2.29 = I.H.P. per 100 cu. ft.
Piston Displacement per minute.
Example:- Compression from atmosphere to 100 lb.
gage, $R = \frac{114.7}{14.7} = 7.81$. Value of factor from
curve corresponding to R = 7.81 is 2.82 (at B)
2.82 x 14.7 = 41.4 lb. M.E.P. in cylinder. 41.4 ÷
2.29 = 18.1 I.H.P. per 100 cu. ft. Piston Displacement
per minute.

*American Machinist, N.Y.*

WARD RAYMOND'S CHART FOR DERIVING MEAN EFFECTIVE PRESSURES FOR ADIABATIC COMPRESSION OF AIR FROM ANY INTAKE PRESSURE [illegible] by multiplying this figure by the number of stages, namely, three, we have a total horsepower of the compressor of 337 indicated horsepower per 100 cubic feet piston displacement of the low-pressure cylinder of the compressor per minute. This divided by 100 and multiplied by the piston displacement of the low-pressure cylinder per minute will give the total horsepower of the compressor.

A little practice with the use of this diagram will show its value for all kinds of special horsepower and mean effective pressure problems. It can be used for compression from initial pressures other than atmospheric, by the same process, simply finding the ratio of compression by dividing the absolute discharge pressure by the absolute initial pressure, whatever that may be. It must always be remembered that the mean effective pressure is obtained for any one cylinder by multiplying the factor obtained from the curve by the absolute initial pressure of that particular cylinder. The indicated horsepower per 100 cubic feet obtained from this is always for the actual piston displacement of the cylinder in question, no matter what the pressure of air may be.

The curves may also be used for working backward, that is to find various pressures, compression between which will give a certain desired horsepower. In fact the flexibility of the diagram grows with continued use. The results obtained are closer than a slide rule will read and more than this would be hairsplitting.

## What Caused the Flywheel Explosion at Scranton?

By Charles J. Mason

Further particulars in regard to the flywheel explosion at the Washington avenue power plant of the Scranton Electric Light Company show that the wrecked engine had been "trailing" some little time before the accident, and in order to relieve it of some of its load, a turbine unit used for the same purpose was cut in. Just as soon as the turbine unit took its load, the engine began to race, and before it could be stopped the wheel let go. It is the opinion of the men in the station that something about the governor or valve gear failed to act in response to the excessive speed.

A peculiar circumstance in connection with the accident is that the cylinder end of the engine bedplate lifted clear off from the foundation, pulling the holding-down bolts apart, and also the bolts of the exhaust-pipe joint under the cylinder. The holding-down bolts were at least 1 inch in diameter and there were four of them. The joint bolts were ¾ inch and four or five in number. The cast-iron flange on the cylinder-exhaust outlet was not broken at all, as might perhaps be expected, the bolts giving way in tension instead. The engine dropped back on its foundation again as though it had not moved from there at all. Something must have occurred other than the wheel going to pieces to have caused the engine to rise in this manner.

## The Massachusetts Rules for Boiler Inspection Indorsed

The following indorsement is one at which those responsible for the Massachusetts Boiler Rules may well be gratified:

Hon. Philip Breitmeyer, Mayor of Detroit:

Dear Sir—I understand that an ordinance has been introduced in your city embodying the Massachusetts rules for boiler construction and inspection.

These rules have been very carefully considered by this association, and at our recent convention at Detroit a resolution was unanimously passe
recommending them for general ado
tion. I was further requested to a
nounce to you that this associati
had taken this action, and respectful
to suggest to you that you recon
mend the adoption of these rules t
your city council.

These rules have now had the a
vantage of two years' practical te
in the State of Massachusetts, ar
while at first there were necessari
certain disagreements in minor point
they are now recognized as the be
rules which could possibly be devis
for insuring safety in the constru
tion and management of boilers.

The commission which drew the
rules in the first place, and which h
the duty and authority to sugg
changes and modifications in them
the legislature, is composed of o
representative from the boiler-maki
industry, one from steam users, o
from the practical engineers who ha
charge of boiler plants, and one re
resentative from the State inspecti
department. This has insured a ca
ful discussion of the regulations fr
all sides, resulting in excellent, pr
tical and fair decisions. In con
quence the rules have very hi
standing among engineers.

I will only note that in a rec
specification of the War Departme
United States Government, asking
tenders on boilers, it is specified t
the Massachusetts rules shall gov
the construction of these boilers.

I take this opportunity to thank y
for the very kind hospitalities you
tended to our association, on beh
of the city of Detroit, and beg to
main,

Very truly yours,

E. D. Meier

President, Amer. Boiler Mfrs. As

Referred to Committee on Or
nances.

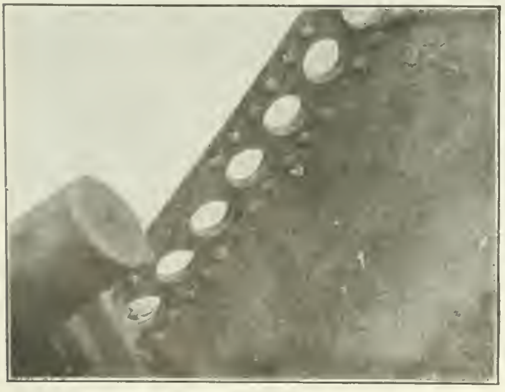


FIG. 2. SHEET CRACKED BETWEEN RIVETS ON INSIDE OF REINFORCING STRIP

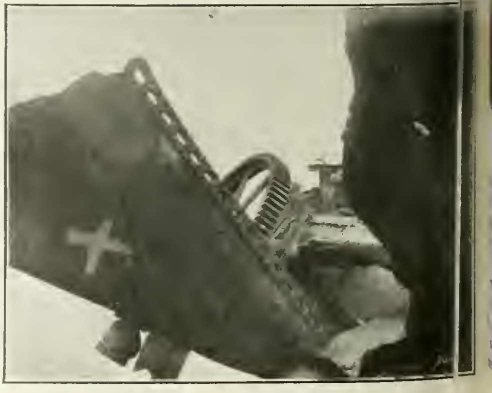


FIG. 3. A SAMPLE OF THE ROUGH CALKING

# Faulty Design Cause of Milwaukee Disaster

## The Six Drums of Three of the Four Boilers Which Exploded All Failed along the Seam, Where the Reinforcing Strip Was Riveted to the Shell

BY OSBORN MONNETT

In the first account of the explosion Pabst brewery, Milwaukee, the ques- n was raised as to whether low water s responsible, and that if this was the se, some of the parts should show signs verheating. Since then the wreckage been cleared away, and all the boilers ve been accessible for examination. It s found that boilers Nos. 1, 2 and 3, bering from Tenth street, had ex- ed, making six drums in all, but that drums of No. 4 did not let go. The ree additional drums which could not mined on the occasion of the first rt are found to have failed in the manner as the others, i.e., along the where the reinforcing strip was d to the shell. Careful inspection e metal in these drums has failed w any signs of overheating, thus nating the low-water theory. Also ing in the condition of the piping fittings has been found to confirm theory that an exploding steam pipe ed the trouble.

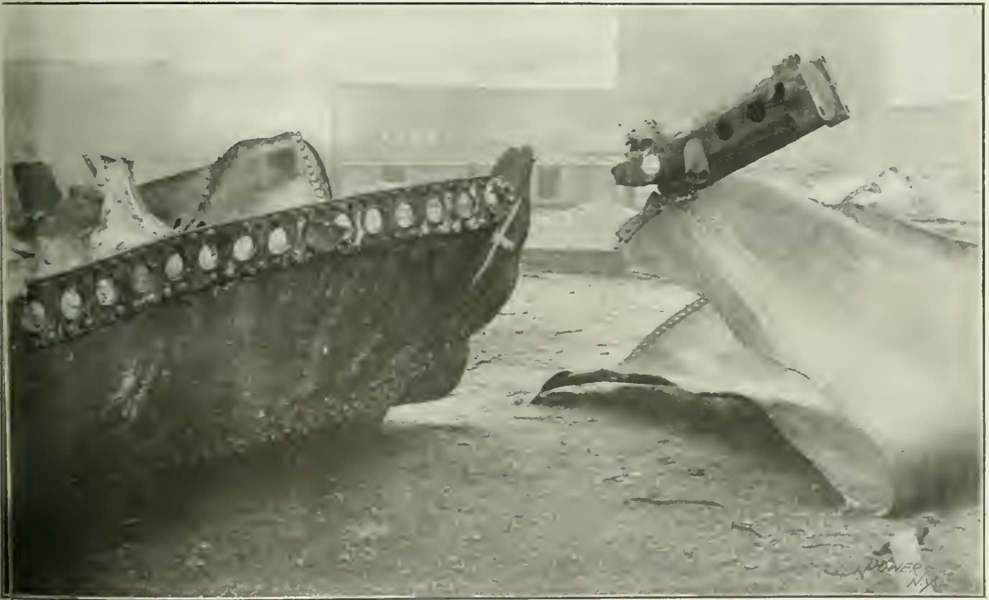


FIG. 1. TWO OF THE EXPLODED DRUMS SHOWING SIMILARITY AT POINT OF FAILURE

study of the construction of the boilers and the conditions under which they failed, leads to the inevitable conclusion that faulty design was directly responsible. The reinforcing strips along which the failures in every case occurred, were of $\frac{5}{8}$-inch steel, riveted on to the outside of the $\frac{3}{8}$ inch sheets, and were always exposed to the action of the hot gases, while the sheets themselves, in direct contact with the water, naturally operated at a much lower temperature. This condition would set up stresses in the reinforcing seams from unequal expansion and contraction, just at the point least able to stand it, having, according to latest measurements and calculations, a strength of only 67.38 per cent. of the whole sheet.

A breathing action might also have easily taken place, caused from the heavy and comparatively nonelastic patch holding the plate rigid and preventing it from assuming the true spherical shape on varying steam pressure, thus resulting in additional stress where the two pieces were fastened together. The history of the case bears out the belief that some such action as this took place. The reinforcing seams were continually giving trouble by leaking, and the fact that leaking occurred is evidence that the metal must have been in distress at this point and that there was some movement tending to loosen the rivets and crack the sheets.

In the effort to stop this leaking, rivets along these seams had in some cases been removed and new ones put in, and an excessive amount of calking had been done around some of the strips; in fact enough in certain places to indent the boiler drums.

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The stockholders of the Bethlehem Steel Corporation have approved an issue of $7,500,000 five-year 6 per cent. sinking-fund gold notes of the Bethlehem Steel Company. The proceeds will be used to retire $2,500,000 6 per cent notes and for additions and improvements to the plant.

# $25,000 Damage from Flywheel Explosi

## Spring in Governor Mechanism Broke and Allowed Engine to Run Away and Burst the Flywheel. Machinery and Building Badly Damaged

On October 14 a flywheel explosion resulting in more than the usual amount of damage occurred at the plant of the Kingston Electric Light Company, Kingston, N. Y. The flywheel belonged to the large generating set of the station, and was 20 feet in diameter. A broken spring in the governor mechanism of the engine was the direct cause of the accident, allowing the engine to run away and burst the flywheel by centrifugal force. Pieces of the wheel flew in all directions, some going through the side of the building and others through the roof, carrying away a big steam pipe and wrecking everything in their path. A large piece weighing over 300 pounds went through the roof and landed several hundred feet away at a point near the central station of the fire department. The engine, dynamo, switchboard, condenser nd other machinery were wrecked, not mention the damage to the building, total loss reaching very close to $25, The photographs show clearly the ex of the damage, and it would pear that practically the entire plant demolished.

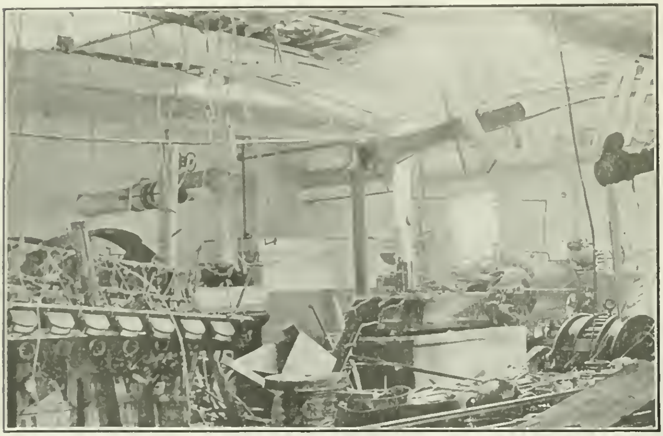

FIG. 1. REMAINS OF THE ENGINE AND GENERAL DAMAGE

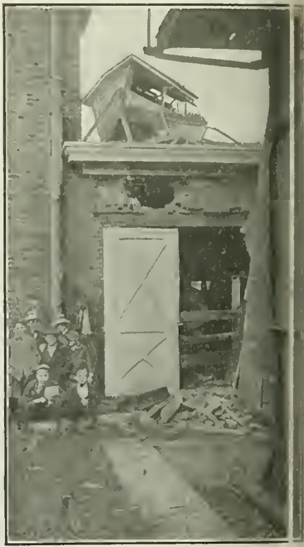

FIG. 3. SOME EXTERIOR DAMAGE

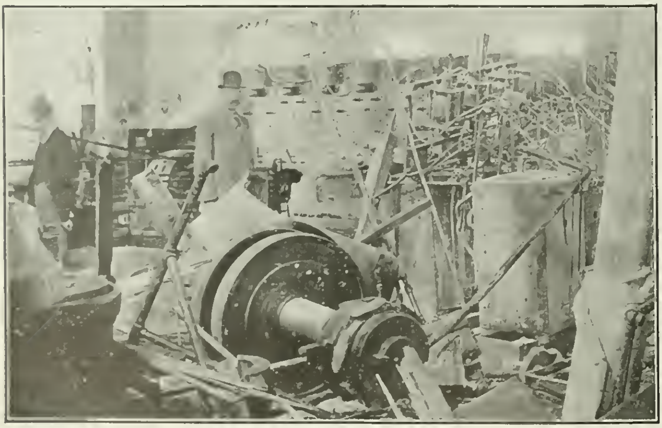

FIG. 2. FLYWHEEL HUB AND DEMOLISHED SWITCHBOARD IN BACKGROUND

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A battery of two boilers had an burning equipment installed, and as f water was scarce, the oil was to sprayed with compressed air. To w up the air before spraying, it was through a series of coils, located in throat of the smokestack, on its way the compressor. On the trial test, everything seemed to work all r steam could not be held up to pres As the plant furnished sufficient s m while burning coal, it was evident he cause was due to the new arranger it. The trouble was finally found to be ue to the coils in the stack cutting o to much of the outlet area. Taking m out and piping the air directly to he burners removed the cause of shor ge, and it was then easy to generate en gh steam.

# Practical Letters from Practical Men

## Don't Bother About the Style, but Write Just What You Think, Know or Want to Know About Your Work, and Help Each Other

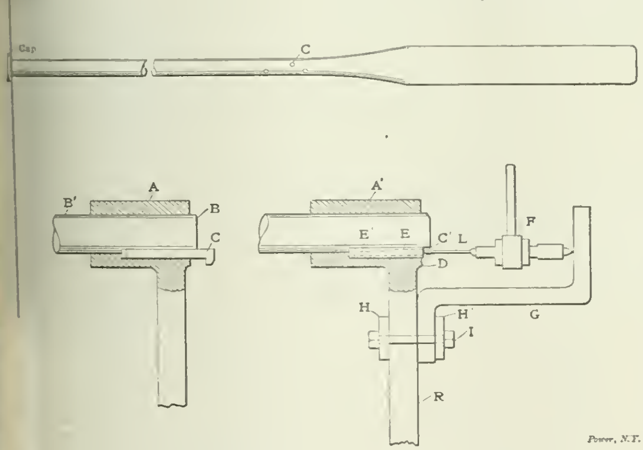
## WE PAY FOR USEFUL IDEAS

### Removing a Key and Drilling a Slice Bar

That some engineers have queer ideas of the duties of various apparatus is plainly demonstrated in the following: The writer was called from a machine shop to make some repairs to a cross shaft on an elevator pump. The order read: "Send machinist to remove key from cross shaft on pump No. 2. Shaft is cutting in cross-stand bearing on left side." I was soon on the job and found an unusual state of affairs.

In the accompanying sketch A is a cross-sectional view of the rocker arm, the cross shaft fitting in the rocker arm. B' is the portion of the arm which fitting in the cross-stand bearing, C is the key that holds the arm and shaft together. A is another view of the rocker arm and at C' is the place where the engineer at some time or another had deliberately sawed off the head of the key, leaving no method of removal without drilling and tapping the key and then pulling it out.

At the other end of the shaft there is a small rocker arm keyed on in a similar manner, but it is necessary to have the end of key cut off for clearance space to allow the tappets to clear the arm. Fortunately I brought a ratchet and some drills with me, and at F is shown the ratchet in position. At G is an "old man" that we made on the job out of a piece of 1½-inch square iron, holding it in place with two straps H and H' to the arm R by means of two bolts shown at I. Before drilling the holes I chipped the bevel surface of the key shown at C' so that it was straight, as shown at D; otherwise it would have been impossible to get the drill to enter straight in the key. I drilled the hole shown by the dotted lines at E, for a ½-inch tap about one-half the length of the key. I then drilled the remainder of the hole with a ¼-inch drill, tapped the larger hole, screwed in a common square-headed bolt and drew out the key with a small chisel bar and a piece of 1¼-inch square iron for a bait. I then removed the arm, forced the shaft out the other way, cleaned out the bearing, dressed off the shaft which was not very bad and made and fitted a new key. The pump is now running all right.



METHOD OF REMOVING KEY AND SLICE BAR ABOVE

While I was walking around the plant at the dinner hour, I noticed a slice bar, and stepping close to it saw that it had several small holes drilled in it, much as is shown in the sketch at C. The engineer said that he had read a great deal about firing tools blowing up, etc., and that he had taken an ounce of prevention for his, by drilling the holes.

MATT KLEPFER.

Depew, N. Y.

### The Unreversible Motor

A power plant which furnished the power for mining and hoisting coal at a large coal mine in Ohio, was taxed to its utmost capacity to furnish steam in sufficient quantities for the different engines and steam pumps. One of the causes for the use of so much steam was that a great amount was lost through condensation, as a number of pumps and small engines were quite a distance from the battery of boilers. There was a large dynamo in the plant, and it was decided to install electric power for the purpose of running some of the small machinery farthest away from the boilers. So a number of small motors were purchased, and it was the intention of the company to use the first one for the purpose of running the ventilating fan. The fan was remodeled and the room was built larger, so as to accommodate the motor, and after some little delay the motor arrived and was put in place.

The electrician of the plant was a man past middle age who had been an engineer for a great many years and had studied electricity a little from certain textbooks, but seemed to have been very slow in grasping the subject.

It was the duty of the electrician to connect the motor to the line and try the fan. This he did in a short time and to his great surprise the fan ran in the wrong direction, and instead of forcing air down into the mine as it should have done, it was pulling the air out. Bob was puzzled for a time, as he did not know how to reverse a motor, but he determined not to let anyone know that he could not cause it to run in the opposite direction. He tried everything he could think of, first changing the terminals where the motor line connected to the main line, but the fan continued to run in the contrary direction. He then tried to reverse it by shifting the brushes on the commutator, but this only made the machine act violently. He became disgusted with the motor and told the contractor that the motor was not the kind that had been ordered, as it would only run in one direction—changing the line terminals ought to reverse the direction of rotation of any armature. Bob quit the job for the day, and it was not until the third day that he went to the city, which was about four miles distant, to ask the city light plant engineer, how a motor could be reversed. He was told to simply change the armature terminals and all would be well. Bob went back the next day to his job, changed the terminals as he had been told to do, and of course the motor ran in the right direction.

George Peffenberger.

Coalton, Ohio.

## Puzzle on Piston Speed

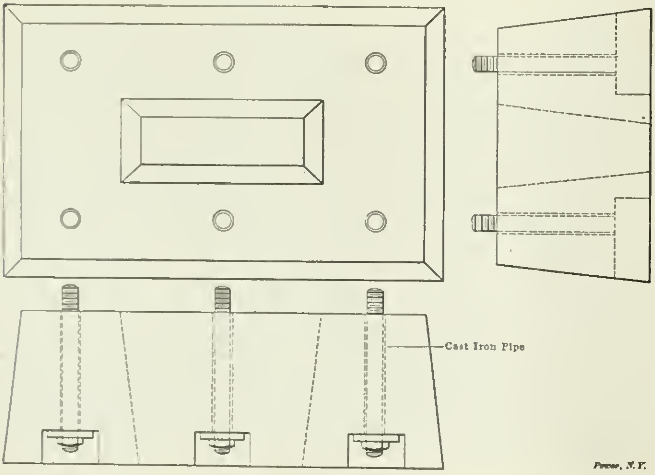
Among the machines in my charge are two large air compressors. The other evening after the load had gone off, and time to breathe had arrived, I watched the coupling on the piston rod between the steam and air cylinders, and I said to my oiler: "Joe, which end of the stroke does the piston run the fastest or does it take the same time for the piston to move from the center of the stroke to the end and back to the center again, on each end?" He smiled, but was too wise to commit himself. We watched it for a few minutes and he thought one end and I the other. The next day I worked it out on paper, but would like to have the comment of Power readers.

Webster Tallmadge.

Jersey City, N. J.

## Removable Foundation Bolts

Foundation bolts are usually built permanently into the concrete or masonry, but this is bad practice especially in large and expensive foundations, for if the thread on a bolt happens to get stripped or the bolt is injured in any other way, it is an expensive and tedious job to tear out the foundation around the bolt sufficiently to allow of putting in a new one. The accompanying sketch shows a method of putting in the bolts, so that they can be removed at any time without disturbing the foundation at all. A cast-iron pipe is built into the foundation where each bolt goes through, and this pipe terminates in a square pocket near the bottom of the foundation. At the top of this pocket a cast-iron plate is built into the concrete. The bolts are held in place by large cast-iron washers and nuts.



REMOVABLE FOUNDATION BOLTS

When putting a bolt in place, the nut and washer are laid on a plank and pushed into the pocket, so that they come directly under the iron pipe. The washer should be considerably larger in diameter than the bolt so that it can be easily centered. The nut and washer are pressed up hard against the top of the pocket and held there, with the plank, while the bolt is screwed in from above. A short piece of plank is left permanently in the pocket to keep the bolt from dropping to the bottom of the pocket while placing the bed of the machine on the foundation.

This method of building a foundation is only applicable where it is possible to dig the dirt away from the bottom of the foundation and thus obtain sufficient room for the work.

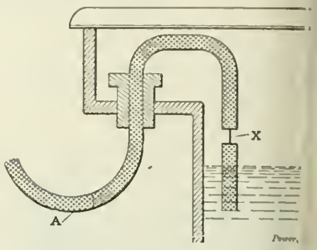
Howard M. Nichols.

Kenyon, R. I.

## Some Transformer Troubles

In a substation in connection with the writer's plant there are three 150-kilowatt water-cooled transformers which step the voltage down from 10,000 volts to 3300 volts. The cooling coils of these transformers are supplied with water from a tank about 300 feet away, and this tank is in turn supplied with water by a triplex pump drawing water through an underground pipe about ¼ of a m away, where a small, sluggishly movi creek is located.

The transformers have been install about 3½ years, and during the p year much trouble has been experienc on account of the cooling coils cloggi up with a hard, brown deposit wl made it very difficult to force w through them.



STOPPING OIL LEAKAGE FROM TRANSFOR

Matters kept getting worse until fin one day the flow stopped altogether in of the transformers, which became hot, the oil reaching a temperature 170 degrees Fahrenheit. This transfor was cut out and the two remaining run open delta, part of the load b removed. The cooling coil was taken and various methods were tried to c the pipe. Diluted acid, steam and w under high pressure accompanied by h mering were all tried, but with no cess, for hardly a drop of water coul forced through. A "troubleman" of manufacturers of the transformers pened along, but he could suggest what had been tried, and a job plumber said that it was impossibl clear the pipe without straightenin out.

Finally as a last resort the coil, w was composed of 20 turns of ¾-inch each turn oval-shaped about 18x40 in was laid on the ground and a wood built inside of it. This was started put out about six times in two days, during that time violent explosions curred at intervals, and at each expl quantities of mud, steam and water blown from either end. At the en the two days a full stream of water through the pipe. The coil was plugged at one end and water under pressure was applied to test for lea the pipe, but none developed.

In the meantime the other two t former coils were rapidly filling u the first transformer was made for service, and the remaining two disconnected one at a time, and their ing coils treated in the same manner three transformers are now in oper and a full stream of water is ru through each cooling coil.

There was another minor trouble these same transformers that had ed since their installation. This was medied at the same time the transrmers were freed from the water-coolg trouble. It was as follows:

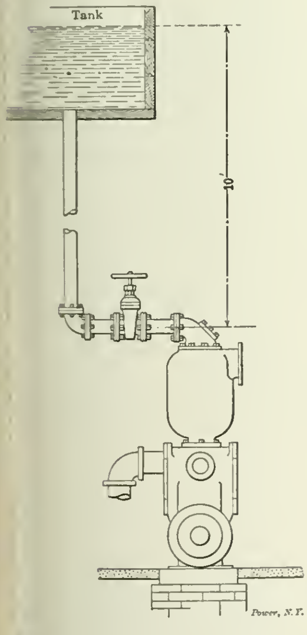
The drawing shows how the secondary, 33,000-volt, leads were brought out. At nt A there was a continual dripping oil caused by the transformer oil being wn over by capillary attraction in the aided covering of the outgoing leads. e trouble was entirely stopped by cutng away all the insulation for about ½ h at point X.

C. T. Maynard.

Proctor, Vt.

## Does a Suction Head Help a Condenser?

f a jet condenser has its injection er come to it under a head of 10 feet, in Fig. 1, will it cost less to run it



. I. CONDENSER WITH SUCTION HEAD

th as though it had to lift its water eet as in Fig. 2?

there is any difference, how much it be and why? If there is no differe, what becomes of the surplus energy the first case?

John H. Thompson.

tchburg, Mass.

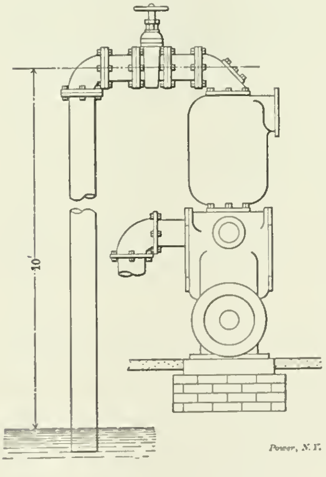


FIG. 2. CONDENSER WITH SUCTION LIFT

## A Stopped-up Blowoff

Some years ago the writer had an interesting experience in the plant of a coal mine, with a stopped-up blowoff. The power house was located on the banks of a stream of running water and being newly built and in an isolated section, we had many educating experiences. The boiler-feed water was pumped directly from the creek, and in fair weather we had little trouble with mud. After hard rain storms, however, there was a great deal of trouble from this cause. At such times it was necessary to blow the boilers down as often as twice an hour to prevent the blowoffs from becoming stopped up.

On the occasion referred to one of them did get clogged with mud which it was impossible to loosen by any of the methods we could think of. One day was the longest we thought it safe to operate the boiler with so much mud in it, for fear of bagging. Accordingly it was decided to cool the boiler down, empty it and dig out the obstruction. The cooling down was easily done but the emptying process was another matter. If 100 pounds of steam would not remove the obstruction, the mere weight of the water would not avail to do so. One has few things to work with in a place of that kind, but finding a piece of 1-inch rubber hose about 25 feet long, we removed the top manhole plate and entered the hose, for its entire length, having care to run it in straight so as to make sure that it was entirely filled with water. When the last end was under water we plugged it up securely and pulled it out, carrying it quickly down the side of the boiler to a point below the bottom of the shell, and then the work of emptying began. By this means all, or nearly all, the water was siphoned out of the boiler, and a man sent in who soon had the blowoff unstopped.

E. T. Binns.

Philadelphia, Penn.

## Peculiar Accident to Engine

It had been necessary to remove the pin from the low-pressure crosshead of a 24 and 48 by 48-inch cross-compound horizontal Corliss engine. The pin had been replaced and the job practically completed, except for removing a 10x10-inch block of wood about a foot long, which lay on the lower guide to support the end of the rod while the pin was removed. The engineer desired to start the engine to try it out as soon as done, and as he happened to be near the stop valve in the exhaust-pipe line, he thought that he would save an extra trip to the valve by opening it before removing the block, intending to remove the block and look the engine over before starting it.

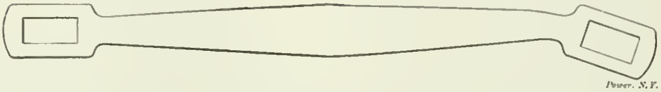


FIG. 1. BENT CONNECTING ROD

The exhaust pipe was connected to a central condensing system, and it happened that the low-pressure side of the engine was near the beginning of the out stroke with the admission valve open. As the engine had been standing idle for several hours with the stop valve closed, the receiver and connecting pipe were filled with air, and the opening of the stop valve withdrew the air from one side of the low-pressure piston, causing the engine to start. The crank passed over the top quarter and the connecting rod came down upon the block of wood which was still lying on the bottom guide. The engine moved very slowly, but the inertia of the moving flywheel and armature carried it onward with sufficient force to bend the connecting rod several inches out of line.

The rod, which was 12 feet long, was taken out and laid over a large fire and heated to a fair red heat where it was bent. It was straightened by means of sledges, a fine wire being stretched parallel to the axis of the rod as shown in the sketch to serve as a guide in straightening. It was then laid on its s[illegible] to the other plane by the [illegible] in the planed surfaces.

H. K. Mason.

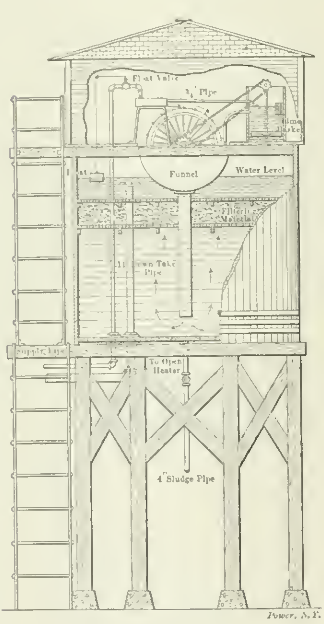
[illegible], Mo.

## Cost of Boiler Cleaning

The water we use for boiler feed is taken from a small pond about 30 yards from the plant, and while it may not have been so bad for boiler-feed water, it was bad enough to give us a great deal of trouble and an endless routine of work in keeping scale removed and keeping the boilers reasonably clean. We have two Erie City water-tube boilers rated at 250 horsepower each, and during the winter when our boilers were taxed to their utmost capacity it became next to impossible to spare one long enough to be thoroughly cleaned. Our cleaning of [illegible] had to be done on Sunday, and as we could not spare one until midnight Saturday night and had to have it ready again by five o'clock Sunday night, it did not give the boiler time enough thoroughly to cool down, but we had to do the best we could. Our boilers scaled so badly that they had to be bored out with turbine tube cleaners every four or five weeks, and given a washing out between times.

We had tried several different compounds, and while some had genuine merit and would at least help us with our troubles, their cost was prohibitive. The expenditures of the company in construction work in the last few years having been so heavy that the installation of a complete water-softening plant would hardly have met with their approval, we concluded to construct one ourselves. Right here I want to say that I should not advise anyone to attempt to construct one. There are several well known makes, some of them advertised in Power, the construction and operation of which are highly commendable, and which in the long run are cheaper to install.

We had on hand a cypress tank in good condition, holding about 14,000 gallons, so we erected an oak stand 12 feet high and mounted the tank upon it. The next thing was to design and proportion an apparatus to mix and deliver the chemical solution according to the amount of water used. This I did by building an overshot wheel 4½ feet in diameter, having 25 buckets. The wheel was an old plow wheel, found in a junk yard. A band of heavy galvanized iron, 6 inches wide, was riveted to the rim, with sides riveted on 3 inches high, then the buckets were spaced and riveted on. Across the tank I placed two 2x10-inch sills on edge, and framed them with short pieces and bolts 11 inches apart. Suitable bearings for the wheel shaft were placed in the center and the wheel placed in position. A funnel shape for the wheel to run in was placed in the frame, clearing the wheel all around, and on the bottom an 11 inch pipe was placed, extending down to within 1 foot of the bottom of the tank. A forebay was placed over the wheel with an apron to guide the water in the buckets. Next, a galvanized tank was made, holding 75 gallons, and was placed on the frame for a lime-saturator tank, the paddles inside being operated by bevel cogs and sprocket wheels and chain from the water wheel. A pipe was run from the forebay to the lime saturator and another from the tank to the funnel under the wheel. The lime is placed in the tank in a wire basket and is slacked gradually. A proper amount of soda ash is also placed in the lime tank at proper intervals. The lime, meeting and mixing with the raw water under the wheel, passes down the downtake pipe to the bottom of the tank, then rises up slowly and near the top passes through an excelsior filter and rises 1 foot above the filter. Six inches under the surface of the water is the top of the supply pipe, where the water is conveyed to an open heater. The water to the softener is fed by a duplex pump controlled by a Fisher pump governor, maintaining a constant pressure in the supply pipe, and the water level in the softener is maintained by a float and balanced valve. At the bottom of the tank are placed a 4-inch pipe and valve, through which the sludge is drawn out once a day.



WATER CLEANSING TANK

This apparatus has been in operation fourteen weeks and during the first six weeks we opened the boilers at regu r intervals and removed all the old sc e that came off, and now our boilers e perfectly clean all the time. It has redu d our coal consumption, as accurately s we can measure it, nearly $70 per mon. There is no more boiler cleaning, v its attendant expense, and we are ı able to give continuous light service n Sunday, which we were unable to do fore. Our open heater previously ha o be opened and cleaned every week, d now it has run for thirteen weeks v no more signs of scale formation.

Our water, by analysis, contained 2 grains per United States gallon, con ing mostly of carbonate of lime and phate of lime. It goes into the softe at times dark and mucky, and after l ing been treated and settled is clear soft. We blow our boilers about half gage twice in twenty-four ho When opened the last time all the scale had come loose from the tubes the whole interior looked like it had l given a coat of whitewash, but the w coating, being only a thin powder, c rubbed off.

This apparatus has certainly den strated the absolute necessity of a w softener in connection with steam pl and the only reason why all plant ow do not have one installed is because don't know their value. It is not a q tion as to whether one can be aff r but as to whether they can afford to without one. Of course, in designing apparatus an investigation had to be n to avoid infringement on any de covered with patents, and in that con tion I have studied the various type use, and in reading the catalogs a what the apparatus will do, it is there is not one claim made that they not fully and easily prove. It woul well for plant owners in general to up the question of water softening once with the various builders of t plants, as there is not an investment can make that will pay as big retur

W. E. Turn

Wilmington, O.

## Simple Rule for Torque of M

*Multiply the electromotive force in by the current in amperes and this duct by 7; divide the product by revolutions made in a minute and quotient will be the force exerted radius of 1 foot from the center of shaft.*

For instance, suppose the voltag is 220, amperes 90 and revolutions 700 r minute; then

$$220 \times 90 \times 7 = 138{,}600$$

and

$$138{,}600 \div 700 = 198$$

pounds, the turning moment at a dist ce of one foot from the center of the s ft.

# Subjects Under Discussion

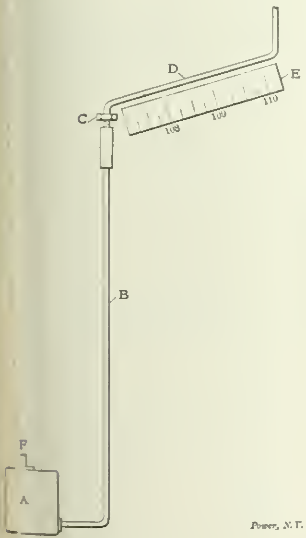
Comment, Criticism and Debate upon Various Articles, Letters and Editorials Which Have Appeared in Previous Issues

BRING OUT YOUR IDEAS

## Water Level Gage for Elevated Tank

Mr. Parmley's description of a water-el gage for an elevated tank, in Power r September 28, suggests a description a solution of a similar problem in a wer plant in Chicago. The tank is 110 t high to the top, and it is desirable to w at all times the exact water level, that it should never go below 30 from the top.

The sketch shows how the gage is con-



ER LEVEL GAGE FOR ELEVATED TANK

ructed. *A* is an iron vessel filled with ercury. *B* is a piece of ¼-inch iron pipe i length sufficient to obtain a column of mercury high enough to counterbalance a column of water somewhat lower than the water will be allowed to reach. *C* is a stuffing box used to connect a glass tube *D* to the iron pipe *B*.

The glass tube *D* is bent to within about 20 degrees of a horizontal line for the purpose of increasing the movement of the end of the column of mercury over what it would be if it was placed vertically. Connection to the gage is made at *F* to any water pipe that may be connected to the elevated tank. The hight of the water in the tank can be told by observing the position of the end of the mercury column relative to the scale *E*.

Chicago, Ill. Almon Emrie.

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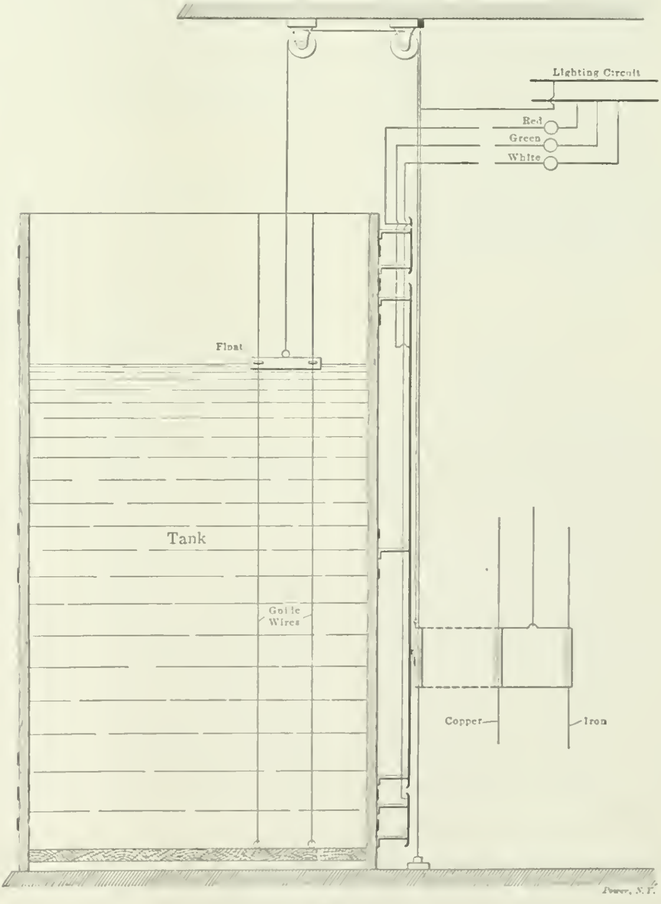
I was much interested in J. C. Parmely's device for indicating water level in a tank, as described in a recent number of Power and The Engineer, as I had to rig up a similar scheme several years ago. My device, however, was somewhat simpler and easier to install. It consists of a wooden float inside the tank, with staples in each end, through which suitable guide wires pass, preventing the float from moving in any direction except up and down. A string from this float passes up to and over a pulley, and is fastened to a piece of sheet iron, say 6x8 inches, the 8 inch dimension of the plate being horizontal. The 6-inch edges of the plate are bent round to form "eyes" or tubes through which two more guide wires pass. One of these guide wires, say the left-hand one, should be of copper and connected to one side of the lighting mains. The other can be of iron or any scrap wire.



ARRANGEMENT TO INDICATE WATER LEVEL

About 1½ or 2 inches to the left of the right-hand guide wire and about ½ inch toward the tank from the plate, are located three rods, one above the other in a straight line, the ends being about 1¼ inches apart and bent in a bit toward the tank. These rods can be fastened to the tank by soldering smaller pieces of lighter wire to their backs, bending the other ends of these smaller wires at right angles and stapling them to the wood of the tank; in doing this the iron bands must be avoided, or short-circuits and other troubles are sure to develop.

On the back of the plate is riveted a strip of spring brass, the unriveted end being sprung out about ½ inch from the plate. This spring—I used a spring from a dynamo brush holder—presses against one of the three rods, according to the hight of the plate, and completes the electrical circuit.

For a tank 12 feet high, I made the top and bottom rods 1 foot long each, and the middle rod 10 feet long. (Of course any number and length of rods could be used.) The uppermost rod should be connected through a red lamp, the lower one through a green lamp and the middle one through a white lamp to the other side of the lighting mains, all lamps being in the engine or pump room.

With a heavy enough plate to overcome "sticking" as the plate comes down, and a big enough float to overcome the friction of guide wires on the up-trip, no trouble should be experienced in keeping a satisfactory indication of the water level by the lamps.

A. E. ANDERSON.

Lujane, Colo.

## Raising Water

In the August 17 issue J. W. Sherman asks for information on raising water. I will state for his benefit, if it is any benefit, just what I have gone through in getting water out of a 6-inch well 185 feet deep.

For two years we raised the water with an air lift and it was very expensive, but I could not make the general manager think so. After that time the management changed and we had a new man at the head of our company. I commenced to talk pump to him and he agreed with my idea from the start. We installed one of the Goulds pumps, and now we are lifting 30 gallons of water per minute from the first of September to the last day of June, 10 months in the year, with a 2½-horsepower motor, where it formerly required to raise the same amount of water with the air lift a compressor and a 10x12 duplex engine, equal to two 10x12 engines running about 25 revolutions per minute each, making the two engines running 50 revolutions per minute.

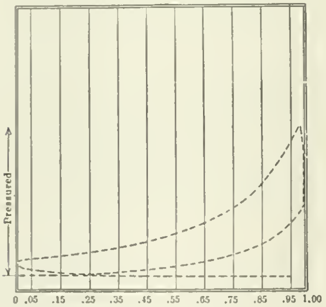
There is a great saving in the coal consumed, since with the air lift we would put in 6 tons of coal on Saturday to run the plant until Monday; now with the motor-driven pump, we put in 4½ tons and have enough to run until Monday night—a saving of about 1½ tons in 36 hours, besides about 12 hundredweight saved every 24 hours during the 6 working days. Mr Sherman can see from this statement that experience has taught me that an air lift is comparatively expensive.

W. B. ARCHER.

Alexandria, Va.

## Finding the Mean Effective Pressure of Indicator Diagrams

In the September 21 issue, Lewis C. Reynolds describes a way of finding the above. His method is very handy when there are several diagrams of different lengths to be integrated, but when there are several diagrams of the same length I prefer the method described below, because the card itself is not disfigured by pencil marks, the work is quicker and it tends to be more accurate.



Stroke = 14 Inches
Bore = 11½ In.
Revs. = 250

Spring = 1/180
Total Hight of Ordinates = 3⅜ Inches
Mean Pressure = $60\frac{3}{4}$ Lb. per Sq. In. $\left(= \frac{3\frac{3}{8} \times 180}{10}\right)$
Indicated Hp. $= \frac{\text{Plan}}{33000} = 41.23$ Hp.

Power, N.Y.

FINDING THE MEAN EFFECTIVE PRESSURE OF INDICATOR DIAGRAMS

For each length of diagram obtained draw the figure here given on a piece of tracing cloth, making the lines as fine as possible. The length of the diagram (stroke) is measured off horizontally and verticals are erected to a hight which covers the highest probable pressure which will be recorded on a diagram. The stroke is divided into eleven parts by the erection of these ordinates, nine divisions being 10 per cent. of the stroke each, and two of them 5 per cent. of the stroke, each.

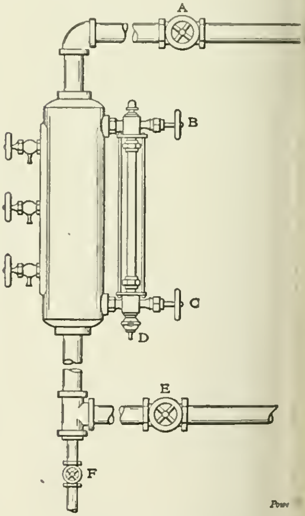
To use, pin the piece of tracing cloth on the back of Mr. Reynolds' board, having the horizontal lines parallel and square with the bottom and sides of the board respectively; two thumb tacks
opposite corners will suffice. Slip the di
gram to be measured up under the lin
with the atmospheric line parallel to t
base line, and add up the lengths of t
ordinates 0.05, 0.15, 0.25, etc., in the usu
way. Divide by 10 and multiply by t
scale of the spring and the result is t
mean effective pressure. The ordin
lengths are best added along the edge
a strip of paper, saving the linen fr
divider holes. In the drawing an act
gas-engine diagram is shown in dott
lines, supposed to be seen as set
measurement under the tracing cloth.

JOHN S. LEESE

Manchester, England.

## Testing Water Gage

As an addition to Mr. Wakema
article on water columns and connectio
I submit the following method of test
the water gage, which may be of use
some brother engineer. It is safer th



WATER GAGE CONNECTIONS

using the try cocks, and is in fact the
way of finding the true water leve
the boiler.

Referring to the sketch, *A* and *B*
steam valves, *C* and *E* are water v
and *F* and *D* the drains. As it is *al*
water we want to find, proceed by cl
valves *A*, *B*, *C* and *E*, and opening d
*F* and *D*. Close *F* and open *C* an
Water blowing from *D* proves valv
and *C* and the passages to be clear.
close *C* and open *B*. If water again
from *D*, it proves that the column,
*B* and the glass are clear. Next cl
and open *A*, and steam blowing th
will prove valve *A* and the passage
Close *D* and open *C* and *E*. You

ow be certain that the water gage is working condition, and the water level own is the correct one.

J. Mitchell.

Montreal, Can.

## Pound in an Engine

The most plausible reason for the ound in the engine described by Le Roy ott in the October 19 number, seems be too much play between the guides d crosshead. When the engine is carry- g the load and running under, the pres- re from the crosshead is always against e upper guides, both on the forward l return strokes. This is readily seen the accompanying sketches, Figs. 1 and in which *P* represents the magnitude d direction of the force exerted by the n, *Q* the resistance due to the load d *R* the resultant of *P* and *Q* which resents the magnitude and direction of pressure against the upper guide.

As soon as the throttle is closed, the n will cease to push or pull on the sshead, but the momentum of the fly- el will keep the engine running for ttle time. While doing so, the effect the inertia of the reciprocating parts cause the crosshead to be brought ernately against the upper and lower ides at the end of each stroke. If the between the guides and the cross- d is great, the knock is apt to be very nt.

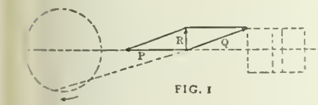


FIG. 1

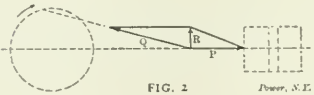


FIG. 2

B. E. Charles.

Auburn, N. Y.

## How Priming was Stopped

r Wakeman's article, "An Unex- ned Accident," opens for discussion a t which should be worthy of investi- n. At first glance it does not appear stroke cutoff on one end and ⅝- ke cutoff on the other end should e more priming of the boiler than an alized ⅝-stroke cutoff.

in a tub of water the palm of the d is placed on the surface, gently ing and relieving alternately and in ılar order, it will cause the water to at the center and edges alternately very considerable hight. This can be mplished more quickly at one certain uency of movement than any other. oo fast or slow, one wave tends to k up the other.

side a boiler directly under the nozzle the level of water changes with each opening of the engine valve, especially when only one engine is used and little if any steam is drawn off for other purposes. Suppose then we assume a boiler of such size that opening the valve 125 times a minute is just the right frequency to set up the waves inside the boiler. An engine running 125 revolutions per minute would admit steam 250 times per minute, and would neutralize its own effect. Practically no difference should be noticeable from no load to full load.

Now unbalance the cutoff so one end does nearly all the work. Instead of 225 openings we would get 125 good openings and 125 openings so small as to be ineffective in breaking up the waves. When it is remembered that it is only necessary to reduce the pressure on one local spot of the water surface one pound to make it jump upward 2 feet, it would be reasonable to expect some moisture in the cylinder.

The writer had an experience similar to the one described which may be interesting, as the remedy applied was decidedly effective.

A small plant containing a Scotch boiler 6 feet in diameter and 6 feet long, exclusive of the attached combustion chamber, supplied steam for a 7¾x12-inch Buckeye engine running at 300 revolutions per minute. For a year there was no trouble from priming. The engine was rated at 40 horsepower and the boiler at 60 horsepower. Later the engine was exchanged for a 12x16-inch Buckeye, the change being made simply to get as nearly perfect regulation as possible for experimental purposes. Within a few days we were surprised by a sound that an engineer only cares to listen to once. Traveling at 240 revolutions per minute, with the governor holding the valves wide open, and the cylinder relief valves cracking like a rapid-fire gun, we were assured that the irrigation operations had started.

The boiler nozzle was 3 inches in diameter, as was the first steam line to the engine. We changed to 4½ inches for the new engine. The dry pipe consisted of a 2½x3-inch tee, screwed "bullheaded" into the nozzle with a nipple 12 inches long in each end. The velocity of steam was thus reduced in the steam main, but in the nozzle and dry pipe was slightly higher owing to the reduced speed and increased cylinder area. This led to a change in the area of the openings into the dry pipe. The tee was replaced by a side-outlet cross 3-inch in all fine openings. The side was screwed into the nozzle, looking up out of the boiler. The openings which then stood fore and aft of the boiler were fitted with nipples 18 inches long and on the end of each 3-inch tees were screwed "bullheaded." The two remaining side outlets of the cross were left open without any piping.

This provided six openings for the entry of steam to the steam main, thus cutting down the velocity and spreading over such a large surface as to eliminate the tendency of the water to rise. This arrangement was tested out later with the water level and pressure varying over a wide range, and it was found impossible to make the boiler prime with any combination of water level, pressure and load that could be arranged.

H. R. Hadfield.

Newark, O.

## Oil Data

We have an 18x15-inch condensing four-valve Atlas engine making 220 revolutions per minute on a boiler pressure of 125 pounds. The load varies from 18 to 168 indicated horsepower, averaging about 100 horsepower for sixteen hours daily.

We fill a quart lubricator every morning, which is often one-third full, using the Standard Oil Company's Rarus cylinder oil. We experienced some trouble keeping the steam-valve stems lubricated until we allowed a slight amount of steam to leak through the packing.

Fred. W. Axe.

Del Mar, Cal.

## Stress in Cylinder Head Bolts

In the discussion on cylinder-head studs, the fact has not been emphasized that in almost any material under strain a certain amount of deformation takes place. In practice when the nut has been screwed up until 1000 pounds pressure has been reached, the pressure is due to a certain tension in the stud. Let us consider the forces acting on the cylinder head alone. As 1000 pounds pressure has been produced between the cylinder and head by means of the nut, the cylinder is pushing against the head with a force of 1000 pounds. But the nut pushes the opposite way on the head with a force of 1000 pounds. If it did not the head would not stay in place. These two equal and opposite forces are the only ones acting on the head. Now if steam is admitted into the cylinder and it exerts a total force of 100 pounds against the head, there must be an equal and opposite force resisting it, if the head is to remain in place. This force is exerted by the nut, which means that the tension in the stud is more than 1000 pounds and the pressure of the cylinder against the head is slightly less than 1000 pounds. But, I hear someone saying, this 100 pounds is taken off from the pressure between the head and the cylinder, so that the total tension in the stud is still 1000 pounds, while the pressure between the head and the cylinder is only 900 pounds. The pressure between them can be decreased only by a further elongation of the stud, which would require a tension greater than 1000 pounds. This tension depends on the modulus of elasticity of the steel from which the stud is made. If the stud could be imagined as having absolutely no elasticity, a force of 1000 pounds and a pressure of 100 pounds on the head would place a total force of 1100 pounds on the stud. If we could imagine the stud to be made of rubber and placed under 1000 pounds tension, then a pressure of 100 pounds in the cylinder would produce no more than the 1000 pounds tension already on the stud, although the pressure between the cylinder and head would now be 900 pounds. This is because the rubber stud could elongate the infinitesimal amount necessary to relieve the pressure of the head, without materially increasing the tension in the stud. These are the two limiting cases. In actual practice, the tension in the stud would be somewhere between 1000 and 1100 pounds with the pressures mentioned, and in ordinary cases nearer to 1100 pounds. The total tension in the stud depends on the coefficient of elasticity of the particular stud in question.

O. W. Middleton.

Chicago, Ill.

## Lubricator Connection

In the letter on changing a single-connection lubricator to a double in the October 21 number, the writer mentions the great mistake lubricator manufacturers make in placing the filling plug at the top of the gage glass, with no provision made for the escape of air while filling. This certainly is a great oversight and I can sympathize with the writer when he tells of standing beside a hot cylinder pouring a few drops of oil into the lubricator, then waiting several moments before the next few drops can be poured in. I can also imagine about what his line of thought is at this time, but he will partially forgive the lubricator manufacturer if he will try the following method which works very nicely:

After the necessary valves have been closed, open the drain valve, and instantly upon removing the filling plug begin to pour oil into the lubricator. In this way you get the benefit of the siphoning action of the water as it runs out, and when it is all out the same amount of oil has taken its place, no air having been allowed to enter.

L. C. Tucker.

Newburyport, Mass.

## An Easily Made Close-Reading Draft Gage

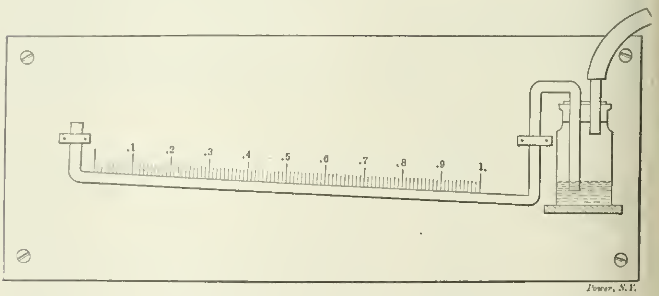
The draft gages described by Mr. Miller in the August 3 number and by Mr. Carter in the October 5 number both possess the disadvantage of not permitting a close reading. Draft readings are usually given in hundredths of an inch and it is evident that the U type, in which the movement of the liquid to indicate one inch of draft is only one-half inch, cannot be read with any great degree of accuracy.

The gage that I use was made from a 3/16-inch glass tube 20 inches long. A right-angle bend was made 1 inch from the end and a similar bend 8 inches from the other end. The long end was then bent into the form of a return bend, each leg being of equal length as shown in the illustration. The tube can be readily bent by heating in a gas jet or gasolene torch, taking care not to bend it so sharp, as to reduce the bore of the tube. Provide a 1-ounce wide-mouth bottle fitted with a cork and bore two holes in the cork so that two glass tubes will fit tightly in them, as shown. With the cork in place insert the free arm of the return bend until the end just clears the bottom of the bottle. In the other hole place a short piece of glass tube and attach a rubber hose which connects with the breeching. A hardwood board 16 inches long, 6 inches wide and an inch thick is provided for the back and the tube is secured in position by two brass straps in such a way that when the top of the board is level the bend at the short end is about ½ inch higher than the bend at the end next to the bottle. Cut an opening in the board so that the bottle will fit back into it and set a small shelf in the opening to form a further support for the bottle. Lay out a scale 10 inches long and subdivide each inch into ten parts and secure the scale back of the tube so that zero of the scale will be at the upper end of the incline. Pour a small quantity of water or light oil into the bottle and blow through the short
tube, which will cause the liquid to pas
over through the return bend, filling i
Now carefully pour the liquid into th
bottle until it rises to the zero mark o
the scale and the instrument is ready fo
use. This gage will not need a multiplic
and can be plainly read to one-hundredt
of an inch. The range of the gage ca
be doubled by doubling the angle of th
incline, which with the same length o
scale will make each division read on
fiftieth of an inch, or the length of th
tube can be doubled, thus retaining th
finer scale gradation.

The design is not original with m
a similar instrument is manufactur
commercially.

Lewis C. Reynolds.

Willard, N. Y.



MR. REYNOLDS' HOMEMADE DRAFT GAGE

## Regulation of Exciter

To cut in resistance in the armatu
circuit of the exciter (which is the fie
circuit of the generator) will surely cau
a greater load on the exciter if it is
sired to keep the generator up to norm
We have a Tirrel regulator on the
ternating-current system; the average e
citer voltage is 75 and average amp
age 18 to excite the field circuit of o
generator. We operate with the resi
ance in the armature circuit of the
citer (or the field circuit of the ge
erator) all cut out, the regulator taki
care of the variations.

Taking Mr. Utley's rule of "the prod
of volts and amperes equals load
watts," we have

$$75 \times 18 = 1350$$

watts. By cutting in about half of
resistance in the armature circuit,
voltage goes up to 100 volts, the amp
age remaining the same at 18 amper
Applying the rule again,

$$100 \times 18 = 1800$$

watts, or 450 watts increase.

In the case of an alternating-curr
generator and exciter, the generator
quires a certain amperage of current

xcite its field circuit; cutting in more sistance in this circuit you must have nore voltage to keep up the amperage.

Charles E. Nigh.

Morgantown, W. Va.

## Professor Ryan's Water Power Formulas

In my article on water powers, pubed in the issue for October 12, two rrs occurred, either typographical or to hasty typewriting. In the second mn of page 604 *v* should represent per *second*, not per minute. In the t columne of page 605 the final *H* in rncis' formula should read $H^{\frac{3}{2}}$.

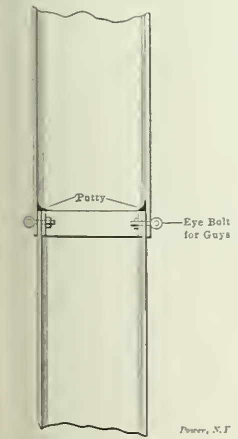
W. T. Ryan.

Minneapolis, Minn.

## Constructing Iron Smokestack

W. N. Zurfluh speaks of a new way of structing an iron smokestack. This, wever, is not a new way, as the plant r ss the road from me has had four ks constructed in this way in the ten years. It has been necessary to t p a new one about every 2½ years, stacks always giving out at the joints. i Mr. Zurfluh will make an investiga- during a rainstorm, he will find that gr at deal more water goes down the de of the stack than the inside; also the joints open down, the draft of stack tends to draw air through the nt and helps to dry up any moisture ich may accumulate, while if the j t is upside down this tendency is g tly reduced.

the plant referred to I helped put new stack a year ago. The old one h come down without even a warning k just as we were getting ready to put water in the boiler. This stack had only been up a little over two years and was constructed on the new principle. Upon examination we found nearly every joint more or less decayed, in many places the iron being thin enough to cut with a tinner's shears while the middle of the sections were as good as ever.



TTIED JOINTS AND BAND FOR EYEBOLTS

In putting up a new stack for the plant at which I am now employed, I got some stone putty and filled the joints inside, as shown in the drawing. Two of us completed the job in half an hour, and then I gave the inside a heavy coat of good stack paint and let the stack lie for a couple of days to dry. I have made several examinations of the inside of the stack at the base and there is no sign of the paint blistering or cracking yet, while the putty is as hard as iron.

I also did away with the guy collars around the stack and put eyebolts through the plates at the joint, using a plate 3 inches wide by 8 inches long and $\frac{1}{4}$ inch thick inside the stack to bring the nuts up on. The whole thing was then puttied over and painted.

A. A. Blanchard.

Oak Harbor, O.

I have read with much interest the letter by W. N. Zurfluh on "An Iron Smokestack Constructed in a New Way," page 712, October 26 number, and wish to say that we have had a 70-foot by 36-inch iron smokestack in use for about 1½ years, which is constructed so the laps are on the inside, as shown in Fig. 2. I believe this is an improvement over the old method of putting the laps on the outside, because I have noticed quite often where the laps are on the outside, as shown in Fig. 1, the stack will show signs of rusting at the joints about five or six months after it has been newly painted, thus showing that rain causes more trouble here than at any other point of the stack. Our smokestack was painted about a year ago and so far there is no sign of rusting anywhere.

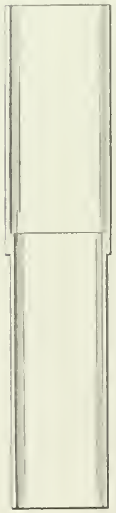


FIG. 1.

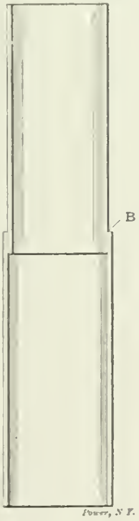


FIG. 2

If a smokestack is constructed as shown in Fig. 2 and is painted once a year, especially at the joints *B*, I can see no reason why it should not give double the service of the old style

H. Jahnke.

Milwaukee, Wis.

## Starting a Throttle Valve

Recently Power had a story and verse on "Where shall the throttle be?" and I suggested that the wheel be over the back cylinder head so that it could be reached from both sides of the engine. On a recent installation I had the throttle placed in that position, much to the disgust of the erecting engineer, but there was another thing that, to him, looked a great deal worse.

A throttle valve closed tight is a difficult thing to start open, as when it sticks it may require both hands and it may require also a wrench or a lever, which is inconvenient.

The wheel on this valve was small in diameter, but had a heavy rim with lots of inertia. It was put on the stem with a fine left-hand thread and the nut with a right-hand thread and screwed up to make a thoroughly tight fit for the wheel. It was a difficult matter to start the valve off its seat by bracing one's self and using both hands.

I took the wheel off, fitted a key in the stem and made the keyway in the wheel hub 1/16 inch wider than the key, and put on a washer so that the nut would not clamp the wheel. With this lost motion it becomes a very easy matter to start the valve from its seat no matter how tightly closed. It can be done, if the throttle can be reached, by at least two fingers. A small wheel with heavy rim is just suited for this purpose.

W. E. Crane.

Broadalbin, N. Y.

It is stated that the methods of the race-track gamblers, who dope horses in order to make them win races, have been copied by unscrupulous owners of gasolene racing boats. The gasolene is doped with picric acid or some other high explosive, and with the increased power thus obtained the boats are able to win races they would lose if ordinary straight gasolene were used. On the race track there are stories of plugs which have been overdoped and died, and it is said there are also gasolene engines which have been unable to withstand an overdose of picric acid and have gone heavenward.

POWER
AND THE ENGINEER

DEVOTED TO THE GENERATION AND
TRANSMISSION OF POWER

Issued Weekly by the
Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

565 Pearl Street, New York.
355 Dearborn Street, Chicago.
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of POWER solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $1 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "POWPUB," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During 1908 we printed and circulated 1,836,000 copies of* POWER.

*Our circulation for October, 1909, was (weekly and monthly)* 135,000.

*November* 2............ 42,000
*November* 9............ 30,000
*November* 16........... 30,000
*November* 23........... 30,000

*This paper reaches 42,000 separate readers each month and 30,000 each week.*

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*

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## The Temperature of a Vacuum

In a misguided moment the writer of an engineers' handbook asked himself: "What is the temperature of vacuum?" and answered "between 98 and 99 degrees."

Many a self-conducted student of steam engineering has been misled by this statement, and many others will be before it can be finally put to rest.

When water is heated, the energy which is put into it in the form of heat is taken up by increasing the velocity of the molecules of which it is composed. These molecules, so small as to be far beyond the power of any microscope to resolve, revolve about each other in orbits as do the members of a planetary system, held together by their mutual attraction, while the centrifugal force due to their motion tends to separate them. Increased temperature simply means that the molecules are moving with greater velocity, which increases their centrifugal force, and there comes a time when the force tending to separate them overcomes the forces holding them together. They fly off as does a stone released from a sling shot; the water becomes steam, and it is the impact of these myriads of minute particles impinging with an inconceivable velocity upon the walls of the containing vessel that constitutes the pressure which steam exerts.

Holding the molecules together in the shape of water there is not only the mutual attraction of the molecules but the pressure acting upon the surface of and thus all through the mass. It is at the point where the centrifugal force is sufficient to overcome the attraction between the molecules and the pressure upon the surface that the change from water to steam, the boiling, takes place.

The temperature is simply the measure of this centrifugal force and it follows that for each pressure there is a certain degree of centrifugal force, or temperature, at which the water will pass into steam. If the steam cools below this temperature, the combined effort of the pressure and their own attraction will reunite the molecules into water, i.e., the steam will condense. If more heat is added it will not increase the temperature so long as there is any moisture present but be used up in converting that moisture into steam. After all the moisture is gone the steam can be "superheated" to a higher temperature, but unless the steam is superheated, so long as it is in the "saturated" condition it must be at the temperature determined by the pressure as above described.

The term "vacuum" is used in steam engineering to denote a pressure less than that of the atmosphere. At the average pressure of the atmosphere at sea level, 14.7 pounds to the square inch, water boils at 212 degrees Fahrenheit. This means that to overcome the traction of the molecules together wh the pressure of the atmosphere upon th they must have that degree of tempe ture (velocity combined with ma which we recognize as 212 degrees.

If the pressure instead of being 7 pounds is 100 pounds (about 85 ab that of the atmosphere), the temperat required will be 328 degrees. On e other hand, if the pressure is less t n that of the atmosphere, i.e., a vacu the temperature required will be less t 212 degrees, and increasingly less as pressure decreases. When the pres is 10 pounds instead of 14.7 it beco 193 degrees instead of 212. When pressure gets down to 5 pounds the t perature is 162. At 1 pound abso water will boil at a temperature of and even at 32 degrees will make st of 0.089 pound to the square inch.

To ask, therefore with reference steam, "What is the temperature c vacuum?" is like asking, "What is temperature of steam in a boiler?" depends upon the pressure whether pressure is above or below the at phere.

An absolute vacuum, a space devoi matter, can have no temperature, temperature is a measure of mole energy, and if there are no mole there can be no temperature.

## Hydrogenless Producer Gas

At a recent meeting of the Mo Science Club, Brooklyn, N. Y., Go M. S. Tait delivered a lecture on ducer Gas Power, in the course of w he said that he had found in practice the system of power-gas productio which part of the exhaust gas from engine is used instead of steam to down the fire-bed temperature does show any increase in economy du the "regeneration" of the $CO_2$ bac CO. The reason for this, he said, that the percentage of $CO_2$ in the exl gases is so small relatively that its version into CO is unimportant. real advantage, he stated, in using haust gases instead of steam to kee temperature down is that the quali the gas is uniform, permitting the of the ignition mechanism to be s the most effective point and kept th

Mr. Tait made the rather surp assertion that with his system of gas duction the maximum ability of th gine would be slightly greater than of an engine of the same bore and s k operating on conventional producer a and in support of that statement said t the average mean effective pressure ob- tained with his system, using com es- sions around 175 to 200 pounds (g e) was 70 pounds. Asked what the ual mean effective pressure is with ord ary producer gas he said "about 60 65 pounds," and when informed by one of the audience that a large number of diagrams taken recently showed 80 pounds and over, he said that was due to the fact that the engine was a single-cylinder machine of a foreign type. Mr. Tait further vouchsafed the more astonishing information that a gas engine can be made to expand down to atmospheric pressure by proper design of the combustion chamber and location of the valves! Taken all in all, however, the address was interesting, and it was productive of beneficial discussion.

## Saving by Diminishing the Denominator

It is an old, but by no means a worn-out saying, that to improve efficiency one may either increase the numerator or diminish the denominator, either earn more or spend less, and nowhere does this principle apply more pertinently than in the management of a power plant.

James Watt recognized this when he directed the most of his energies toward the use of the separate condenser and the protection of the cylinder walls.

During the passage of the nineteenth century engineers and inventors seem to have given more thought to increasing the numerator. Beginning with the atmospheric engine of Newcomen and the [illegible] engine of five or ten pounds initial pressure, the change went steadily on and steam pressures crept up to twenty pounds—fifty pounds—seventy-five pounds—one hundred pounds (and this last was high pressure in the seventies.)

The iron-shell boiler gave out at this pressure and the open-hearth steel boiler came in to take its place. One hundred and twenty-five pounds taxed the strength of steel and the sectional boiler was involved. One hundred and fifty pounds—two hundred pounds—fifty degrees superheat—one hundred degrees—two hundred degrees—steam pipes strain and twist, joints leak, fittings burst, packings burn out, pumps go on a strike, engine valves gall and stick, the engineer gets nervous and begins to long for the good old times. We sometimes wonder where it will all end.

These developments have all tended, in the long run, toward economy of fuel, economy of space and economy of time; one has but to compare the ponderous, heavy, slow-moving Cornish engine of our grandfathers, or even the Corliss engine at the Centennial in 1876, with the compact, buzzing turbo-generator of the modern power station to realize this. Our modern power unit is but an exemplar of our modern business organization, [illegible], compact, efficient, moving at high pressure and high speed. When either works well it is a marvel; when either goes to smash the spectacle is one that compels attention.

It is with a sense of relief that one notices the present-day tendency to look after the denominator a little more, since it is apparent that the numerator is about large enough.

A visitor to the gorge below the falls at Niagara twenty years ago saw vast streams of water issuing from cavities in the face of the cliff forty or fifty feet below the edge, and falling idly into the river below.

These were the waste sluices of water wheels located in chambers dug in the cliff and receiving water from the canal above.

Three-fourths of the power thus went to waste because no attention was paid to the denominator. Today horizontal water wheels, connected to electric generators, are located at the water's edge and receive the water through metal pentstocks so that no power is lost by neglected fall.

The advent of the steam turbine has done much to call attention to the importance of economy at the lower end of the heat diagram. For reasons which it is not necessary to explain here the turbine is better adapted than the reciprocating engine to take advantage of low-terminal pressures. Either when used alone or when in conjunction with a high-pressure reciprocating unit, the steam turbine can justify the use of comparatively expensive condensing apparatus and profit by the correspondingly good vacuums.

It is generally understood that when an engine exhausts into the atmosphere nearly as much available energy is thrown away as there is used in the cylinder.

Let one stand in the winter time on the roof of a high building in any of our large cities, noting the white clouds of steam escaping from atmospheric exhausts in every direction, and he will realize better the enormous waste which is continuously going on.

It is true that many large reciprocating engines are running condensing, but the gage on the condenser more often shows twenty inches than twenty-five. To maintain and utilize a vacuum of twenty-eight or twenty-nine inches would not only require an expensive condensing equipment but also an abnormally large low-pressure cylinder.

When the low-pressure turbine is used to supplement the high-pressure reciprocating engine, each unit is working in that part of the scale for which it is best adapted and the result is a flexible and efficient machine. To a certain extent the same result can be and has been attained by converting the simple high-pressure engine into a compound or a triple engine.

In a new plant, again, it may seem more workmanlike to put in steam turbines alone. This is a question in regard to which sufficient data are now lacking and further experience may change present conclusions.

Be this as it may, it has already been demonstrated that the addition of a low-pressure turbine to an existing system will frequently add power to a much greater extent than it will increase the running expenses and will also furnish a reserve unit for emergencies. When running at full capacity the plant will have nearly if not quite double the power, with practically no increase in the running expenses.

In case of a break down either unit can be used alone, while the other is being repaired; this assumes of course that a direct connection is made between the turbine and the boilers for use in such emergencies.

The simplicity of the low-pressure turbine, on account of its small range of pressures, is one strong point in its favor. Although comparatively a new development, dating from 1902, this application of the steam turbine has come rapidly into favor.

Low-pressure turbines of the Rateau, Curtis or Parsons types are now in quite general use as supplements to reciprocating engines, with actual savings of from ten to thirty per cent. in the consumption of steam per kilowatt-hour.

It may be asked whether the installation of a good condensing apparatus will not give the same result at a much smaller initial expenditure. The answer to this would be that a redesign of the engine would in most cases be necessary, to adapt it to the lower exhaust pressure and higher degree of expansion and that even then the engine would not give the same economy as would the new combination of engine and turbine.

## Gravity and Buoyancy in Double-Harness

Samuel H. Schneider, a nice-looking young man to judge from his photograph as reproduced in a Paterson, N. J., newspaper, has had an inspiration which is going to "revolutionize (as usual) present methods of generating power and also to greatly decrease the cost of maintenance of power plants."

Mr. Schneider has asked for a patent for "a waterproof and air-tight vacuum body, automatically folding and unfolding, which is of equal weight whether folder or unfolded, but by displacing more or less space in a liquid will rise and fall accordingly."

If Mr. Schneider had bought an accordion for a fraction of what it would have cost him to apply for a patent and unfolded it under a head of water, whether by means of permanent magnetism or otherwise, he would have found that the same head which is useful to press the buoyant body upward is also an embarassment during the unfolding process.

# Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

## Crosby Continuous Diagram Indicator

A new design of continuous-diagram indicator is described and illustrated herewith. The steam cylinder, piston and pencil arm arrangement are the same as in the regular design of outside-spring indicator got out by the Crosby Steam Gage and Valve Company, 97 Oliver street, Boston, Mass.

The size and shape of the piston is different from the inside-spring type, the area of the piston being one square inch, and is in form the central zone of a sphere, which it is claimed greatly reduces the friction of the piston in the cylinder.

The drum for the paper is made with an outer and inner shell, the outer shell having a slot $1\frac{1}{4}$ inches wide cut out as shown in Fig. 1. Midway in the slot a pin is fitted, as shown, which is for the purpose of holding the roll of paper on which the diagrams are drawn. On the interior of the main drum is a central cylinder connected to the drum. On top of the drum, and working with it, is a nurled head, loosely attached to the drum spindle, which controls the distance the paper is advanced after a diagram has been taken. This adjustment allows a variation of from six to one hundred diagrams on each foot of paper. On the top of the drum is a detent motion which allows the operator to use the indicator as an ordinary instrument.

The drum is designed to use a roll of paper 2 inches wide, put up in rolls of 6 and 12 feet long. Upon this roll the successive diagrams are traced and the paper is wound from the roll around the drum onto the inside drum. The roll of paper is placed on the pin within the opening of the drum as shown in Fig. 2 and is then passed around the outside of the drum and in through the opening and into the central cylinder to which it is attached. After the paper has been wound on the inner drum it may be withdrawn through the top, and the paper containing the diagrams removed. Sec Fig. 2.

In Fig. 3 is shown a series of diagrams taken from a rolling-mill engine, showing

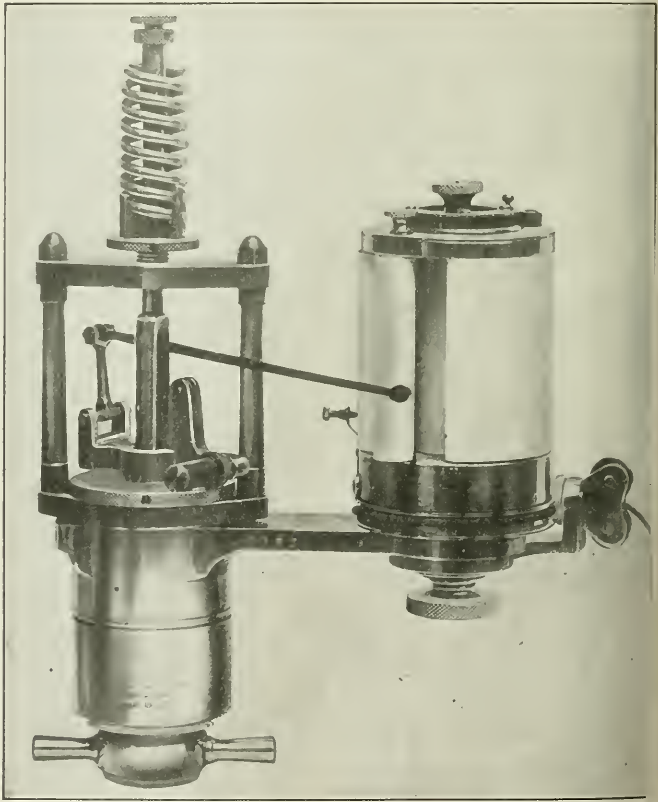


FIG. 1. CROSBY INDICATOR WITH PAPER ROLL IN POSITION READY FOR TAKING DIAGRAM

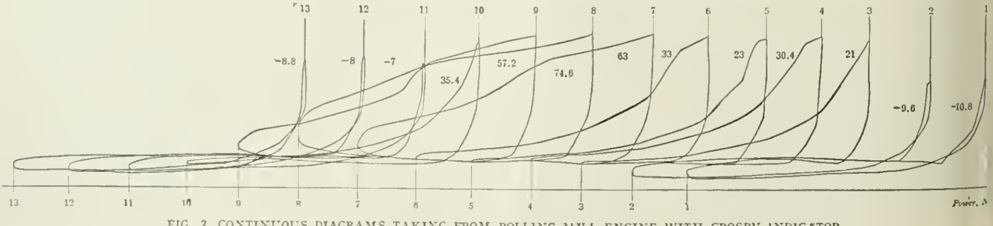
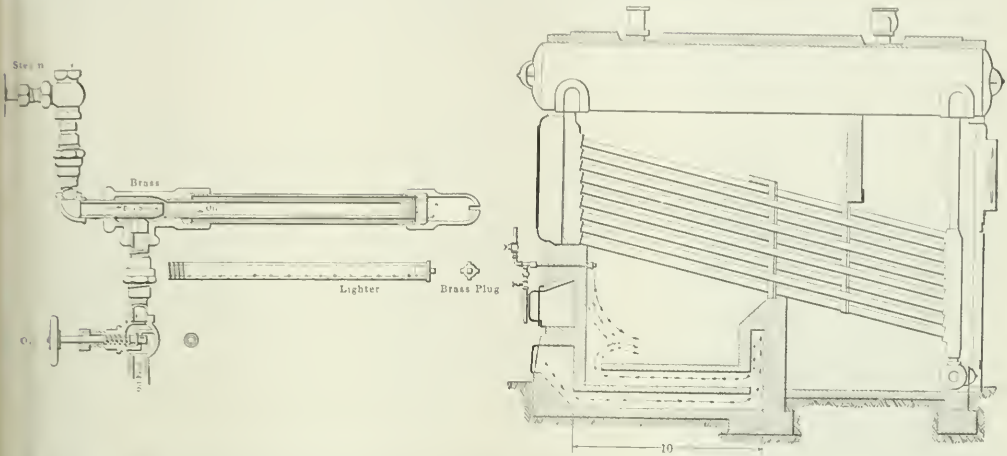


FIG. 3. CONTINUOUS DIAGRAMS TAKING FROM ROLLING-MILL ENGINE WITH CROSBY INDICATOR

he engine performance with friction load p to full load, when the steel plates were passing through the rolls, and back friction load again, the figures at the p and bottom showing the beginning of e steam line and point of release of ach diagram.

## Witt Crude Oil Burner and Noiseless Furnace

The Witt crude-oil burner and noiseless furnace are illustrated and described herewith. The burner is made with either single or double openings in the tube The tip with double openings has a separation which causes an equal amount of oil to issue from each. A small amount of oil is passed around the oil pipe, entering the tip, which keeps the oil hole clean. The oil is regulated at the head of the burner and has no needle-valve rods to get stuck in the burner. It will also be noticed that there is no body of oil in the burner and that the burner does not require a large opening in the boiler front for insulation.



WITT CRUDE-OIL BURNER AND HOW IT IS APPLIED TO A BOILER FURNACE

The boiler setting illustrates a boiler equipped with one of these burners, and shows that the burner protects the tubes of a water-tube boiler from the direct flames, and that the air is preheated before coming into contact with the boiler tubes. The air is admitted through the flue below the furnace leading to the bridgewall, and returning directly under the oil burner. The burner is placed directly under the tubes, but since the heated air enters at the bottom of the combustion chamber the flame is not local, but is distributed throughout the furnace. The burner and furnace are manufactured by the G. E. Witt Company, 850 and 852 Howard street, San Francisco, Cal.

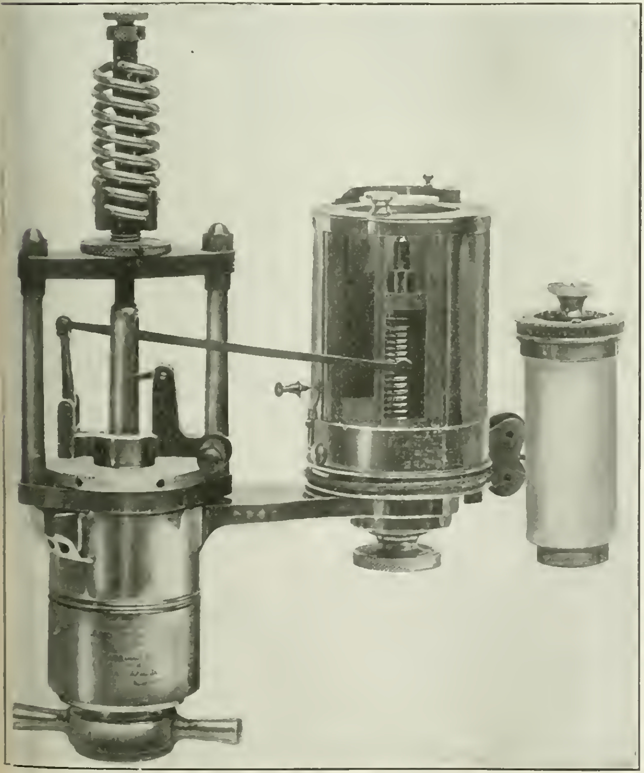
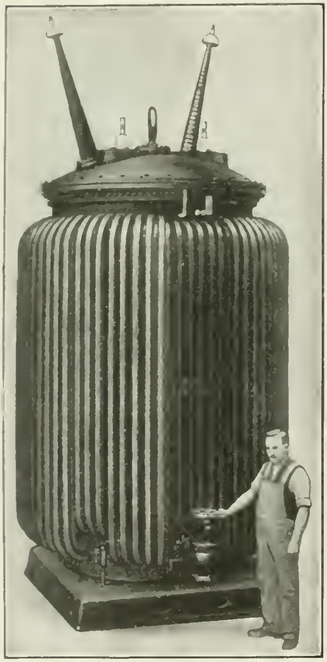


FIG. 2. CYLINDER OF CROSBY INDICATOR WITH CONTINUOUS DIAGRAMS REMOVED

## A Large Self-Cooling Transformer

The maximum size for which a transformer can be built self-cooling is limited by the amount of heat-radiating capacity for which the case can be designed. Standard cases with corrugated sides are regularly supplied with transformers up to about 600 or 750 kilovolt-amperes, but beyond this size the weight and size of the case become so great that some method other than mere increase in size must be resorted to in order to get the necessary radiating surface. The accompanying engraving illustrates a type of transformer case recently developed by the Westinghouse Electric and Manufacturing Company to overcome this difficulty. It consists simply of a heavy boiler iron case to which are welded a number of radiating tubes, arranged vertically with a 90-degree bend at the top and bottom where they enter the case. The oil with which the case is filled circulates through these tubes. The tubes are well separated from one another, so that the air circulates very freely among them and the efficiency of the radiating surface is considerably higher than for the ordinary corrugated case.


A LARGE SELF-COOLING TRANSFORMER

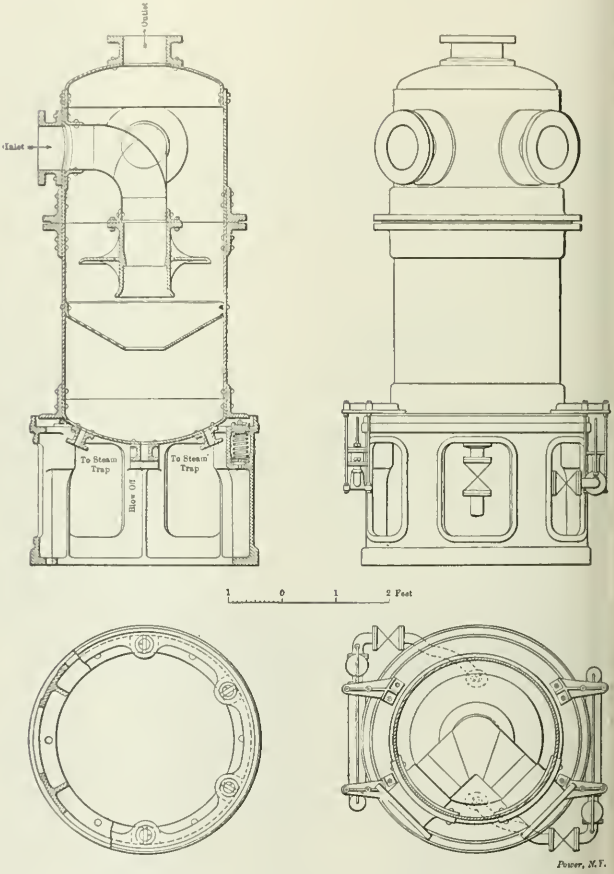
This type of case is especially advantageous also for large transformers in substations and other places where water for cooling purposes is either not available or else very costly, or where weather conditions are so severe that water-cooled transformers may give trouble, or where it is impractical to have normal attendance.

The Westinghouse Electric and Manufacturing Company has just built twelve 1000-kilovolt-ampere, 100,000-volt transformers of this type for the Southern Power Company; three of them are for outdoor and nine for indoor service.

## A Novel Design of Steam Separator

A novel design of steam separator is shown in the accompanying illustration, and is in operation in the Greenwich generating station of the London County Council tramways, London, England. The separator body consists of a steel vessel in which the direction of steam flow is suddenly changed as found in ordinary practice. The particular feature of interest in this steam separator is the fact that it rests upon a series of steel balls as shown in the sectional view of the illustration, the balls being carried upon supports which rest upon springs in a cast-iron stand, which is bolted to the floor of the engine room. Owing to this construction, the separator can be moved in any direction, either sidewise or rolling on the balls, or up or down by relieving or compressing the spring.

The advantage in this will be evide when it is taken into consideration th there is a great deal of contraction a expansion in pipe-line construction steam plants, and their motion, when co nected to the separator, causes the se arator easily to adjust itself, thus elimin ing any severe strain in the pipe line separator connection. It is evident th such strains could not be taken car were the separator bolted securely to e floor.



DETAILS OF STEAM SEPARATOR AT THE GREENWICH GENERATING STATION

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The B. F. Sturtevant Company, m u facturer of blowers and engines at I de Park, Mass., has established in its works a branch of the Massachu tts Savings Bank Insurance. An instr or goes among the men explaining the ue and necessity of systematic saving. ny of the employees have taken adva ge of this proposition and have insur in amounts ranging from $500 to $1000.

# Inquiries

*Questions are not answered unless they are of general interest and are accompanied by the name and address of the inquirer.*

---

### *The Scotch Yoke*

Is the Scotch yoke being used to any extent to take the place of the old-time connecting rod, either for high speed or for heavy duty? In answering please name a few of the principal users.

S. J.

We do not know of any instances in hich the Scotch yoke is used for high-peed or heavy-duty engines. It is used pon some pump work. It was said that Buffalo builder of gas engines would se the yoke in place of the connecting od but we have been unable to locate it.

### *aising the Temperature of Steel*

How many B.t.u. are required to raise he temperature of a piece of steel veighing 20 pounds, from 52 degrees ahrenheit to 90 degrees Fahrenheit, 52 egrees being the temperature of the tmosphere. And how many B.t.u. would e required to raise the temperature of a iece of steel weighing 20 pounds from 8 degrees Fahrenheit to 72 degrees Fahrenheit, and maintain that increased mperature for 48 hours?

C. H. G.

The specific heat of steel, as determined Regnauld, is given in Rontgen's Therodynamics as 0.1165 soft, 0.1175 hard. hat is to say, it requires, say, 0.117 of a at unit to heat one pound of steel one gree. To heat 20 pounds from 52 to , i.e., through 90 — 52 = 38 degrees ould take

$$20 \times 38 \times 0.117 = 88.92 \text{ B.t.u.}$$

o raise the same weight from 48 to 72 grees would take

$$0 \times (72 - 48) \times 0.117 = 56.16 \text{ B.t.u.}$$

If none of the heat units got away it uld require no more heat units to keep at that temperature. It is simply a atter of supplying the loss by radian, convection and conduction. This ll be quite different if it is in an oven m what it would be in cold storage. you can get some data as to what it in contact with and surrounded by, and ir temperatures and velocities (in the se of air or gas), you can make an elligent guess at this loss.

### *hausting to the Receiver*

Lately I have taken charge of a small nt for heating the building. I use a lucing valve; part of the returns come k to a receiver and put back in the ler and part go to a trap and discharge out of doors. These coils are be the receiver.

Now, I have a large bucket trap in the gine room over the receiver where ne of the returns come back, and what ant to know is: Can't I do away with se traps that discharge out of doors and pipe the other coils back to this same trap over the receiver? Or, would it be all right if I left those traps there and piped from the traps into the receiver?

T. J. W.

If your receiver is vented into the atmosphere so that only the atmospheric pressure exists in it, the traps which now exhaust to the atmosphere may be made to deliver their water to the receiver, if you can carry pressure enough upon the coils which they drain to overcome the head between the traps and the receiver—something like a pound for each two feet in vertical hight.

### *How is Horsepower Determined?*

How is the horsepower of a stationary engine arrived at, and what figures are used in ascertaining this information?

Following are the dimensions: Size of cylinder, 11x24 inches; speed, 90 revolutions per minute; steam pressure, 125 pounds.

Probably you may be able to suggest some mechanical books giving such information.

G. F. C.

A horsepower is 33,000 foot-pounds per minute.

The number of foot-pounds developed by an engine per minute is the number of feet passed through by the piston multiplied by the average unbalanced force, i.e., the mean effective pressure upon the piston.

The mean effective pressure is that quantity per square inch multiplied by the area of the piston in square inches.

The horsepower then is

$$\frac{\textit{Mean effective pressure} \times \textit{Area} \times \textit{Piston speed}}{33{,}000}$$

The area of an 11-inch circle is 95 square inches.

The piston speed of an engine with a 24-inch or 2-foot stroke running 90 revolutions per minute is 2 × 2 × 90 = 360 feet; (2 feet per stroke, 2 strokes per revolution, 90 revolutions per minute).

The mean effective pressure is harder to get. It depends not only upon the initial pressure but upon the point at which the steam is cut off and upon the back pressure, whether the engine is run condensing or noncondensing, etc.

In a table of hyperbolic logarithms find the logarithm of the ratio of expansion, i.e., of the number of times the steam is expanded. Neglecting clearance this would be 4 for a quarter cutoff, 3 for one-third cutoff, etc. Add 1 to the logarithm and multiply it by the *absolute* initial pressure found by adding the barometric pressure to the gage pressure. Divide the product by the ratio of expansion and the quotient will be the mean forward pressure.

For example, suppose the ratio of expansion is 4, the hyperbolic logarithm of which is 1.3863. Add 1 to this, making 2.3863. Suppose the barometric pressure to be 14.7 pounds, the absolute initial pressure would be

$$125 + 14.7 = 139.7$$

say 140 pounds. Then,

$$\frac{2.3863 \times 140}{4} = 83.5 \text{ pounds.}$$

Now, what is your back pressure above absolute zero? Suppose the engine is noncondensing and has such compression that the average back pressure is 10.3 pounds above the atmospheric, making an average absolute back pressure of 10.3 + 14.7 = 25 pounds. Take this form the 83.5 and you will have 58.5. This is what a perfect indicator diagram within those limits of pressure would give. You must use your judgment in deciding how nearly the engine in question would come to making a perfect diagram. Knocking off 3.5 pounds for round corners, etc., and calling the mean effective pressure 55 pounds, the horsepower would be

$$H.P. = \frac{55 \times 95 \times 360}{33{,}000} = 57.$$

If you can get one of the Horsepower Supplements, which appeared with POWER of February, 1906, you will have the whole story, with tables complete.

It is also told at some length in The Steam Engine Indicator by F. R. Low and in The Power Catechism. Price, $2.00.

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## Seventy-five Years of Engine Building

The C. and G. Cooper Company of Mount Vernon, O., has just issued, under the title "Seventy-five Years of Engine Building," a little brochure of fifty pages setting out the history and development of the industry which has reached its "diamond anniversary."

The experience of the company in the engine business began in 1833 with the construction of an engine to drive their cupola fan. This engine was of exactly one horsepower, being propelled by one of these useful animals. The book is handsomely printed in two colors on heavy supercalendered stock with marginal sketches, outlining the development of the locomotive and stationary engines, both steam and gas, of the Mount Vernon works, from simple beginnings, etc. The text details the history of the company and is illustrated with portraits of its founders and the men who have aided in its upbuilding, and concludes with the quality quotation from Ruskin which it would be well for purchasing agents to cut and hang over their desks if it were not for mutilating a handsome specimen of the printers' art. The cover is in a soft brown, heavily embossed, with fly leaves of the same color tinted with a pattern of governors. It is more than a catalog, and he who is fortunate enough to procure one will prize it for its artistic worth.

## Society Notes

The engineers connected with the [illegible] Ferries of Greater New York held their annual banquet at Mouquin's [illegible] restaurant on Wednesday evening, November 10. About one hundred were seated at the tables. Speeches were made by John J. Ambrose, superintendent of the ferries; W. J. Reynolds, national president of the National Association of Stationary Engineers, John J. Crean, steamboat inspector; Denis F. O'Brien, attorney for the Marine Engineers Beneficent Association, No. 33, and John Berry, president of the same organization. Entertaining musical numbers were given by Billy Murray, Joe McKenna and Bert Self, and Harry Elder told stories.

## Personal

Trygve Jensen, a graduate of the Department of Electrical Engineering of the University of Illinois, was recently awarded the prize offered by the Edison Medal Committee of the American Institute of Electrical Engineers for the best thesis presented in competition, under certain conditions specified by the committee. The title of Mr. Jensen's thesis was, "The Operation of a 100,000-volt Transformer." The prize consists of a diploma and a cash award of $150. Obtaining this prize is not only complimentary to Mr. Jensen but it is evidence of the high quality of engineering instruction that is imparted at the University of Illinois.

## Business Items

Arthur M. Page, who was with the Eaton, Cole & Burnham Company for 17 years and recently with the Pratt & Cady Company is now general manager of the New York office of the Chapman Valve Manufacturing Company, 49 John street.

F. J. Low has succeeded C. N. Manfred as manager of advertising for the H. W. Johns-Manville Company, of New York. Mr. Low has been associated with this company several years and brings to his new position a thorough knowledge of factory and construction work and of the technicalities of the publicity requirements.

## New Equipment

The S. C. Shannon Co., Appleton, Wis., will erect a cold-storage plant.

The Rapid City (S. D.) Packing Company will erect a $15,000 plant.

The Rapid City (S. D.) Creamery and Produce Company will erect a plant.

The Duluth (Minn.) Brewing Company will erect a cold-storage building.

The town of Delmont, S. D., is figuring on building an electric-light plant.

The Russell Commission Company, Dickinson, N. D., will erect a cold-storage plant.

The North American Storage Company, Watertown, S. D., will erect a plant next spring.

T. N. Vail has commenced work on building for the new waterpower electric plant at Lyndon, Vt.

The Springfield (Ohio) Heating, Light and Power Company is building a new three-story plant.

The Citizens Light and Power Company, Xenia, Ohio, contemplates building a new plant next spring.

The Linton (Ind.) Lighting Company will rebuild their power house next spring. S. W. Perrott is superintendent.

George H. Alexander, Doe street, Birmingham, England, would like catalogs and quotations on engine packings and belting of every description.

## New Catalogs

Western Gas Engine Company, Los Angeles, Cal. Catalog. Gas engines. Illustrated, 64 pages, 6x9 inches.

The Ball Engine Company, Erie, Penn. Catalog P. Steam engines, side crank type. Illustrated, 38 pages, 7x10 inches.

Atwood & Morrill, Salem, Mass. Catalog B. Regulators, pump governor, valves, steam trap. Illustrated, 22 pages, 6x9 inches.

The New York Engine Company, Watertown, N. Y. Catalog. Gas engines and producers. Illustrated, 24 pages, 6x9 inches.

Martin Grate Company, Fisher building, Chicago, Ill. Catalog. Rocking and shaking grates. Illustrated, 14 pages, 6x8½ inches.

Washburn & Granger, 120 Liberty street, New York. Catalog B. Dean dumping, shaking and stationary grates. Illustrated, 6x9 inches.

The Wetzel Mechanical Stoker Company, Trenton, N. J. Catalog. Wetzel automatic mechanical stoker. Illustrated, 6½x9½ inches.

American Blower Company, Detroit, Mich. Catalog 259-E. Vertical inclosed self-oiling steam engines, mechanical draft apparatus, fans, blowers, automatic-return steam traps, etc. Illustrated, 48 pages, 3½x6 inches.

## Help Wanted

*Advertisements under this head are in-serted for 25 cents per line. About six wo make a line.*

WANTED—Thoroughly competent st specialty salesman; one that can sell h grade goods. Address "M. M. Co.," Pow

AN ENGINEER in each town to sell best rocking grate for steam boilers. W Martin Grate Co., 281 Dearborn St., Chic

AGENTS WANTED to sell Burgmann c brated engine packings in territories not covered. See our advertisement on page

WANTED—Large engine shop wants gressive head foreman to increase product excellent opportunity; position steady; m be an aggressive hustler with experience; references. Address Box 72, POWER.

CHIEF ENGINEER that can handle and apparatus in a 2000 kw. central sta within 100 miles of New York City; p opening for the right man. Address, gi full particulars, references and salary. 75, POWER.

SUPERINTENDENT—Qualified to take tire charge of plant manufacturing brass iron valves, fittings and steam specia from foundry to finished article; also miliar with high-pressure piping installati give references and full details regarding chanical and executive experience; good tion for high-grade man; communicat strictly confidential. Address Box 73, Po

## Situations Wanted

*Advertisements under this head are serted for 25 cents per line. About six w make a line.*

POSITION AS OILER, assistant or neer; eight years' experience in small s plants; married; age 29; references present employers; I. C. S. student; do repair work. Box 74, POWER.

A MAN OF WIDE experience in the of electrical and general machinery here abroad is open to a business proposition fering an opportunity of buying an activ terest in same; prefer an established m facturing business, but will consider straightforward proposition where returns assured. Box 77, POWER.

ELECTRICAL ENGINEER with highest erences, wishes to form connection with concern, preferably in or near New Y three years' experience in Mexico, five in Chili; speaks Spanish and German flue has had wide experience both in selling constructing electrical, steam and hydr machinery; open for immediate engage Address "H. K. W.," Box 71, POWER.

## Miscellaneous

*Advertisements under this head are serted for 25 cents per line. About six w make a line.*

PATENTS secured. C. L. Parker, Soli of Patents, 4 McGill Bldg., Washington,

ANY FIRM or engineer in charge steam plant that is troubled with scale i boilers can get absolutely free, the best cator and reducing wheel made, with v lined mahogany case. For particulars dress Great Lakes Chemical Works, Ma woc, Wis.

## For Sale

*Advertisements under this head are serted for 25 cents per line. About six makes a line.*

FOR SALE—20x48 Wheelock engine two 72"x18' high pressure tubular boile good condition cheap. Address "Engi Box 2, Station A, Cincinnati, Ohio.

FOR SALE—Cheap six 66"x18' 0" se hand tubular boiler shells with sixty-s tubes, good for 125 pounds steam pres also four 42" steel stacks 90' 0" long one 72" stack 90' 0" long heavy plate. dress Box 76, POWER.

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Crocker-Wheeler Co. ....
Crosby Steam Gage & Va Co. ....
Curtis & Curtis Co. ....

# Plant of the Hartford Electric Light Company

## First American Parsons Turbine, Fourth Foster Superheater and Largest Boilers in the United States Were Installed in This Plant

The power plant of the Hartford Elec- ic Light Company, located at Dutch nt in the city of Hartford, Conn., is extremely interesting plant for a num- r of reasons. It had in use until re- tly the first Parsons type of turbine t out by the Westinghouse Company. has now in use the fourth superheater the Foster type made by the Power ecialty Company, of New York, and stalled in 1901. It also operates the largest boilers in the United States, se being the Bigelow Hornsby water- boilers manufactured by the Bige- w Company, of New Haven, Conn. e two boilers, which are in one set- , have 25,000 square feet of heating face, or a rated capacity of 2500 rsepower.

he location of the plant is on a point land formed by the junction with Connecticut river of a small stream ing through the city of Hartford, wn as Park river. This point is of rical interest from the fact that it the landing place of the Dutch under r an Block in 1614. which was eighteen rs before the first English settlers e.

fore describing the station and its pment, a brief general description of scheme of power distribution will ven.

his plant commenced operation in 5. and before this date power was ob l from the old Pearl street plant. h has since been utilized as a main ibuting point for the system of power lighting supplied by the Hartford ric Light Company.

o water-power plants are operated njunction with this plant, they be- i ocated on the Farmington river about t ve miles from Hartford. These three p ts supply all the current distributed b the company, and are connected to- g er in parallel at Pearl street. The w r power plants run at the full ca- p of the water supply, and the D h point plant makes up the balance of the load and cares for the regula- ti

g. 2 shows the relative positions of th plants and the distributing stations. A ut 70 per cent. of the current used in Hartford is distributed from Pearl st t, and the remainder directly from D h point. The State street substa- tio is equipped with rotary converters and a 17,000-ampere-hour chloride battery, and one section of the city is supplied from this point, but the current is all transmitted to this substation through Pearl street.

Current generated at Dutch point is 2400-volt, 60-cycle, two-phase, and is distributed over the larger area of Hartford at this voltage on a four-wire system. The current generated at the water-power plants is 500-volt two-phase, which is transformed to 10,000-volt three-phase by the Scott system of transformation, for transmission to Pearl street, where it is stepped down to 2400 volts two-phase, and connected in parallel with the Dutch point power house.

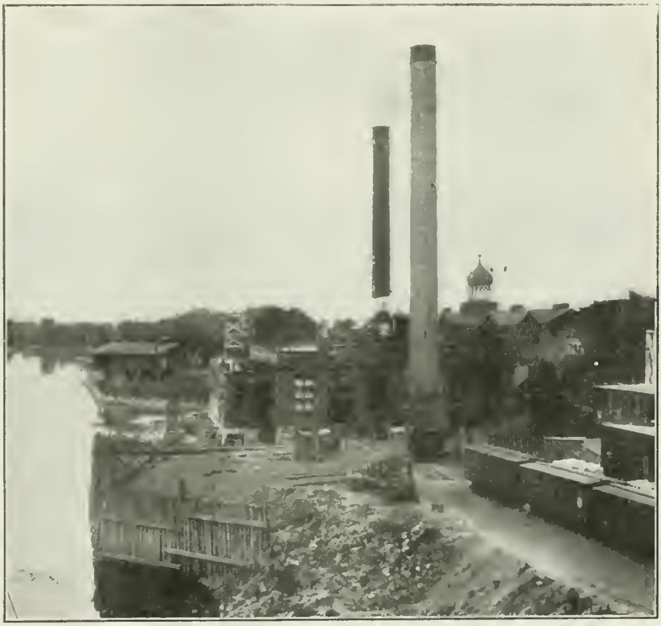

FIG. 1. THE POWER STATION AT DUTCH POINT

The center of the city is supplied with direct current by means of rotary converters, and this is transmitted over a three-wire system, the voltages being 110 and 220. In addition to the city service proper, the Dutch point plant supplies a line for Elmwood (a suburb of Hartford) with 4800-volt two-phase current, through step up transformers located in the plant, as well as an 11,000-volt three-phase line to Laurel street terminal for delivery to the Connecticut Company, for the operation of railway lines in the western section of the State. From the point of delivery to the Connecticut Company at Laurel street, this current is transmitted to New Britain, Conn., where it is stepped up to 33,000 volts and connected in with the system of high-tension transmission used by the Connecticut Company between this point and its water-power plant at Bulls Bridge on the extreme western edge of the State. A steam plant located at Waterbury, Conn., also feeds this high tension line. It will be noted that the Dutch point plant operates power, lighting and railway loads and runs in conjunction with three water-power plants and one other steam plant On account of the extreme variations in the available water supply, the maximum load on the plant varies within very wide limits.

### THE POWER PLANT

This is an all-turbine plant, the only reciprocating machinery besides the boiler feed pumps, hotwell pumps and air pumps being two small exciter engines. The turbine room and its equipment is illustrated in Fig. 3. This room is 116 feet long by 48 feet wide, and is spanned by a 25-ton Niles-Bement-Pond crane, which serves the entire length of the room. The floor is constructed of structural steel and cement and covered with tile; the walls are wainscoted about 5 feet above the floor line with enamel brick.

The main generating units are all driven by the Westinghouse-Parsons type of turbine, the capacities being, for the one immediately in front in Fig. 3, 2000 kilowatts, the two next 1000 kilowatts each, and the last one 3500 kilowatts. This latter turbine has been installed only since October, 1908, and its location was formerly occupied by the pioneer turbine of the Westinghouse Company, which was a 1500-kilowatt machine originally installed in the Pearl street plant in 1900, and moved to Dutch point in 1905. This machine did service up to the time of its removal.

### CONDENSING OUTFIT

The condensing-water intake pipe is located near the north end of the station. The forebay is provided with a trash rack to prevent entrance of brush and other material of considerable size, and the intake pipe is equipped with double screens of ¾-inch mesh hung from winches by cables, which permi ready removal for the purpose of clea ing. The intake pipe is about 4 feet b low mean low water, and connected it are four Alberger centrifugal pum of the vertical-shaft type. Two of the pumps are driven by 50-horsepower a two by 65-horsepower type C Westin house induction motors. The total co densing surface in the plant is 26,0 square feet, all being Alberger co densers. The 3500-kilowatt turbine served by two 6000-foot condensers co nected in parallel, and the valves a arranged so that this machine can opera on either condenser singly if requir The two 1000-kilowatt turbines a served by a single 6000-foot condens while the 2000-kilowatt machine is p vided with an 8000-foot condenser.

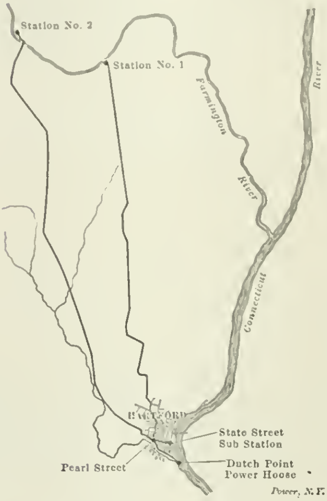

FIG. 2. LAYOUT OF ENTIRE SYSTEM

The hotwell pumps on all condens are piped so that any condenser may separated from the system and the c densation pumped to a weighing ap ratus located in the basement, making water-consumption test of any turbin simple matter. The two 1000-kilow turbines and the 3500-kilowatt mach have valves between the turbine and c densers, while the 2000-kilowatt turbin connected directly to its condenser wi out the intervention of valves. Th valves on the 1000-kilowatt units

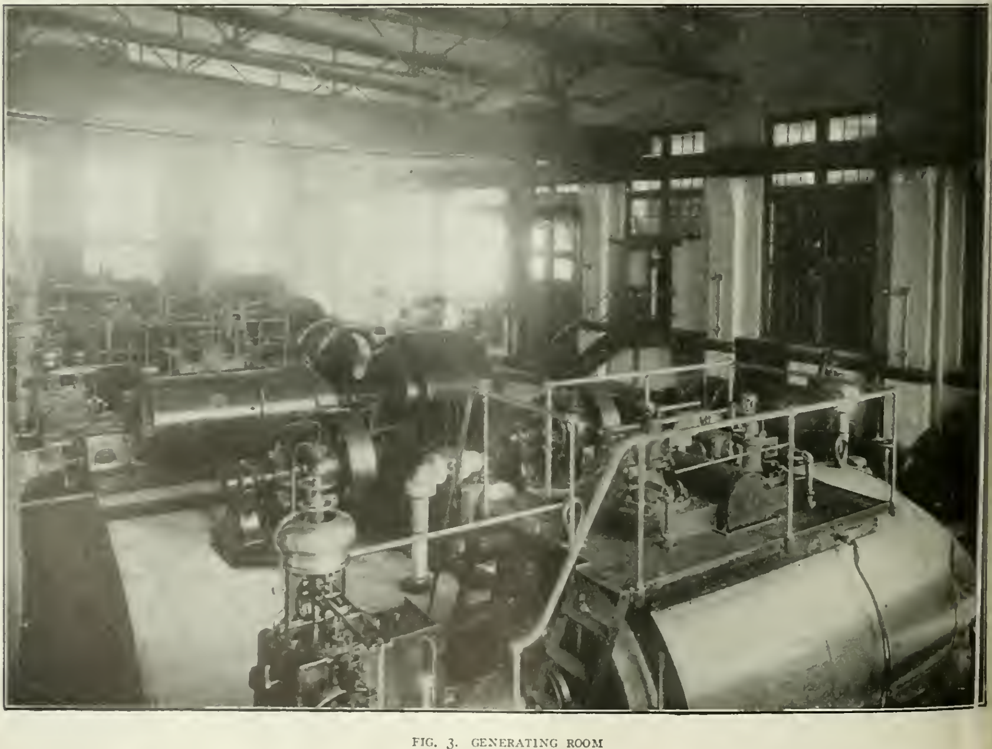

FIG. 3. GENERATING ROOM

hydraulically operated, while those on the 3500-kilowatt machine are of the Pratt & Cady electrically operated type.

There are three air pumps used in the plant, two of these being two-stage Alberger pumps 8, 18 and 18 by 24 inches, and the other a single-stage Worthington, 12 and 22 by 18 inches.

### Exciters

Three exciter sets are used, two of hese being of 50-kilowatt capacity each, ind driven by 10x12-inch Chandler-Taylor reciprocating engines; the third et is of 75 kilowatts capacity and driven y a horizontal-type Curtis turbine. All he exciters are arranged to connect to wo separate sets of busbars, from either i which exciting current may be sup- ed to the machines in operation. There a storage battery used in connection ith the exciter system, and the current sed for the operation of the automatic witches on the low-tension board is sup- ied from the exciters or battery, these witches being operated by the battery one, should circumstances require it.

### Boiler Feed

Boiler-feed water is drawn from two en tanks located in the boiler rooms, ese tanks being piped together to op- ate as one tank. All water from the twell pumps is discharged into these nks, and the make-up water required supplied principally from the overflow the roof tank. The overflow from standpipes on the water seals to the hines also discharges into the boil- supply tanks, and should these sources supply fail to keep the proper amount water in the tanks, there are auto- ic valves arranged with floats to open l admit water from the city mains to ply any deficiency. The pump to the i tank, which draws a supply from river, is set so as to just about care the make-up water required.

he feed water is drawn from these t ks by one or more of the three 12 and 7 by 12-inch Dean feed pumps, and is f ed through two feed-water heaters c nected in parallel, which are sup- p d with steam from the auxiliaries. T feed water is raised in temperature i these heaters to 185 or 200 degrees f n a temperature of about 85 degrees.

### Boiler Equipment

he boiler equipment consists of six A tman Taylor, Babcock & Wilcox ty water-tube boilers, and two Bige- lo Hornsby water-tube boilers. The f ner are of the double-deck type, con- ta ing 5500 square feet of water-heating ace. Each boiler is equipped with a F er superheater and the Parsons sys- te of forced draft. The ashes are du ped from the grates into a hopper, an from there discharged into cars and du ped outside the plant to be given aw , as the demand is always greater th the supply.

The Bigelow-Hornsby boilers are in a separate room, and Fig. 4 shows the front of one of these boilers with the eight firing doors. On account of this boiler being new to the American engineer, a rather detailed description is warranted. This boiler is built up of small drums 26 inches in diameter, into the heads of which are expanded twenty-one $3\frac{1}{4}$-inch tubes. Four of these units are connected together by nipples, fore and aft, making a section containing 1250 square feet of water-heating surface. The two front units are inclined, while those in the rear are vertical. The main steam drum is placed in the upper part of the V formed by the front and rear units.

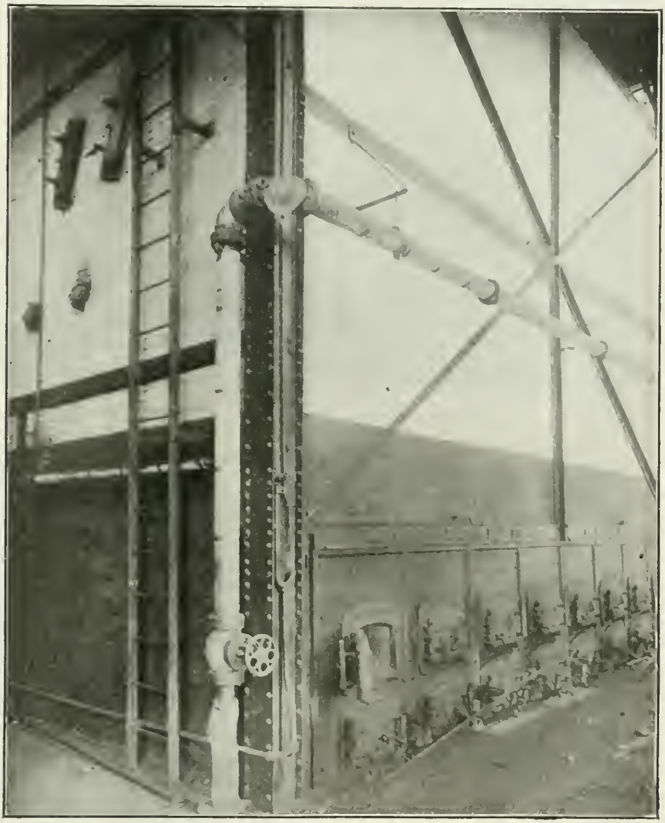

FIG. 4. ONE OF THE BIGELOW-HORNSBY BOILERS

The superheater, which is of the Foster type, is hung in the space below the steam drums. The baffling on this boiler is unique, as it is arranged to carry the gases straight through the boiler from the grate to the uptake, and not by the sinuous path generally used in other types of water-tube boilers. The tube layout is such that the gases are carried across the heating surface in thin layers of 1 to $1\frac{1}{2}$ inches in thickness. This arrangement of baffles is very effective.

The furnace of these boilers affords exceptional opportunity for complete combustion of the fuel. The grates are of Neemes type 8 feet 6 inches deep by 24 feet 8 inches wide, and the distance from the grate to the roof of the furnace is 10 feet. Owing to the unusual amount of direct-heating surface in this boiler, it is very prompt to respond to sudden demands for steam, a condition requiring such service frequently arising at this plant in the event of sudden storms, on account of the lighting load supplied. The Bigelow-Hornsby boilers, like the Aultman Taylor boilers, are provided with the Parsons system of forced draft.

### Coal Handling

The regular fuel used consists of a mixture of 70 per cent. buckwheat and 30 per cent. gas slack. The coal is brought up the Connecticut river in barges and unloaded at the dock shown in front of the station in Fig. 1. A portable crane way grab bucket is used for this purpose, and transfers the coal to a dump car. This crane and car may be seen to the right of the power house in Fig. 1. Tracks are provided from the deck to the rear of the plant, at which point the tracks are on trestle work, and the space beneath is used for coal storage. The coal bunkers are placed on the outside of the boiler rooms, as clearly illustrated in Fig. 5. Chutes from these bunkers enter the boiler rooms, so as to deliver coal conveniently for firing. The coal is placed in the bunkers by the same bucket crane used in unloading the barges.

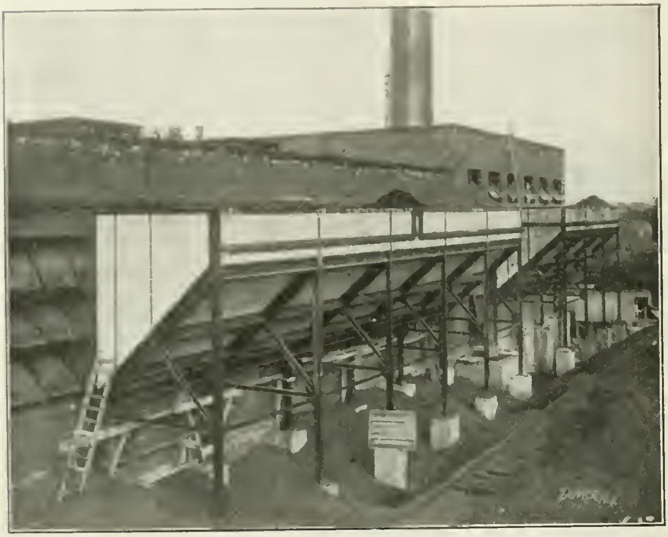

FIG. 5. COAL BUNKERS EXTERIOR TO PLANT

### Switchboard

The switchboard is of the remote-control type, the maximum voltage at the board being 110. There are sixteen panels on the main board. The three panels across the end of the main board are high tension and control the plant, lights and motors for the condenser circulating pumps. The switchboard panels are divided as follows: Seven feeder panels with two feeders to a panel, four generator panels, three exciter panels and one storage-battery panel. There is also one panel used for a Tirrill voltage regulator, which automatically regulates the voltage of the main units through the exciters. The generator panels are equipped with a power-factor meter, a polyphase integrating wattmeter, two ampere meters and one direct current field ammeter.

All the turbines are equipped with electric-speed control devices operated from the switchboard, enabling the attendant to vary the speeds for the purpose of synchronizing when cutting a machine in on the line. All of the feeder panels are equipped with the Westinghouse alternating-current overload relays controlling the line switches. These relays are short-circuited by fuses, which serve as a time limit on the operation of the relay, the relays not becoming operative until the overload has lasted for a sufficient length of time to blow the fuse. Besides the usual signal lights to denote the positions of the main switches, there is an electrically operated gong which notifies the switchboard attendant whe any switch is out.

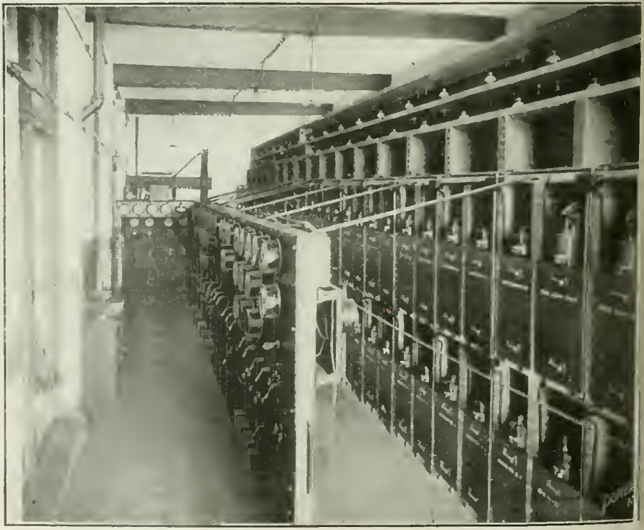

FIG. 6. SWITCHBOARD AND HIGH-TENSION COMPARTMENTS

At the end of the switchboard a smal cross board is placed overhead, shown i Fig. 6, which is equipped with fou voltmeters. Three of these are connecte to each section of the main busba structure, and the fourth may be connected to any generator panel, thus permitting ready comparison between th line voltage and that of an incomin machine.

The main switches and busbar structure are at the rear of the switchboar room, and as clearly illustrated in Fi 6, the switches and connections are a in separate compartments. The back the structure and the top pieces carryi the buses and main connections are concrete instead of the usual soapstor construction.

Main bus switches are provided so th the busbars may be cut into three distin sections for the purpose of making r pairs. The connections to the bus through the main switches are carri down on the back of the structure separate compartments, and a link swit is placed on these connections both abo and below the main switch, so that a main switch can be positively cut off fr the system to make repairs.

### Transformers

The transformer room is located the subcellar under the switchboard ro, and contains two 2400-11,000-volt tr formers connected for two-phase, th phase transformation on the Scott tem, and two 2400-4800-volt two-ph transformers. The latter transfor were originally air cooled, but all ow piped for water cooling. The cool- g coils are located in the river, and e oil is pumped from the hot oil tank rough these coils by two Worthington ntrifugal pumps, operated by 5-horse- wer induction motors. This arrange- nt keeps a pressure on the oil in the s greater than the water pressure sur- unding them, and any leakage that ght occur would be from the oil to water, rather than the reverse.

At the end of the pressure line deliver- oil to the transformers, a small metal k is placed containing lime. A portion of the oil is bypassed through this k for the purpose of removing the isture. A kink not usually met with similar cooling equipments, is placing ght glass in the oil-discharge con- tion from the transformers, which bles the attendant to tell at a glance he oil is circulating properly.

he transformer room is cooled by a f shaft. A track runs in front of the isformers, and a small truck is pro- d upon which any transformer may b rolled and transferred to the shaft he end of the room, where it may be ted out for repairs or replacement.

description of this plant would be mplete without reference to the p dent of the company, A. C. Dunham, has given Hartford one of the most ient and uptodate electric-light and er services in the country. He was neer in the electric-lighting field, pt to adopt any improvement which ssed real merit, being the first in United States to adopt the steam ne for electric-lighting service, and rst user of really large boiler units, ature of power plant construction h is now receiving wide attention the engineering fraternity.

e are indebted to F. M. Wilbraham, engineer of the company, for data relive to the operation and construc- The Westinghouse, Church, Kerr were the engineers and con- rs for the Hartford Electric Light pany in building and enlarging the

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## An Experience with Leaky Vertical Fire-Tube Boilers*

BY F. W. DEAN

In 1905 I made a design for a large r al fire-tube boiler, two of which were built, to be placed on a brick fire- rovided with a chain grate. In lance with a great number of pre- s the water leg was short, being t 2 feet deep below the under side of crown sheet. Unusual provision was made for easy circulation by wide spac between tubes at every 45 degrees of t circumference instead of the customary 90 degrees or, as in some cases, at 180 degrees. The distance from the top of the grate to the under side of the crown sheet was 7 feet The following are the general dimensions of the boilers as they now are:

| | |
|---|---|
| Inside diameter of smallest course of shell | 120⅞ in. |
| Inside diameter of largest course of shell | 122$\frac{11}{16}$ in. |
| Inside diameter of water leg | 112 in. |
| Hight of water leg | 7 ft. 2¼ in. |
| Hight of brick furnace | 5 ft. 8 in. |
| Distance from grate to tube plate | 12 ft. 2¾ in. |
| Outside diameter of tubes | 2½ in. |
| Length of tubes | 20 ft. 0 in. |
| Number of tubes | 488 |
| Pressure for which the boiler was designed | 165 lb. |
| Kind of grate | B. & W. chain |
| Size of grate | 8 ft. 6 in. by 9 ft. 0 in |
| Grate area | 76.5 sq.ft. |
| Water-heating surface, say | 4900 sq.ft. |
| Superheating surface | 1811 sq.ft. |
| Total heating surface | 6081 sq.ft. |

The boilers were designed for S. D. Warren & Co., and were used in their paper mill at Cumberland Mills, Me. They were built by the Portland Company, of Portland, Me. Each boiler was rated at 500 horsepower, or substantially 1 horsepower for every 10 square feet of water-heating surface, and was expected to work at 1000 horsepower a good portion of the time. Artificial induced draft was used and it was possible to obtain a draft of 2½ inches of water in the smokebox.

At the back end of the chain grate, instead of a water back or a brick back, a vertical or slightly inclined common grate was used, against which the unconsumed coke would accumulate, and under which the ashes would pass and fall upon the ashpit floor. Difficulty was found in making the coke accumulate uniformly and the ends of this grate were frequently bare.

The boilers were started gently and then operated at high capacity. After about two weeks a number of the tubes began to leak at the lower ends. They were expanded, but shortly began to leak again, and this process was repeated until the tubes were so injured that they could not be further expanded. They were then removed and new ends were welded on, but after a comparatively short time they leaked again. The leaks were more on the back half of the boilers than on the front. In winter when a nearby door in the building was open and cold air blew on the vertical grate, when the ends of the grate were bare, the leakage would increase. After learning how to keep the vertical grate covered, and keeping the door closed, the general trouble continued.

Knowing the sensitiveness to dirt on the crown sheet of vertical fire-tube boilers, as the design permitted access to the interior, these crown sheets were examined and found to be clean. Thinking that possibly some invisible oil had entered the boilers in some way, one of the boilers was boiled out with caustic soda, but with no effect.

The opinions of several boiler experts were obtained, but they differed and were unsatisfactory. One thought that the workmanship was poor, another that the design was the worst he had ever seen. Another thought that the tube plates were too limber and even recommended riveting crown bars to them to stiffen them.

Spring Hill coal from Nova Scotia was used at first, followed by New River coal from West Virginia. With the Spring Hill coal the lower ends of the tubes quickly became incrusted with clinker, and were finally closed by it and a little later the clinker would hang in stalactites from the tube ends. Not all of the ends would be closed, but this was the case with a large proportion of them. With New River coal there was less trouble. Spring Hill coal was satisfactory under horizontal boilers and never plastered over the tubes; in the vertical boilers, however, the incrustation was so hard that it had to be removed with chisels. This incrustation was of course molten earthy matter injected by the draft against the tubes and tube plate and there congealed by the comparatively low temperature of the metal. In the horizontal boilers it falls to the bottom of the setting before it arrives at the tubes. In water-tube boilers it can be seen adhering to the lower tubes.

The existence of this incrustation probably furnishes the explanation of the tube leakage. As a large proportion of the tubes became stopped up the others had to pass all the hot gases, the water about their ends was probably driven away and they became very much overheated, causing them to over-expand, to become upset, and at some later time, when they became cooler, to be loose in the holes.

As a last resort, when it seemed as if the boilers must be consigned to the scrap heap, someone suggested that to lengthen the firebox and raise the boilers by the amount of the extension might cure the trouble. One boiler was thus altered, started August 31, 1908, and run at the estimated rate of 1100 horsepower 24 hours per day for some three months, without the slightest leakage, although the tubes were very thin from over-expansion. The other boiler was then altered, and started February 25, 1909. When the first boiler was worked at the estimated rate of 1100 horsepower it consumed 84,000 pounds of New River coal in 24 hours, burning it at the rate of 46 pounds per square foot of grate per hour. Neither boiler has leaked up to the time of presenting this paper.

The distance from the grate to the tube plate is now 12 feet 2¾ inches. There is some incrustation, but it is light, brittle and easily crushed, and can be blown off by a rotating multiple-tube blower in the smokebox. The tubes are conveniently and quickly blown in this way every three or four hours.

The boiler plant at this mill consists of Babcock & Wilcox boilers, 90-inch horizontal return-tubular boilers, and the two vertical boilers described. The latter were installed to reduce the space occupied, both on the floor and above. The rear door of the chain grate is exposed and the clinker is dropped at the back end, where it is easily removed without inconvenience to the fireman. Above is room for the smoke flues and economizer, which with other types of boiler would have been placed, in this case, with difficulty.

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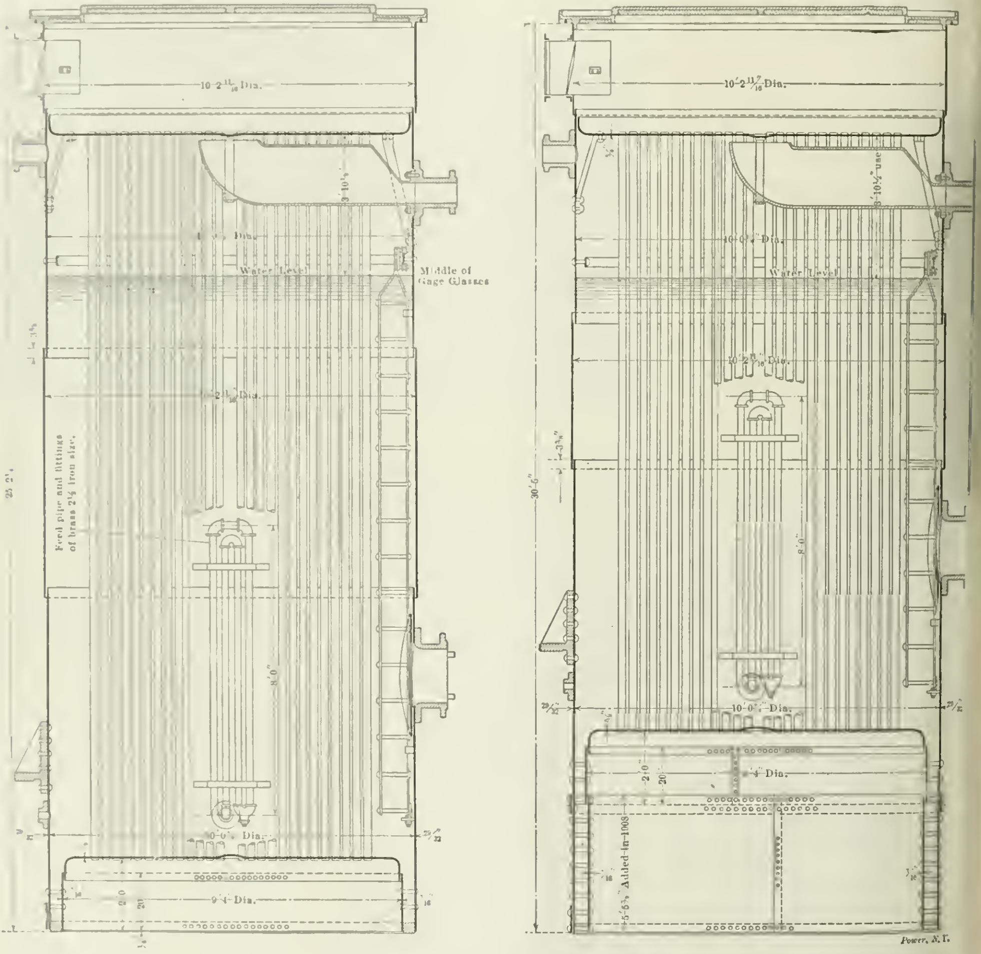
*Presented at a meeting of the American Society of Mechanical Engineers.



REPAIRING A LEAKY VERTICAL FIRE-TUBE BOILER

After these boilers had been operated long enough to show that they were reliable and a good investment, it was decided to test one of them, with the results given in the accompanying tables.

While the evaporation is good it is not satisfactory. The function of a boiler is to absorb the heat generated in a furnace. The furnace efficiency may be poor and the boiler efficiency good, and that was the case during these trials. The best furnace result occurs when the carbon is burned to $CO_2$ with as little surplus air as practicable. In these trials the $CO_2$ was low and some CO was nearly always found. It was impossible to get any better combustion for reasons which I do not know. Experiments will probably be made to ascertain this and overcome the trouble. It might disappear with another kind of stoker.

That the boiler efficiency was good is evident from the low temperature of the escaping gases, when developing over 1000 horsepower, which is at the rate of less than 5 square feet of water surface per horsepower. It will be noticed that the evaporation was best on combustible when the boiler was operated at double its rated horsepower. It was found impossible to keep the horsepower down to 500. This could only be done by reduci the grate area.

An interesting result of the tests is t the superheat was the same at all rates power.

Returning again to the matter clinker on tubes, it occurs on locomoti which burn anthracite, and I underst on locomotives of the Boston & Ma railroad which burn coke. In the lat case coke-burning locomotives cannot used on long runs, but whether a quality of coke would be more succ I do not know. Professor Denton informed me that clinker accumulate the boiler tubes of a transatlantic st ship on which he was a passenger to an extent that men were sent int combustion chambers to remove it. H also referred to a Manning boile which this trouble occurred.

# Another Butt-Strapped Joint Failure

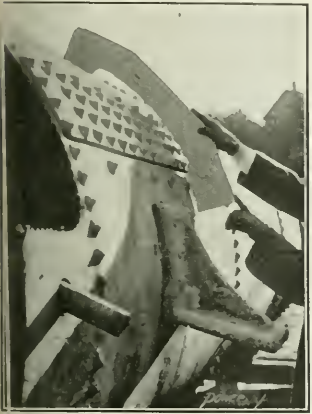
## Is the Butt-strapped Rivet Joint a Cure for the Hidden Crack? The Second Case within a Year of Failure of a Joint of This Type

A boiler rupture of more than usual terest, which very fortunately did not sult in an explosion, recently occurred the plant of Hotchkiss Brothers & , manufacturers of wood trim, at orrington, Conn. At four o'clock on th afternoon of September 21, the fire-m noticed water running down the side of ne of the units of a battery of two horizontal-tubular boilers used to operate the mill. The water came from the right-hand side of the shell over the grate, at such a rate that the fire was drawn and by five o'clock water had collected to a depth of about six inches in the ashpit. The trouble was assumed to be caused by a leak along the calking edge of a seam, and a boilermaker was secured to make the necessary repairs so that the boiler might be put in service the following day; but when the brick covering was removed in the vicinity of the leak it was found that the water came through a crack in the solid plate along the outer row of rivets below the butt strap of the longitudinal joint which was triple-riveted.

It was decided to abandon the use of the boiler and a new one was installed in its place. Through the courtesy of W. A. Hotchkiss we were able to take numerous measurements showing the contour of the shell in the vicinity of the cracked seam and also of the other seams.

The boiler was built in 1895 by the Cunningham Iron Works, the stamps on all of the shell plates being "Central Iron Works Fire Box Steel 60,000 T. S. Harrisburg."

The shell, which was made in three courses, was 17 feet 2 inches long over all, and 66 inches inside diameter at the end courses. There were seventy-nine



HOWING THE DEVIATION OF THE SHELL FROM A TRUE CYLINDER AT THE RUPTURED JOINT

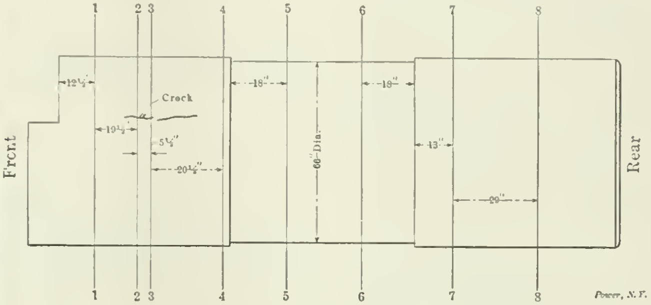


FIG. 2. SHOWING LOCATION OF PLANES IN WHICH THE DISTORTIONS SHOWN IN FIG. 3 WERE MEASURED

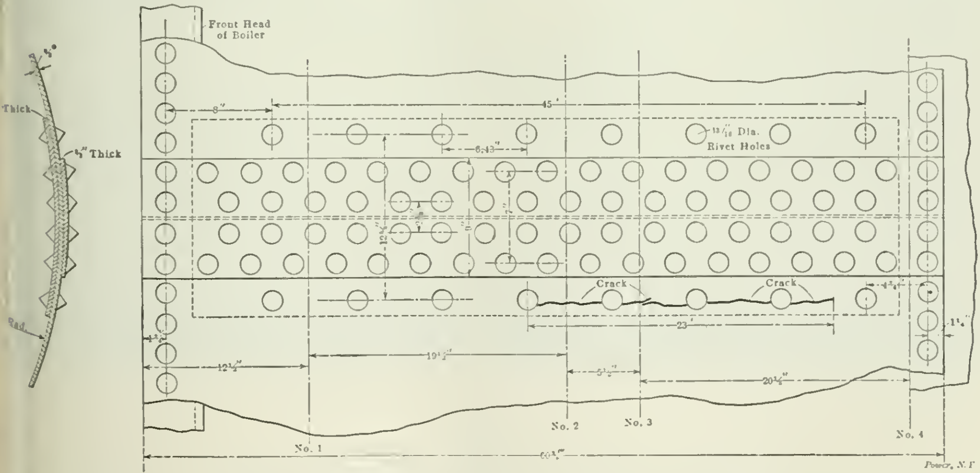


FIG. 1. DETAILS OF THE TRIPLE-RIVETED BUTT-STRAP JOINT WHICH FAILED

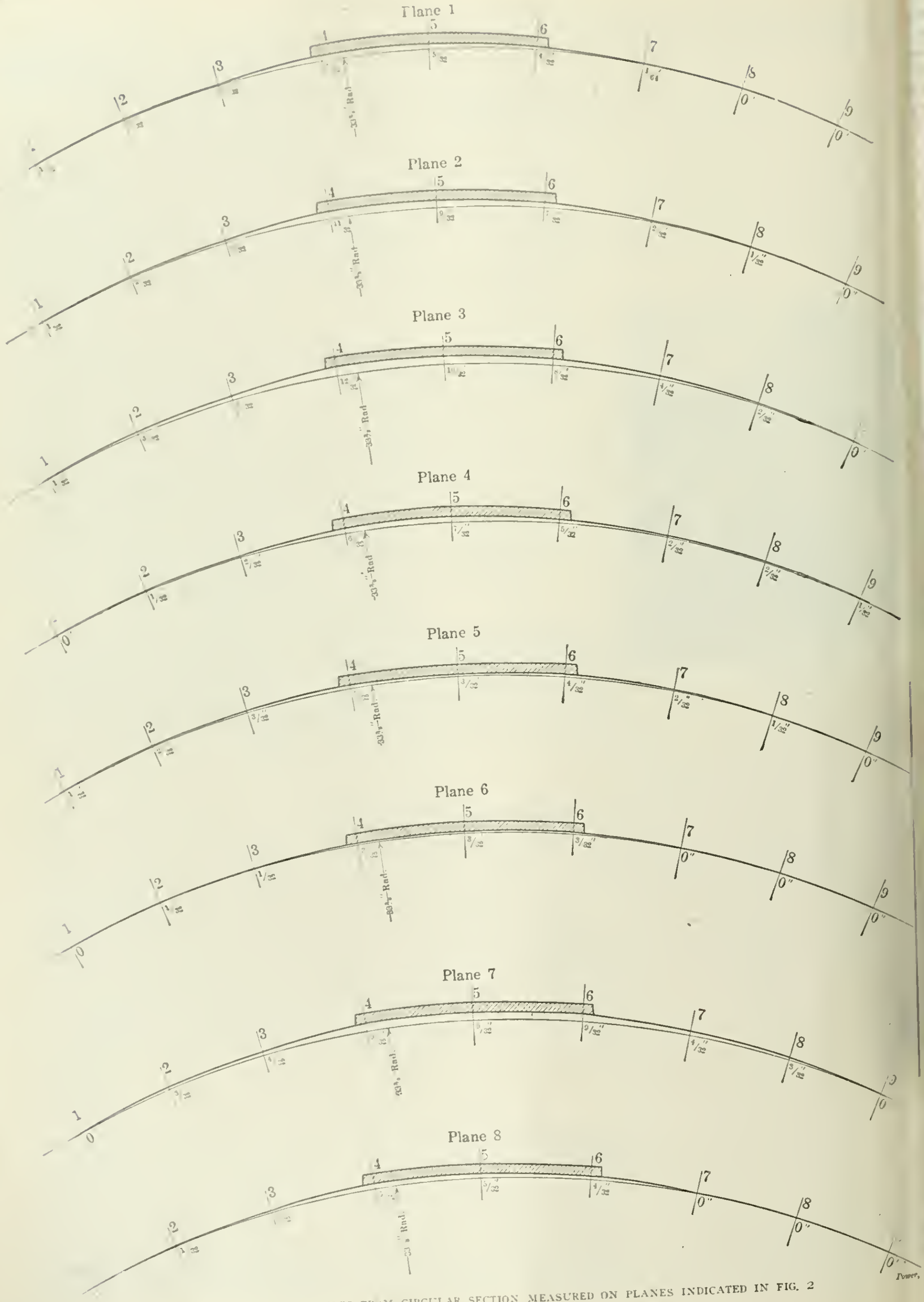


FIG. 3. DEPARTURES FROM CIRCULAR SECTION MEASURED ON PLANES INDICATED IN FIG. 2

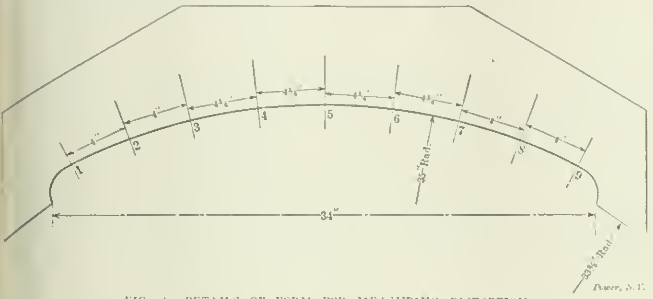


FIG. 4. DETAILS OF FORM FOR MEASURING DISTORTION

3.5-inch tubes 16 feet long and the bracng above the tubes consisted of five 1.5-nch diameter through rods with upset nds. The boiler was supported on the etting walls by four cast iron brackets, ach of these being attached to the shell y six 13/16-inch rivets. The shell and traps were both of ⅜-inch thickness, nd the rivets all 13/16-inch in diameter, tched about 6 7/16 on the outer rows nd 3 7/32 on the inner rows. Fig. 1 ows the dimensions of straps and the acing of rivets, also the location of the ack, which is also illustrated in Fig. 5. length of the rupture was 23 inches nd it commenced 7⅛ inches in front of e line of girth rivets connecting the nt and center courses, and extended ward the front from this point. The ack was not in one continuous line but d a break near the center of its length, h ends of the crack at this point overlapping each other as shown in Fig. 5.

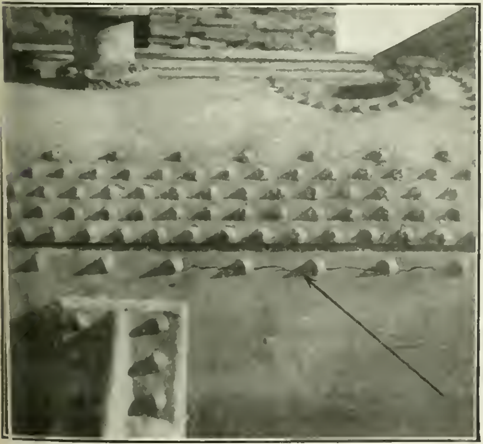


FIG. 5. THE 23 INCH CRACK

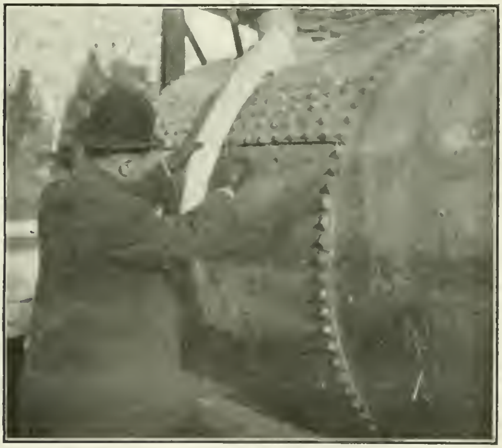


FIG. 6. METHOD OF MEASURING THE DISTORTION

hile the formation of this crack had probably extended over a long period of time the final breaking through was very sudden as evidenced by the severe leaking caused at once by the failure. The contour of the shell was measured in the planes marked 1 to 8 in Fig. 2, the positions of points 1 to 4 on the front course being also indicated in Fig. 1. The points on the front course were selected at irregular distances as shown, on account of the interference of nozzle, manhole and bracket with more evenly spaced positions. Point 7 was selected on the rear course because it represented the point of maximum divergence from a true cylinder on this course.

The method used for measuring the contour at the several points is illustrated in Fig. 6, the form used consisting of a board which had ends about four inches long sawed to a radius of 33⅜ inches, this being the radius of the outside of the cracked course. Between these ends a curve of 35 inches radius was accurately cut, and the distance between this curve and the shell was measured with inside calipers, as shown in Fig. 6. The board form actually used to take the measurements with, however, was of much greater length than that shown in this view. The dimensions of the board form are given in Fig. 4, the points marked 1 to 9 in this figure corresponding to the similarly numbered points in Fig. 3. Notwithstanding the fact that this form spanned about 36 inches of the circumference of the shell, it was not long enough to reach entirely over the distorted portion adjacent to the seam. This is shown by the fact that some of the contours in Fig. 3 commence with deviations of 1/32 of an inch instead of with zero as they would have done if the shell had been true to form at the points where the board templet rested upon it. Fig. 3 shows the contour of the shell across the joints, true to scale in the respective planes indicated in Fig. 2. To ascertain if the shell was generally out of round, numerous measurements were made on different portions of all courses away from the seams, and at none of these points was the shell found to deviate more than 1/32 of an inch from a true cylinder. It will be noted in Fig. 3 that the greatest variation from a true cylindrical form is in the plane 3-3, of Fig. 2, which is nearest the center of the crack.

While the seam on the rear course is very much out of true, as shown by the contours at points 7 and 8 of Fig. 3, it will be noted that it is not one sided like the seam of the front course, but that the deviations from a true circle are symmetrical with respect to the strap. The extreme variation, as shown in plane 7, was confined to a very short length of shell, not more than 7 or 8 inches long. The fact that the joint on the front course was considerably out of true could be noted by sighting along the shell just below the outer butt strap, the shell showing a decided hump about the middle of the crack.

This boiler had been in use about 13 years at a pressure of 90 to 100 pounds. The efficiency of the seam was 87½ per cent. and, using the stamped tensile strength as a basis of calculation, the shell had a factor of safety of practically six when carrying 100 pounds pressure, so the cracking of this sheet cannot be attributed to undue strain. This is the second failure in New England of a butted and strapped joint which has come to our knowledge in about one year's time, the previous one being that of the Woonsocket boiler, described in POWER for January 20, of this year.

## Efficiency Tests of Lubricating Oils*

By PROF. FREDERICK H. SIBLEY

The tests described in this paper were made at the Case School of Applied Science, Cleveland, O., and had for their object:

a. To determine the relation between the viscosity and the wearing and lubricating qualities of the oils.

b. To determine the effect of the constituents of the various oils on the lubricating qualities.

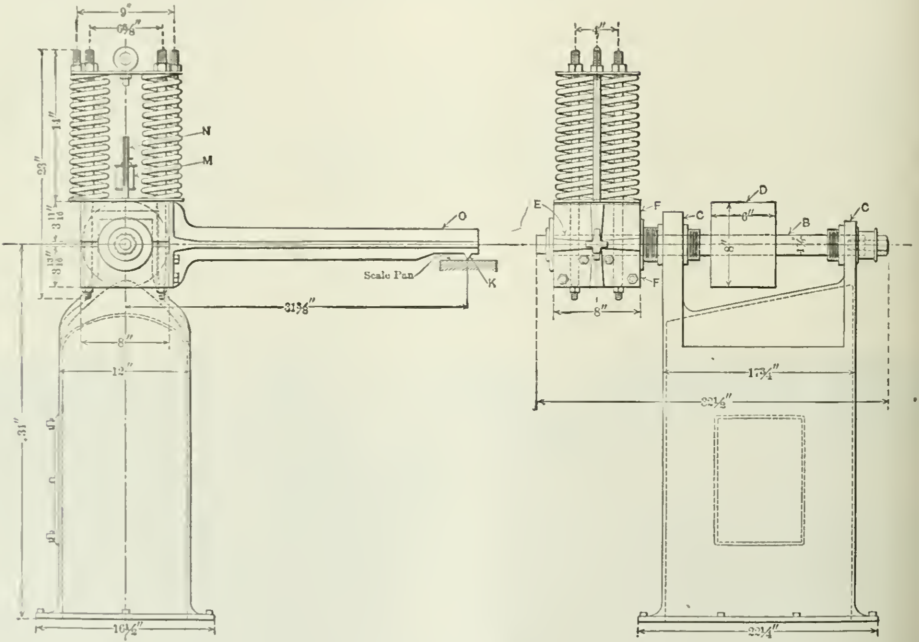


FIG. 1. APPARATUS USED FOR TESTING THE EFFICIENCY OF LUBRICATING OIL

Twenty-two oils were tested, the method of procedure being to find the chemical composition and viscosity of each oil and then to use it as a lubricant in a journal hearing. The temperature and frictional resistance were observed for a given length of time under a known load and speed. Previous experiments have left the question of the relation between viscosity and friction rather unsettled, but it is probable that if the load selected is a suitable one for a given oil then the friction will increase if the viscosity is increased. There seems to be no positive relation established between the viscosity and the wearing qualities of oils.

The apparatus used in these tests was the Benjamin machine shown in Fig. 1. The pulley $D$ on the shaft $B$ is driven from a countershaft, having tight and loose pulleys. The journal $E$, upon which the tests were made, is 8 inches long and 3.22 inches in diameter. Around the journal fits a babbitted sleeve, which is split in the middle, the upper half having oil grooves diagonally across it and intersecting in the middle in the form of a letter X. At the intersection of these grooves is the hole for the admission of oil. The lower half of the sleeve is without oil grooves. The sleeves are held in position on the journal by the cast-iron blocks $FF$. A collar at the back, next to the bearing $C$, and a washer and nut in front, prevent an endwise motion of the collar and sleeves, while allowing free rotation. The load is applied to both sides of the journal at the same time by compressing the springs when the nuts at the top of the springs are screwed up. Under ordinary working conditions the load is applied to but one side of the journal. These experiments therefore do not conform to actual conditions of pressure and wear, but as the results are comparative they are as fair to one oil as another in this respect.

The springs were calibrated before the tests by compressing them to a length c
11½ inches, observing the load and the
making this length the same for all th
tests. The lever arm $O$ was fastened t
the upper block and its outer end wa
fitted with a knife edge which rested o
a scale pan. The lubricant was fe
through a sight-feed oil cup at $M$. Th
temperature of the bearing was deter
mined by means of a thermometer in
serted in an oil well at $N$. The machin
was driven by an electric motor and th
speed kept practically constant at 5
revolutions per minute by means of
water rheostat.

The tests were conducted as follow
great care being taken to keep the co
ditions as nearly constant as possible f
all the oils: The journal and sleeve we
first cleaned with coal oil (kerosene) a
rubbed dry with waste. The machine w
then put together and the factor kno
in these tests as the lever-arm const
was determined. This was found by re
ing the knife edge $K$ on the scale p
and rotating the journal first to the ri
and then to the left with no compressi
in the springs. The average of th
readings gave the constant weight of
arm on the scales. Then the frictio
resistance of the machine at any inst
was measured by the difference betw
the scale reading at that instant and
lever-arm constant. After the const
had been determined the springs w
screwed down to a length of 11½ inch
giving a load of 1302 pounds for
whole bearing.

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*Abstract of a paper read before the American Society of Mechanical Engineers.

The oil cup was partly filled and the l kept at a constant level to keep the w constant at eight drops a minute. ie machine was then started, and temrature and scale readings were taken ery ten minutes. The oil feed and the eed of the machine were kept pracally constant. At the end of two hours oil supply was shut off and the run ntinued under the same conditions until the friction and temperature of the bearing indicated that the oil had given out.

The results of the tests are shown graphically in Figs. 2, 3 and 4. The horizontal scale shows the time in hours from beginning to end of test. The full lines refer to the bearing temperature on the right-hand scale, and the dotted lines refer to the coefficient of friction scale at the left.

The coefficient of friction from which the dotted lines were plotted = journal friction ÷ load. For the machine used in these tests, this equation becomes

$$\textit{Coefficient of friction} = \frac{(\textit{scale reading} - \textit{lever arm constant})\dfrac{\textit{lever arm}}{\textit{radius of journal}}}{\textit{load}}$$

The scale reading is taken from the log sheets of the test; the lever-arm constant

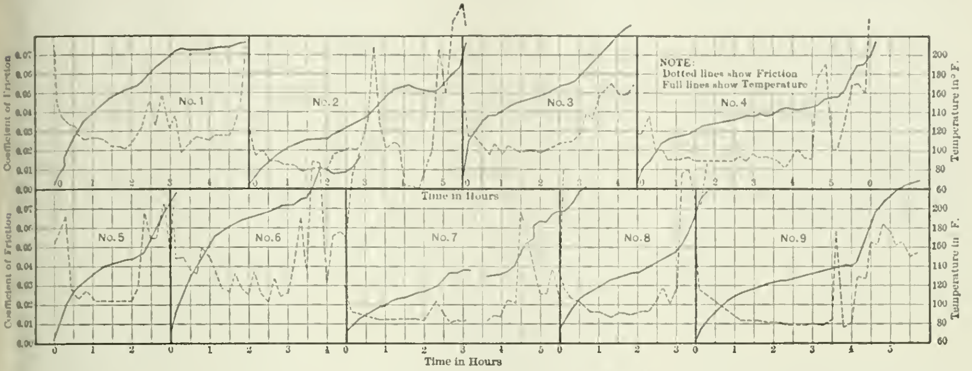

FIG. 2. CURVES OF FRICTION AND TEMPERATURE OBTAINED IN TESTS 1 TO 9

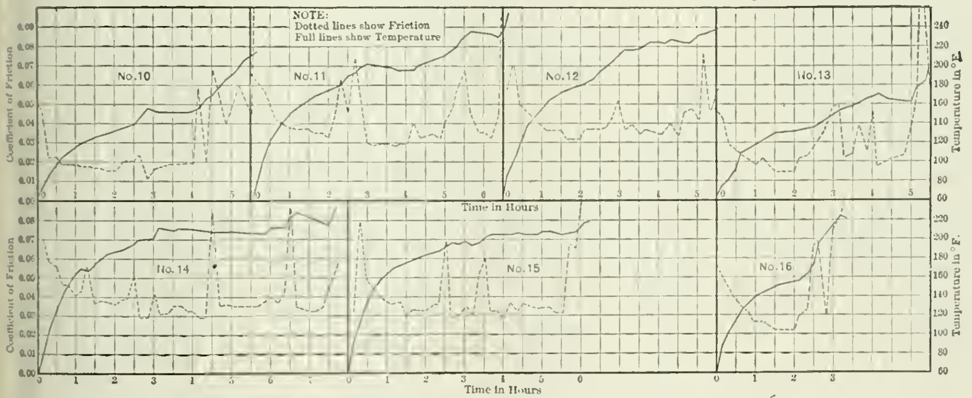

FIG. 3. CURVES OF FRICTION AND TEMPERATURE OBTAINED IN TESTS 10 TO 16

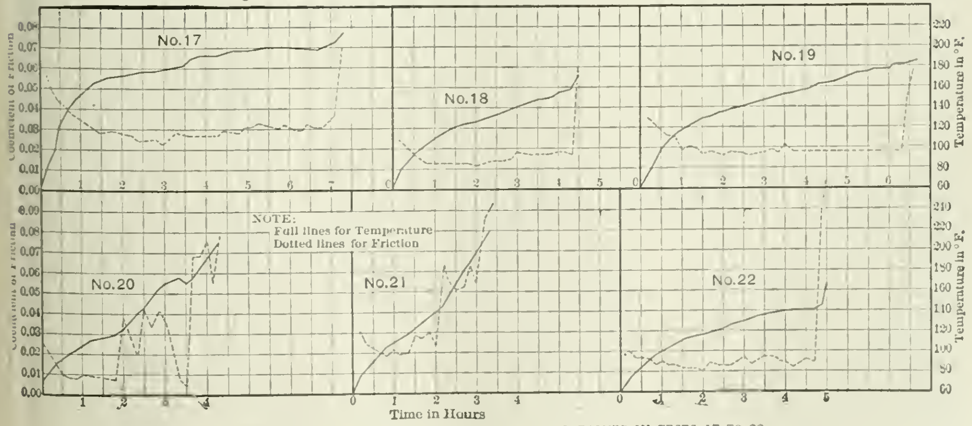

FIG. 4. CURVES OF FRICTION AND TEMPERATURE OBTAINED IN TESTS 17 TO 22

was equal to [illegible] for this machine; the length of the lever arm was 31.025 inches; the radius of the journal was 1.61 inches, the load on the journal was 1302 pounds.

In the case of the castor oil, where the coefficient of friction at the end of two hours was 0.024 (see chart), substituting in the above formula and transposing gave the following result

$$\textit{scale reading} = 0.024 \times 1302 \times \frac{1.61}{31.625} + 13.656 = 15.25.$$

The scale reading being the known factor, the coefficient of friction was calculated for intervals of 10 minutes corresponding to the time of the readings.

Table 1 gives the result of the chemical tests together with the data not shown in the diagrams of Figs. 2, 3 and 4. The constituents of the oils, shown in column 4, were found by distillation, each constituent having a different temperature at which it separated from the oil. The purpose was to compare each oil having one of the above hydrocarbon radicals with the first three oils given, and thus to determine the relative effect of these hydrocarbon constituents.

TABLE 1 CONSTITUENTS OF OILS AND DETAILS OF TESTS

| No. | Kind of Oil[1] | Principal Constituents | Specific Gravity | Saponification Number | Viscosity | Flash | Fire | Oil Feed (8 drops per min.) |  |  | Endurance |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  | Hours Feed | Max. Coef. | Max. Temp. | Hours Run | Max. Coef. |
| 1 | Pure castor (vegetable source) |  | 15B | 181 | 104 at 210° | .... | .... | 2 | 0.0467 | 165 | 2.55 | 0.0740 |
| 2 | Pure sperm (animal source) |  | 30B | 390 | 192 at 70° | .... | .... | 2 | 0.0212 | 113 | 3.30 | 0.0960 |
| 3 | Rape seed (vegetable source) |  | 24B | 324 | 108 at 150° | .... | .... | 2 | 0.0278 | 154 | 2.24 | 0.0561 |
| 4 | Engine No. 32789 | Nos. 4 to 17 inclusive have for their principal constituent one of the four hydro-carbons $C_nH_{2n+2}$, $C_nH_{2n}$, $C_nH_{2n-2}$, $C_nH_{2n-4}$ | 26.6B | 0 | 163 at 70° | 378 | 432 | 2 | 0.0373 | 126 | 3.06 | 0.1109 |
| 5 | Machine No. 32631 |  | 20B | 0 | 472 at 70° | 360 | 400 |  | 0.0656 | 146 | 1.10 | 0.1183 |
| 6 | Capitol cyl. No. 32790 |  | 22B | 10 | 123 at 212° | 483 | 553 | 2 | 0.0496 | 186 | 2.50 | 0.0977 |
| 7 | Dynamo No. 32,792 |  | 34B | 0 | 86 at 70° | 347 | 394 | 2 | 0.0156 | 111 | 2.55 | 0.1308 |
| 8 | Union thread cutting No. 1 |  | .......... | 53 | Low | 200 | 230 | 2 | 0.0278 | 130 | 1.48 | 0.0920 |
| 9 | No. 75 |  | .......... | 18 |  | 145 | 197 | 2 | 0.0335 | 121 | 3.12 | 0.0619 |
| 10 | 15° cold-test lub. No. 18 |  | 27B | 18 | 480 at 70° | 168 | 199 | 2 | 0.0457 | 129 | 3.35 | 0.0992 |
| 11 | No. 74 |  | .......... | 25 | .......... | 267 | 318 | 2 | 0.0723 | 170 | 4.35 | 0.1260 |
| 12 | Model cyl. No. 14 |  | 28.6B | 19 | 135 at 210° | 258 | 310 | 2 | 0.0694 | 178 | 3.30 | 0.0741 |
| 13 | Eldorado engine No. 27 |  | .......... | .... | .......... | 179 | 203 | 2 | 0.0429 | 129.5 | 3.27 | 0.1430 |
| 14 | Filtered cyl. No. 72 |  | 29.6B | 19 | 105 at 210° | 246 | 284 | 2 | 0.0769 | 182 | 4.10 | 0.0902 |
| 15 | Shield cyl. No. 6 |  | 28.6B | 19 | 130 at 210° | 178 | 309 | 2 | 0.0533 | 187.5 | 5.40 | 0.0826 |
| 16 | Summer lub. No. 38 |  | 29.4B | 19 | 120 at 250° | 205 | 228 | 2 | 0.0515 | 152 | 1.30 | 0.0817 |
| 17 | Amer. valve No. 17 |  | 27.6B | 30 | 125 at 210° | 285 | 382 | 2 | 0.0581 | 172 | 5.20 | 0.0704 |
| 18 | Penn. | $C_n H_{2n}$ | 0.861abs. | 0 | 37.6 abs. | .... | .... | 2 | 0.0241 | 126 | 2.30 | 0.0619 |
| 19 | Penn. | $C_n H_{2n-2}$ | 0.868abs. | 0 | 87.4 abs. | .... | .... | 2 | 0.0326 | 134.5 | 4.35 | 0.0581 |
| 20 | Texas | $C_n H_{2n-4}$ | 0.923abs. | 0 | 75.3 abs. | .... | .... | 50m + 50m | 0.0439 | 144 | 2.15 | 0.0855 |
| 21 | Penn. | $C_n H_{2n}$ | 0.850abs. | 0 | 37.6 abs. | .... | .... | 2 | 0.0297 | 140 | 1.20 | 0.0921 |
| 22 | Penn. | $C_n H_{2n}$ | 0.861abs. | 0 | 37.6 abs. | .... | .... | 2 | 0.1035 | 116 | 3.00 | 0.10 |

[1] Nos. 4 to 17 inclusive are standard products made from Ohio and Pennsylvania products.

The specific gravity is given in degrees Baumé and is determined by the formula:

$$\frac{130}{\textit{specific gravity}} - 130 = \textit{degrees Baumé}.$$

The viscosity was determined with a Saybolt viscosimeter. It is expressed in the number of drops per minute that will pass through a given orifice at a definite temperature. The viscosities were taken at different temperatures because it is not practicable to take them all at the same temperature. The viscosity of an oil like No. 7, for example, if taken at a temperature of 210 degrees would not fairly represent the viscosity of that oil, as it was never intended to be subjected to such a high temperature.

The "saponification number," column 5, is the number of milligrams of potassium hydrate that will be taken up by one gram of the oil, that is, the number of milligrams of KOH per gram of oil that would be required to make soap. In an engine cylinder at a high pressure and temperature an oil may become decomposed, and the fatty acid being liberated will attack the metal of the cylinder. It follows therefore that the higher the saponification number of an oil, the greater the quantity of acid that may be liberated to attack the cylinder walls.

It can hardly be said that the tests show any definite relations between the viscosity and the wearing and lubricating qualities of the oils. They are interesting rather as showing the behavior of the particular oils in question in comparison with the relatively familiar examples numbered 1, 2 and 3. The viscosity of an oil does affect its lubricating quality in that if the oil is adapted to the load put upon it, then the lower its viscosity the better lubricant it will be. With heavy oils some work will be absorbed in overcoming the internal resistance of the oil itself. The load should conform to the character of the oil, a light oil being unsuitable for a heavy load. The reason why some of the oils in these tests broke down early was because the load was too heavy for them.

Oil No. 21 contained paraffin and the injurious effect of this substance on the lubricating quality of the oil is shown the chart for that oil, Fig. 4.

Oils No. 18, 19, 21 and 22 are i vidual hydrocarbons separated by l continued fractional distillation f Pennsylvania and Texas oils. The se $C_n H_{2n}$ may be regarded as represen the larger portion of the constituent lubricating oils as made from crude pe leum. The higher viscosity of these hy carbons, which are relatively poor hydrogen, is shown in the table. fessor Mabery has been led to bel from his examination of different vari of petroleum and the separation of i vidual hydrocarbons, that in oils those of Nos. 4 to 17 of the table general composition is represented b series $C_n H_{2n}$, $C_n H_{2n-2}$. They doubtless contain smaller amount hydrocarbon poorer in hydrogen.

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The United States Civil Service mission announces an examinatio December 15, 1909, to fill two vaca in the position of assistant engine $1080 each, National Museum, S sonian Institution. The subjects weights are as follows: Letter wr 10; practical questions in mechanica electrical engineering, 65; experien mechanical and electrical engine work, 25. The application form is 1093.

# Low Pressure Turbines

## Capacity More Than Doubled and Cost of Operation Decreased 30 Per Cent. by the Addition of a Low-pressure Turbine to a Condensing Engine

## Meeting of Mechanical Engineers at Boston

The engineers of Boston and vicinity the number of about 250 attended a eting on Wednesday evening, Novem- 17, held under the auspices of the al members of the American Society Mechanical Engineers, and devoted to discussion of the low pressure steam r ine. Prof. Ira N. Hollis, who oc- ies the chair of mechanical engineer- at Harvard University, in opening meeting announced that the next ting would be devoted to a considera- n f the effect of superheated steam on t-iron fittings and that at the January eting they hoped to entertain the next sident of the American Society of Me- nical Engineers, George H. Westing- use, together with the vice-president, retary and other members.

he first speaker of the evening was ry G. Stott, superintendent of motive ver of the Interborough Rapid Transit mpany of New York, who told of the lts obtained by attaching a low-pres- turbine to one of the 5000-kilowatt s in the Fifty-ninth street station. unit is driven by twin-compound nes of the Manhattan type, having nders 42 and 86 inches in diameter, ning at 75 revolutions per minute, ranteed for 100 per cent. overload capable of carrying 8000 kilowatts nuously, with a rise in temperature nly 35 degrees Centigrade. It was -acticable, however, to run it at this city as the engine under this load ired something over 20 pounds of m per kilowatt-hour. An increase in capacity of the station, which was rative, could be effected by putting dditional units of either the piston turbine type, but the addition of a -pressure turbine to the existing unit ld not only give the required in- se of capacity, but would improve the ncy. This consideration led to the llation of a Curtis three-stage tur- of 5000 kilowatts capacity, taking the st steam from the two compounds h run the unit. The reciprocating e is run under a fixed back pres- of about 16½ pounds absolute, al- gh a variable back pressure would nore efficient, and will be used in e installations. The reason for the nt practice is that some riveted ex- t pipe, which was on hand, was used the present installation, and it was d to be so leaky as to affect the vac- prejudicially when the pressure n it was allowed to fall below that of tmosphere. A separator was installed between the engine and turbine to eliminate the oil and moisture, which amounted to about 10 per cent., which the separator did not separate. It was filled with innumerable baffles and they put in some more, which did not improve it very much. The baffles then began to become loose, with the result that the engine room sounded like a boiler shop. The baffles were finally removed altogether, with an improvement in the efficiency of 5 per cent. The whole secret of separation is the supplying of a chamber large enough to protect the water as it is dropped out of the steam and allow it to be removed by a pump. They are putting in some 28 feet in length and 8 feet in diameter. The turbine has no governor except the emergency, the alternating-current generator keeping automatically in step with that of the main unit. The machine is electrically coupled by means of the leads of the engine generator. All they have to do is to start the turbine generator as an induction motor, and as soon as the load is synchronized and the engine steam is going to the turbine, the turbine generator will take some 8 per cent. of the load. As the total load is increased, the load becomes more equally distributed between the two units, and when a total output of 1500 kilowatts is reached, each one carries approximately 7500. The station is upon railroad work, with a plus and minus variation of 15 per cent. in load, lasting from a few seconds to several minutes. It is very important to get rid of moisture in the steam which goes to the low-pressure turbine, as its effect is doubled, due to frictional losses.

The atmospheric relief valves have to be set about 10 pounds above the atmospheric pressure, and the large valves under this pressure gave a great deal of trouble by chattering. As soon as the chattering commenced, of course, the vacuum went to pieces.

The rest of the story is practically all success, and is, therefore, easier to tell. Twenty-six tests of from four to twelve hours' duration each had been made; the service condenser in the base of the turbines enabled them to recover all the steam furnished, and it was weighed upon a 20-ton scale, capable of weighing to one-half pound, checked by a Venturi meter, which was not, however, found to be satisfactory for the service. Allowances were made for the water taken out by the separator. The net effect of the addition of the low-pressure turbine was an improvement in economy of 23 per cent., and a doubling of the output.

A remarkable effect was the straightening out of the efficiency curve of the combined units, which varies only 0.4 of a pound between 9000 and 15,000 kilowatts output, the point of maximum efficiency being about 12,000 kilowatts where the consumption is about 13 pounds per kilowatt hour, and the unit may be run back to 9000 and up to 15,000 without increasing this to more than 13.4. In the two new units the turbine has not been altered, but the generators have been increased so that the point of maximum economy will be at 14,000 kilowatts instead of at 12,000.

They are able to turn out a kilowatt-hour on the switchboard for 1½ pounds of coal, including all the auxiliaries. The coal has a thermal value of about 14,500 B.t.u.

"As a matter of fact," said Mr. Stott, "it makes no difference whether we include the auxiliaries or not, because we discharge their exhaust steam into the separator, whence it goes into the turbine."

While the improvement in steam economy was around 23 per cent., the total improvement, including operating expenses, which takes into account the saving in labor, lubricating oil, etc., amounts to some 30 per cent.

The relative operating and maintenance cost of the three types of units stands now:

| | |
|---|---|
| Reciprocating engines........ | 100 |
| Steam turbines.............. | 77 |
| Combination engine and turbine .................... | 70 |

The speaker allowed that the steam turbine was about 10 per cent. more efficient in steam consumption than the reciprocating engine, and offered a further opportunity for saving 13 per cent. in labor, etc. Another source of saving with the turbine was the possibility of using the condensate. With the piston-engine units barometric condensers were used, and the water was thrown away. It is not much of a problem to get the oil out of steam, but it is impracticable with any apparatus which a metropolitan station can afford to install to get it out of the emulsion after the steam has condensed.

Referred to the Rankine cycle, the thermal efficiency of the combined units is almost exactly 23 per cent.

In a condenser the transfer of 400 or 500 B.t.u. per square foot per hour was [illegible] as the limit. By rearrangement of the baffles, etc., they have been able to increase this to 750 B.t.u. per hour.

Taking 1.46 as the ratio of kilowatt to indicated horsepower, thus allowing for electrical and frictional losses, the consumption per indicated horsepower is a little under 10 pounds of dry saturated steam per hour. The addition of the turbine has resulted in an increase in capacity of 125 per cent.

W. L. R. Emmet, of the General Electric Company, considers himself the parent of the low-pressure turbine, having read a paper upon the subject at the World's Congress in St. Louis in 1904. The installation of which Mr. Stott had told was particularly interesting because the engine-driven units were the largest which had been produced and were the immediate predecessors of the turbine-driven unit. One of the best points of the low-pressure turbine is that it is efficient through a wide range of load. The reason is that the piston engine has a fixed capacity in the low-pressure cylinder, and just as soon as this capacity is past, the efficiency falls off rapidly. There are a great many overloaded engines in the world, and they run a great deal of the time in the overloaded condition. The low-pressure turbine has the advantage of flattening the load curve and enormously increasing the capacity. The peak capacity of the unit in question had been increased from 6500 to 16,000 kilowatts. Another change which Mr. Stott had made was to put more grate surface under his boilers, so that out of the same boiler plant he can get a great deal more steam. The combined result is that he has easily doubled the capacity of his station. This result accomplished by other means would have cost $200 a kilowatt. Everything that has been done has cost under $30, and probably a good deal under. The same thing is feasible for anybody who has a steam engine and who can use or sell electricity. In Kansas City he had examined a plant where by changes which would cost under $20 per kilowatt an addition of 40,000 kilowatts could be added to the capacity. At St. Louis is another plant where the same addition can be made for slightly less money.

The piston engine is the more efficient in the high-pressure stages of the expansion, but the turbine can complete the expansion through the lower stages where the piston engine cannot.

Engineers are apt to think that their engines cannot be run noncondensing. When the combined unit under consideration is operated with 16,000 kilowatts on it, the engine is carrying a greater load than that which would normally be put upon it running condensing.

There are valves on the admission end of the turbine, by which the distribution of the load as between the turbine and piston engine can be shifted considerably. As a rule, you can put heavy overloads on noncondensing engines, the ample expansion in the second cylinder resulting in good efficiency. On a 1500-kilowatt engine in Milwaukee the noncondensing efficiency steadily improved up to above 2000 kilowatts. Condensing it was very much worse at 2000 than it was at 1500.

The installation which Mr. Stott had described was an example of the simplest application of the low-pressure turbine. Where the supply of steam is intermittent, the mixed type of turbine can be used, having a set of nozzles through which steam can be supplied directly from the boilers, or another source, when that from the intermittent source is insufficient. Such a unit at the plant of the Illinois Steel Company is developing a kilowatt-hour with 19 pounds of dry saturated steam. He was surprised that the low-pressure turbine had not found more favor among the mills of New England, where there appeared to be ample opportunities to use it to advantage.

H. E. Longwell, of the Westinghouse Machine Company, said that the low-pressure turbine is no new thing. In the earliest days everything above 500 kilowatts was made in two sections, a high- and low-pressure section, often with a reheating receiver. The two shafts of these turbines were connected with a coupler. It was with many misgivings that the Westinghouse company put in at Hartford a 1500-kilowatt unit, the first of that size to be built in a single casing.

The disconnected compound engine is nothing new. It has been quite a usual thing to run engines in one portion of the shop upon the exhaust steam of engines in another portion. In the joining of the low-pressure turbine to the high-pressure piston engine we have simply made a combination of old and well known elements.

He was not able to understand why the combination of piston engines and low-pressure turbines should be so much better than a straight turbine. The three-stage turbine attached to the Interborough engine must be exactly like the last three stages of the straight turbines, and the comparison must be between the reciprocating engine and the two initial stages. If the addition of the three low-pressure stages has been productive of such excellent results, why would it not be better to discard the low-pressure cylinder of the piston engine and add the two initial stages of the turbine. Mr. Stott, in sketching the efficiency curves of the engine upon the blackboard had said that as the overload increased the efficiency curve noncondensing ran into and blended with the condensing curve; in commenting upon which Mr. Longwell said that it looked to him like destroying the economy of an engine by putting a condenser onto it.

Max Rotter, of the Allis-Chalmers Company, for fear that the low-pressure turbine might, in light of the previous discussion, be deemed of universal app cation, cited some instances where use was not advisable. His company h been asked, for example, to put a lo pressure turbine onto an engine exhau ing under a pressure of seven poun absolute, so that the turbine would ta the steam at six or seven pounds bel the pressure of the atmosphere and it down to 28 inches vacuum. The p ject is absolutely feasible on paper. T trouble would be in operating the c denser effectively with all the leaks wh would be possible on a low-pressure inder and connecting main containin pressure six or seven pounds less th that of the atmosphere.

They had actually been asked to fig on a turbine to run on steam fr geysers. This could be done if the water could be so confined that the bine could get the steam off from it, it would take about 50 pounds of w to a pound of steam, and geysers w not usual in localities where power in demand.

There is one very good feature of low-pressure turbine, in addition to th which had been brought forward, that was the possibility of using dustrial steam. For instance, there turbine being installed in a rubber p where steam from the vulcanizers is leased at 10 pounds pressure above atmosphere. The scheme is to disch these vulcanizers into a receiver at a atmospheric pressure, and the numbe vulcanizers is such as to furnish a tically continuous supply of steam the production of 1000 to 1200 kilow the only expense being for conden and the initial cost of the installa Being a turbine man, he hated to anything against the low-pressure bine. He had not seen a single sol instance in which figures would not the steam turbine coupled to a p engine to require less steam than a piston engine or a complete tu working through the same range. there are cases where the low-pre turbine is not advisable. He bel the situation in New England, of w Mr. Emmet had complained, to be to the fact that the question in rega the production of power in mill and ufacturing establishments is not cheaply it can be produced?" but, absolutely reliable and flexible?" a low-pressure turbine we can ge reliability, but we cannot get all the ibility, for we have robbed the engi the condenser and the turbine of its i stages. The cost of power produc an industrial plant is such a small er that whether you make it 25 per nt. more or less does not cut any figu at all. The thing that the operating gi- neer demands is absolutely conti ous running with the least bother.

One of the cases where he woul not

lvise the use of a low-pressure turne is where you have an old engine hich runs by the grace of God and a w tie bolts such as you see illustrated the columns of the technical press ıder the title of "How We Patched the linder."

There are many cases where engines e running underloaded instead of overıded. By adding a condenser to the mpound engine you will lower the mean 'ective pressure at which the engine ins its best efficiency. This is one n, and the other gain is that directly to the condenser, and the sum would more than could be gained by adding l w-pressure turbine.

He would never put a low-pressure rbine onto a compound engine which uld not be run condensing; that is, re the steam must be used for manu:turing purposes. The audience was ıned to take this statement as a joke, t Mr. Rotter explained that they had ally had propositions to put a lowssure turbine in series with a piston ne, with the expectation of exhaust the turbine under a back pressure of al pounds above the atmosphere in r that the steam might be used for ting and manufacturing purposes. re are cases where it might be of adge to add a low-pressure turbine t a simple noncondensing engine—but are rare.

ith a belted engine while the plant creasing and being gradually electriso that the belt load is continuously d sing while the electrical load is inng, a point would soon be reached it would 'e necessary to install a unit, and it would be better sense ut in a high-pressure condensing tur to start with which would fulfil all necessities.

his is not intended to apply to con s which generate power as a comity.

dward F. Miller, professor of steam neering at the Massachusetts Inte of Technology, submitted the acpanying table, showing the possibilities by expanding steam from the absolute pressures given in the first column to 28 inches of vacuum. The significance of the several columns is explained by the headings. The values given under the next to the last heading are the number of pounds of steam which would be required by an engine having a nonconducting cylinder, so that there would be no thermodynamic losses with the given assumptions for the efficiencies of the engine and generator, and the values under the final heading give the steam which would be required, with different ratios of attainment to this ideal efficiency.

Mr. Stott, being asked from the floor what pressure was used at the Interborough station, replied 190 pounds gage; and in reply to an inquiry as to the steam consumption of the engine under running conditions in the test which he mentioned replied 26 pounds per kilowatt-hour, equivalent to 18 or 19 pounds per indicated horsepower-hour. The engines were, of course, designed to be run condensing and had a cylinder ratio of 4.2. If they had been designed to run noncondensing, the ratio would have been smaller.

| Abs. press. at ent. | Temp. at ent. Deg. F | Abs. press. at exit. | Temp. at exit. Deg. F. | Quality of steam at ent. | Quality of steam at exit. | Thermal eff. of non-conducting eng. Per cent. | Steam per H. P. of non-conducting eng. | Steam per kw.-hr. of non-conduct. eng., calling the mech. eff. of eng. 90% and eff. of generator 93%. | Steam consumption per kw.-hr. of low press. turbine, assuming ratio of actual eff. to that of non-conducting as 0.63, 0.675, 0.72. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 60 | 215 | 1.005 | 102 | 1.000 | 0.8785 | 15.93 | 14.72 | 23.55 | 33.6 | 31.4 | 29.4 |
| 13 | 210 | 1.005 | 102 | 1.000 | 0.8827 | 15.38 | 15.23 | 24.36 | 34.8 | 32.5 | 30.4 |
| 53 | 200 | 1.005 | 102 | 1.000 | 0.8916 | 14.23 | 16.50 | 26.40 | 37.7 | 35.2 | 33.0 |
| 34 | 190 | 1.005 | 102 | 1.000 | 0.9007 | 13.03 | 18.09 | 28.94 | 40.1 | 38.6 | 36.2 |
| 51 | 180 | 1.005 | 102 | 1.000 | 0.9125 | 11.75 | 20.13 | 32.20 | 46.0 | 42.9 | 40.3 |
| 99 | 170 | 1.005 | 102 | 1.000 | 0.9203 | 10.48 | 22.66 | 36.26 | 51.8 | 48.3 | 45.3 |

Mr. White, local representative of the Westinghouse company, explained that it was quite usual in the New England mills to use a large proportion of the steam exhausted by the engines for manufacturing purposes and heating. If a low-pressure turbine large enough to use only what remained were installed in series with an engine, any surplus steam, in periods of diminished demand for manufacturing purposes, would have to be blown away. He explained how a turbine could be put in of sufficient size to utilize the maximum steam supply, and made to drive a synchronous generator connected to a synchronous motor belted to the main shaft. If this turbine got more than the normal amount of steam, the energy which it generated would be transmitted from the main shaft through the motor, reduce the load upon the engine, shortening up the cutoff, diminishing the steam supply and bringing things back to normal.

Mr. Dreyfus sketched some efficiency curves showing that the efficiency with a constant initial pressure to the turbine is uniformly greater than that when it is allowed to vary. He also suggested that credit should be given to those who had taken an active part in the work of perfecting and introducing the low pressure turbine and called attention to that of Professor Rateau and of Mr. Parsons as far back as 1894.

Mr Emmet said that a synchronous motor is very good, and not a very large motor is necessary.

## Annual Meeting of the American Society of Mechanical Engineers

The thirtieth annual meeting of the society will be held in the Engineering Societies building, 29 West Thirty-ninth street, New York, December 7 to 10.

The professional papers assigned to the meeting are as follows: Tests on a Venturi Meter for Boiler Feed, Charles M. Allen; The Pitot Tube as a Steam Meter, George F. Gebhardt; Efficiency Tests of Steam Nozzles, F. H. Sibley and T. S. Kemble; An Electric Gas Meter, C. C. Thomas; Tan Bark as a Boiler Fuel, David M. Myers; Cooling Towers for Steam and Gas Power Plants, J. R. Bibbins; Some Studies in Rolling Mill Engines, W. P. Caine; An Experience with Leaky Vertical Fire Tube Boilers and the Best Form of Longitudinal Joint for Boilers, F. W. Dean; Testing Suction Gas Producers with a Koerting Ejector, C. M. Garland and A. P. Kratz; Bituminous Gas Producer, J. R. Bibbins; The Bucyrus Locomotive Pile Driver, Walter Ferris; Line Shaft Efficiency, Mechanical and Economic, Henry Hess; Pump Valves and Valve Areas and A Report on Cast Iron Test Bars, A. F. Nagle.

In addition to the above papers there will be several valuable reports submitted by committees of the gas-power section.

## Foreign Belting Company to Build Factory in New Jersey

The belting manufacturing firm of R. & J. Dick Company, of Glasgow, Scotland, having found itself compelled by the provisions of the new tariff law to build a plant in America or sacrifice its trade in this country, has secured ground for a factory between Clifton and Passaic, N. J. Plans for a factory 200x250 feet, which is larger than the home plant, have been prepared, and will be executed by the J. J. O'Leary Company. There will be an independent power house of 50x90 feet dimensions. The plant is to be in working order by spring

# Tanbark as an Economic Fuel for Boilers*

## Evaporative Tests and Flue Gas Analyses Show That Combustion of Wet Spent Tan Compares Favorably with Coal Burning in Factory Plants

### BY DAVID MOFFAT MYERS

It is the object of this paper to give the chief characteristics of wet spent tan as a boiler fuel. It is believed that tanbark contains a larger percentage of moisture than any of the other moist fuels, and it is perhaps safe, therefore, to assume that its correct treatment as a fuel may indicate to a certain extent the most efficient means of dealing with other moist fuels.

The nature of tanbark is too well known to require minute description but it may be stated, as relating directly to its use as a fuel, that its condition in the fire room varies with the method of its preparation for leaching, and its treatment in the leaches. Bark which has been finely disintegrated and has been blown a long distance through a pipe or flue will reach the furnaces almost in a state of a wet powder difficult to burn. On the other hand, with less thorough disintegration and a shorter fan drive the tan will be in larger pieces which allow a freer passage to the draft. The tan in the fire room varies in temperature according to its final treatment in the leach house and according to the distance it is conveyed from the leach to the furnaces. Under good conditions it often reaches the fire room at a temperature of 110 degrees Fahrenheit. The amount of moisture in the tan varies with the leaching process and usually runs from 62 to 70 per cent. Oak tan is easier to burn than hemlock, because it is harder and does not become soggy and pack on the grate, and admits the draft more freely than the hemlock.

Calorific tests conducted on samples of tan which were dried before burning showed an average heat content of 9504 B.t.u. per pound. In the same test it was also shown that the degree of leaching to which the tanbark is subjected does not affect its fuel value except inasmuch as actual weight is subtracted by the leaching process, so that a smaller quantity of fuel reaches the fire room. As regards the loss of weight due to leaching, 100 pounds of air-dry bark ground at the mill will result in about 213 pounds of spent tan, containing 65 per cent. moisture, in the fire room. That is, the weight of the spent tan is 2.13 times the weight of the bark ground.

Since a pound of fuel contains 65 per cent. moisture, 0.35 pound, or the dry amount, must evaporate 0.65 pound of moisture. The calorific value of 0.35 pound of dry tan is

$$0.35 \times 9500 = 3325 \text{ B.t.u.}$$

which is the total B.t.u. in a pound of moist fuel. Subtracting the moisture loss would give

$$3325 - 660 = 2665 \text{ B.t.u.}$$

as the available heat in a pound of fuel as fired.

As previously deduced, the weight of the bark as ground multiplied by 2.13 will equal the weight of the spent tan. Therefore the available heat for boiler purposes obtained from a pound of average air-dry hemlock bark is

$$2.13 \times 2665 = 5676 \text{ B.t.u.}$$

As compared to coal of 13,500 B.t.u., one ton of hemlock bark ground at the mill would equal 0.42 ton of coal. The chemical composition of the dry tan is as follows:

TABLE 1. CHEMICAL COMPOSITION OF DRY TAN

| | Per cent. |
|---|---|
| Mineral Ash | 1.42 |
| Hydrogen | 6.04 |
| Carbon | 51.80 |
| Oxygen | 40.74 |
| Total | 100.00 |

The sample in Table 1 was hemlock tan containing 6 per cent. oak tan. When dried at 110 degrees Centigrade, it lost 66.77 moisture.

#### EVAPORATIVE TESTS

The actual evaporative power of tan was taken from the results of 22 comp boiler tests burning tan alone. Eight these were thermal-efficiency tests. tests were conducted in accordance the American Society of Mechanical gineers' code. The type of boiler in ev case was the horizontal tubular. The naces varied considerably in design economic results, but they were all of dutch-oven type set in front of the bo and all were fired from the top thro feed holes. All of the tests were m under natural draft, and the results sh in Table 2 were obtained in one of 24-hour boiler- and furnace-effici tests, which was selected to show may be considered ordinary condit and results in tan burning.

In a special furnace designed and structed by the author, a thermal effici of furnace and boiler of 71.1 per c burning hemlock tan, was obtained, efficiency being based on the avail heat of the fuel. The principal feat of this furnace, which was subsequ installed in a number of plants, w Large combustion space over the bur fuel, automatic stoking with rotating c shafts, oppositely inclined grate surf converging downward to a set of sha and dumping grates, drying on dead p over which fuel passed before recei the air supply, concentrated draft opposing grate surfaces to a focu combustion caused by parallel spacin longitudinal flat grate bars with bev edges, reverberating draft action resu from concentrated draft currents and curvature of the arch, thus dire

TABLE 2. EVAPORATIVE POWER OF WET SPENT HEMLOCK TAN.

| | |
|---|---|
| Kind of fuel | Wet spent hemlocl |
| Kind of furnace | Wide high oven, 2 rows firing |
| Method of starting and stopping test | Alte |
| Grate surface, square feet | |
| Water-heating surface, square feet | 20 |
| Heating surface ÷ grate surface | |
| **AVERAGE TEMPERATURES, PRESSURES, ETC.** | |
| Steam pressure, by gage, pounds | |
| Temperature feed water entering boiler, deg. F. | 1 |
| Temperature escaping gases from boiler, deg. F. | 4 |
| Force of draft between damper and boiler, inches water | |
| Temperature outside air | |
| Temperature of tan as fired | |
| **HORSEPOWER** | |
| Horsepower developed | |
| Rated horsepower at 15 square feet | 1 |
| Percentage rated horsepower developed | |
| **ECONOMIC RESULTS** | |
| Water evaporated under actual conditions per lb. tan as fired, lb. | 32 |
| Equivalent evaporation from and at 212 deg. per lb. tan as fired, lb. | 48 |
| Equivalent evaporation from and at 212 deg. per lb. dry tan, lb. | 30 |
| **EFFICIENCY** | |
| Calorific power of dry tan per lb., B.t.u. | 94 |
| Percentage moisture in tan as fired | [illegible] |
| Available heat in 1 lb. of wet tan as fired, after subtracting loss due to evaporating moisture, B.t.u. | 24 |
| Efficiency of boiler including furnace, based on available heat in fuel, per cent. | .2 |
| Efficiency of boiler including furnace, based on total heat in fuel, per cent. | .9 |

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*Abstract of paper presented before the American Society of Mechanical Engineers.

comes back upon the dead plates. The results obtained from this furnace are given in Table 3.

### EFFECT OF PRESSING AND BURNING MIXED WITH COAL

To learn the exact economic effect of burning coal with pressed tan and also the result of pressing the tan to eliminate some of the moisture, three thermal-efficiency tests were conducted, all on the same boiler and furnace, the conditions as near as possible being the same in all tests and the furnace operated by the same firemen. The furnace and boiler were of the same general type already referred to. The firing was heavy, the cone then nearly reaching the arch each time after firing. The furnace had a grate surface of 11 feet 4 inches by 7 feet, or 79 square feet, and the perpendicular distance from the grate surface to the highest point of the arch inside was 48 inches. The boiler was 6x18 feet and contained 2089 square feet of heating surface, the ratio of heating surface to grate surface being 26.3 to 1.

The result of this series of tests shows that the burning of coal with pressed tan increased the thermal efficiency from 59.4 to 63.4 per cent., and also increased the boiler output from 92 per cent. of the rated capacity to 135.5.

TABLE 3. RESULTS OBTAINED WITH SPECIAL FURNACE.

| | |
|---|---|
| HORSEPOWER | |
| Horsepower developed | 86.5 |
| Rated horsepower of boiler at 15 sq. ft per h.p. | 120 |
| Percentage rated horsepower developed | 72.1 |
| ECONOMIC RESULTS | |
| Water evaporated under actual conditions, per lb. of tan, as fired lb. | 1.77 |
| Equivalent evaporation from and at 212 deg. per lb. of tan as fired, lb. | 1.93 |
| Equivalent evaporation from and at 212 deg. per lb. of dry tan, lb. | 5.55 |
| EFFICIENCY | |
| Calorific value of dry tan per lb., B.t.u. | 9850 |
| Percentage of moisture in tan as fired | 65.33 |
| Available heat per lb. of tan as fired, B.t.u. | 2623 |
| Efficiency of boiler, including furnace, based on available heat in fuel, per cent | 71.1 |
| Efficiency of boiler, including furnace, based on total heat in fuel, per cent. | 54.4 |

FIRING

Firing was even and continuous with automatic stoking. Bed of fuel maintained on grates was about 9 inches thick.

Since the thermal efficiency was practically the same with both pressed and unpressed tan, the principal advantage of pressed over unpressed tan in this particular case lies in the intrinsically greater calorific value of the pressed tan owing to its reduced moisture. In this particular case in which the unpressed tan contained 63.6 per cent and the pressed tan 50.6 per cent. moisture, the actual gain in available heat units was 45 per cent. over the unpressed tan, or 1⅛ per cent. gained in heat value for each per cent. increase in moisture. In actual practice, however, a total gain of about 7 per cent. can be obtained, but against this must be charged the power to run the press, maintenance, repairs and the disadvantage of noise and vibration in the fire room. The principal point to remember in changing from wet to drier tan, is to reduce the grate surface proportionately. Failure to observe this precaution has resulted in the throwing out of commission of more than one press.

### EFFECT OF SMALL COMBUSTION SPACE OVER THE FIRE

A special test on a low arch furnace was made to obtain comparison with high arches. A furnace containing nine feed holes and having a hight from arch to grate of 26 inches, was tested with the miserable result shown in Table 5.

### BURNING A MIXTURE OF TAN AND COAL

Among other methods of burning the two fuels, the ordinary coal-burning setting has been tried. The grates are usually of the shaking variety and are set directly under the boiler and generally only 24 to 30 inches beneath the shell of the boiler. The coal and tan are fired alternately by hand. Owing to the large volume of tan as compared to its heating value (spent tan weighs about 33 pounds per cubic foot), the fire doors have to be opened very often, thus admitting a great access of cold air to the fire. The fire bed has a strong tendency to burn through in spots and form blowholes. The temperature-retaining effect of the dutch-oven arch is lost, and instead the fuel gases come in direct contact with the shell of the boiler, which cools them before combustion is thoroughly under way. The result in every such case the author observed, was dull, smoky fire of greatly varying temperature and never good combustion. In a certain plant where this method was thoroughly tried out it proved so unsuccessful that it was discontinued and the grates were replaced by dutch ovens in which a mixture of tan and coal was burned, the fuel being mixed before firing.

TABLE 4. COMPARATIVE RESULTS OF THREE TESTS.

| | Test No. 1 | Test No. 2. | Test No. 3. |
|---|---|---|---|
| Thermal efficiency of boiler including furnace based on available heat in fuel, per cent | 63.4 | 59.4 | 59 |
| Evaporation from and at 212 deg. per lb. tan as fired, lb | 1.98 | 1.90 | 1.65 |
| Evaporation from and at 212 deg. per lb. dry tan, lb. | 5.43 | 4.71 | 4.54 |
| Percentage rated h.p. developed | 135.5 | 92 | 72.1 |
| Type of furnace | | wide and high | |
| Heating surface ÷ grate surface | 26.3 | 26.3 | 26.3 |
| Number of firing eyes | 6 | 6 | 6 |
| Height of combustion chamber, inches | 48 | 48 | 48 |
| Kind of firing | deep | deep | deep |
| Firing intervals, minutes | 18.8 | 18.8 | 19.1 |
| Kind of fuel | pressed tan and coal | pressed tan | unpressed tan |
| Moisture in tan, per cent | 60.1 | 59.6 | 63.6 |
| Steam pressure, lb | 76 | 74 | 63.4 |
| Temperature feed water, deg. F | 163 | 160 | 161 |
| Flue temperature | 531 | 486 | 445 |
| Force of draft in uptake, inches water | 0.51 | 0.49 | 0.43 |
| Duration of trial, hours | 10 | 10 | 10 |
| Flue gas analyses, average per cent. $CO_2$ | 13.8 | 10.9 | 10.5 |
| Per cent. O | 4.9 | 7.8 | 8.6 |
| Per cent. CO | 0.15 | 0.93 | 0.68 |

TABLE 5. TEST ON LOW ARCHED FURNACE.

| | |
|---|---|
| Efficiency of boiler and grate, per cent. | 26.4 |
| Evaporation from and at 212 deg. per lb. tan, as fired | 0.63 |
| Percentage rated h.p. developed | 39 |
| Heating surface : grate surface | 28 |
| Kind of tan | Hemlock |
| Percentage moisture in tan | 67.2 |

The above illustration affords a good comparison of combustion with and without a brick arch over the fire bed with hand firing, and it goes to show that a brick or refractory arch is a necessity for good combustion when the two fuels are so related in quantity that their heat values are about equal.

As a further demonstration, experiments with automatic stoking were cited. The mixed fuel was fed into a chain-grate stoker operating on induced draft. This was done under the most favorable conditions possible and under the supervision of an engineer representing the chain-grate company with the assistance of the author. The steam pressure and the furnace temperature dropped rapidly and it was soon necessary to eliminate the tan and feed coal alone to prevent the fire from going out. Experiments with different methods of mixing and feeding the two fuels all resulted in killing the fire.

Like experiments were conducted on a Detroit stoker set in front of the boiler and having a brick arch completely over the fire. No scientific tests were conducted, but the mixed fuel easily carried the load formerly carried by the coal, it being necessary only to increase the feed of the stoker. The steam pressure was increased, and as far as the eye could detect there was not the slightest decrease in furnace temperature, the combustion being clear and to all appearances excellent.

From these experiments it seems entirely safe to state, that for efficient combustion of a mixture of tan and coal in ratio by weight of 5.2 to 1 a refractory arch over the greater part of the fire, and preferably over the entire fire bed, is not only advisable but necessary. It follows that tanbark of the usual moisture and heat content cannot be burned without the application of a refractory arch, or some device of similar function, such as a large combustion chamber lined with refractory material.

Wood is sometimes burned in combination with tan in the same furnace. Good results are obtained when the wood is ground to about the same fineness of the tan, when it is known in the sawmill district as "hog feed." When wood in slab or log form is burned in the same furnace with tan the results are usually very poor, owing to blowholes formed in the fire bed and consequent large access of air.

### Draft and Grate Surface

The force of draft required in general practice for tan burning is somewhat higher than that required for producing the same boiler output with bituminous coal. No definite figures can be given for the force of draft as related to tan burned per square foot of grate surface, owing to the widely varying designs of furnace and methods of firing. It may be stated, however, that for full capacity not less than ½-inch draft should be provided for in the uptake of a horizontal tubular boiler, when the boiler is set so that the gases flow under the shell and through the tubes directly to the stack or uptake.

Owing to space required, facility in cleaning fires, minimum radiation from furnace and expense of building and repairing, it is desirable to make the furnace grate area as small as possible and still conform to capacity requirements. It is therefore necessary to know the boiler horsepower developed per square foot of grate surface. This depends upon the rate of combustion of the tan, which is an extremely variable quantity, but averaging the results of nine typical boiler tests, it may be said that under usual conditions for oak tan the boiler horsepower per square foot of grate is about 2.08; and for hemlock tan 1.5 boiler horsepower per square foot of grate is an average figure.

When coal is burned in the same furnace with the tan the development per square foot of grate varies, of course, with the richness of the mixture and with the other usual conditions. In four cases out of five selected at random the boiler horsepower per square foot of grate was 2.5 to 2.7.

### Grates

Grates for tan burning are made in different patterns, but usually contain from 20 to 30 per cent. air space, the actual opening between the bars being 3/16 to ¼ inch. Larger spaces than these allow the tan to fall through into the ashpit. A shaking grate is hardly necessary for burning tan alone, owing to the small percentage of ash. No clinkers form; only a very fragile crust on the grate obtains in three or four hours. In some cases fires are cleaned only once in twelve hours with good results, though like a coal fire, a tan fire should be shaken or disturbed very little. If a slice bar is used on a brightly burning tan fire, dense smoke results and the flame is killed for some time.

The temperature in the throat of a properly designed tan furnace burning tan alone will reach 1500 degrees Fahrenheit. The depth of fuel on the grate varies with the design of the furnace and the method of firing. In ordinary practice the tops of the cones of tan directly beneath the firing eyes vary from 2 to 5 feet above the grate surface, while the depth of tan where the cones meet will be from 6 to 18 inches, depending upon the design and firing of the furnace.

When spent hemlock tan forms a cone from the conveyer discharge on the fireroom floor it forms an angle of slide of about 55 degrees to the horizontal. Inside a hot furnace, however, this angle is about 45 degrees, and in laying out a tan furnace the latter angle is used in figuring the distribution of fuel on the grate. The angle of slide of tan on a sloping grate is 39 to 41 degrees, and these angles were used in planning the special tan furnace referred to previously.

### Single Furnace Best

Among other experiments with this fuel the author has made tests to compare results of double settings with single settings and believes that the single setting should have the decided preference. A possible though not a decided improvement in combustion is sometimes obtainable with a double setting, but this is more than offset, especially in small plants, by the advantages of convenience for cleaning, repairs and adaptation to load given by the single setting.

### $CO_2$ Content in Flue Gases

The combustion of tan, as indicated by flue-gas analyses made with an Orsat apparatus, compares most favorably with the combustion of coal in factory plants where the same amount of attention is paid to the boiler room. In fact, the percentage of $CO_2$ runs higher than in ordinary coal-burning plant. For instan the average $CO_2$ of 17 evaporative te of different tan-burning furnaces was per cent.; the lowest average $CO_2$ in of the tests was 4.3 per cent., which rep sented unusually and abnormally p conditions; and the highest average in any one of them was 16.9 per c The CO averages about 0.5 to 0.6 cent. and ranges from practically zero to 2 per cent.

## A Triumph for the Marine Turbine

While the battleship "North Dak has considerably exceeded her cont requirements, practical interest center the increased steaming radius made sible by the high efficiency of the Cu turbines, with which she is equip rather than the fact that her maxin speed was 22.25 knots with a requiren of only 21 knots. With a coal consu tion of only 105 tons per 24 hours at ordinary cruising speed of 12 knots compared with 111 tons burned on sister ship the "Delaware," fitted reciprocating engines, it is possible the "North Dakota" to steam fur without recoaling. Calculation from sults of her trials shows that her ste ing radius at 12-knot speed is 9000 kn while at 19 knots it is 4600 knots an the maximum speed of 21½ knots hour it is 3000 knots.

RESULTS OF OFFICIAL TRIALS OF U. S. BATTLESHIP "NORTH DAKOTA."

| | 3 Hr. of Full Power Trial. | 24 Hr. Trial at 19 Knots. | 24 Hr. Tr at 12 Kn |
|---|---|---|---|
| Actual average speed | 21 64 | *19.24 | 12 |
| Revolutions per minute | 280.4 | 231.9 | 143 2 |
| Shaft H.P. of main turbines | 31,400 | *16,710 | 3,800 |
| I.H.P. of engine auxiliaries | 1,100 | *660 | 400 |
| Water rate of main turbines only | 13 6 | 14 11 | 20. |
| Water rate for all purposes based on total H.P. | 13.96 | 15.29 | 22.3 |
| Coal used, pounds per hour | 54,400 | *27,550 | 9,802 |
| Coal used, tons per 24 hours | 583 | 295.3 | 105 |
| Coal per hour per shaft H.P. of turbines | 1 74 | *1.65 | 2 |
| Coal per hour per H.P. for total H.P | 1.68 | *1.58 | 2 |
| Coal per hour of equivalent I.H.P. based on 8 per cent. friction for reciprocating engine | 1.55 | *1.46 | 2 1 |

All preceding figures are official except those starred.

STANDARDIZATION TRIAL.

| | |
|---|---|
| Highest speed on mile, uncorrected for tide, knots | 22 |
| Mean of five high runs | 21 |
| R.P.M for 21 knots | 263 |
| R.P.M for 19 knots | 228 |
| R.P.M for 12 knots | 142 |
| Maximum shaft H.P. developed on mile | 35,150 |

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The United States Civil Service C mission announces an examination December 14-15 for the position of chanical draftsman, $1500 per ann Engineer Department at Large, Portl Ore. The subjects and weights ar follows: Mechanical design, 30; work, 10; drawing, 30; training and perience, 30. The application forn No. 1312.

# Tests on a Venturi Meter for Boiler Feed*

By Prof. C. M. Allen

A reliable and accurate hot-water meter as been in demand for a good many ears. The principle of most of the cold-ater .meters, where there are moving arts in the water, is not at all adaptable r hot-water work. A hot-water meter r boiler-feed purposes must stand not y the variation in temperature but also siderable variation in pressure, and ite often it has to stand a certain ount of water-hammer, this depending ewhat upon the style and condition t pump used. The Venturi meter, hav- g no moving parts to get out of order d being of material which will stand ordinary corrosive effects, should ake a reliable hot-water meter.

2 The object of these tests was to de- rmine the accuracy of a Venturi meter he used for measuring boiler feed er a great variety of conditions. The n was to make a complete series of ts upon a small Venturi meter under the probable conditions that would er be met in boiler-room practice. The ts were made under varying tempera- res and velocities; under varying pres- res, intermittent and steady; using a plex power pump in good condition, d with one plunger out of commission, duplex steam pump in good condition in poor condition, and an injector.

3. The meter was installed in the am-engineering laboratory of the rcester Polytechnic Institute and set the way most convenient not only for ighing the water passing through the ter, but also for heating the water re it went through the meter, and mping it in in various ways. The meter d was built by the Builders' Iron undry of Providence, R. I., and is what rdinarily called a 2-inch meter, the tream and down-stream ends being inches in diameter and the throat ¾ h in diameter. The main part of the ter is of cast iron and the internal rtions are lined with brass. Surround- the up-stream end and throat are lar chambers between the brass eve and the iron casing. Six holes drilled through the brass lining into e annular chambers at about equal nces around the circumference. in ler to give the actual pressure heads the meter at both throat and up- eam end. From the outside of these ular chambers were pipe connections a manometer tube which consisted of lass U-tube containing mercury. There re the necessary valves and pet-cocks manipulate the meter, blowing out air whenever it accumulated. The eral layout of the apparatus is shown Fig. 1.

4. The apparatus was set up so that the meter could be supplied from a 1¼-inch metropolitan injector, a 4½x2¾x4-inch duplex pump or 4x5¾ inch triplex power pump; or from a pressure tank supplied from the city mains or by a large duplex pump. These pumps were arranged to take their suction from a pit 12 feet long, 6 feet wide and 4 feet deep, directly beneath the Venturi meter. A 1-inch steam line was put in to heat the water. There being about 300 cubic feet in the supply pit, a very even temperature could be maintained. In order to keep the discharge from the pumps constant, a suction well was supplied, kept at constant level by an additional pump from the main pit. The discharge from all the pumps used was carried up a vertical 2-inch pipe, at the top of which was an air chamber 4 inches in diameter and 3 feet long, with a valve so inserted that it might be cut out whenever desired. From this vertical pipe ran a line containing the Venturi meter, a thermometer well for determining temperatures, and a valve for throttling water in order to get any desired pressure. At the end of this line was a swinging end that discharged into either of two 5000-pound weighing tanks.

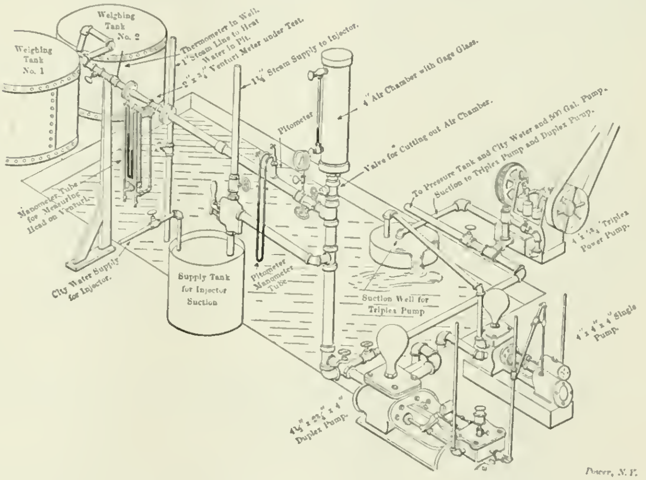
Weighing Tank No. 2
Weighing Tank No. 1
Thermometer in Well.
1" Steam Line to Heat Water in Pit.
2" x ¾" Venturi Meter under Test.
1¼" Steam Supply to Injector.
4" Air Chamber with Gage Glass.
Pitometer
Valve for Cutting out Air Chamber.
To Pressure Tank and City Water and 500 Gal. Pump.
Suction to Triplex Pump and Duplex Pump.
4"x5¾" Triplex Power Pump.
Manometer Tube for Measuring Head on Venturi.
City Water Supply for Injector.
Supply Tank for Injector Suction
Pitometer Manometer Tube
Suction Well for Triplex Pump
4"x4"x4" Single Pump.
4½"x2¾"x4" Duplex Pump.
Power, N.Y.

FIG. 1. LAYOUT OF APPARATUS, VENTURI METER TESTS

5. The first tests were made with cold water in order to determine the coefficient. These were made with steady pressure, securing a very constant flow. Water was run through the meter until the conditions had become constant. One tank was weighed while the water was being discharged into the other. The tests were started by diverting the discharge into the weighing tank and taking the time Readings of the Venturi meter were taken every thirty seconds for low velocities and every minute for higher. The tests were ended by diverting the discharge into the other tank, taking the time and weighing.

6. When hot-water tests were made, it was found that a certain amount of water evaporated; evaporation tests were therefore made, which proved this amount to be a negligible quantity.

7. In order to compare the workings of the meter under the various conditions, it was decided to determine the coefficients for this meter under these conditions. The discharge of the Venturi meter was figured from the regular formula, using a coefficient of one, and the actual weight obtained from the weighing tanks was divided by this value to obtain the real coefficient.

8. The following temperatures were used during the tests: 80 degrees, 120 degrees, 140 degrees and 180 degrees Fahrenheit. Water for these tests was supplied by the triplex power pump with different velocities through the meter. Tests were made at 140 degrees with and without the air chamber, the water being furnished by the triplex power pump; then at 140 degrees with one plunger of the triplex pump disconnected so as to produce fluctuations in the velocity and pressure of the water supplied to the meter.

9. In order to duplicate more nearly the conditions of boiler feed, an air chamber and check valve were placed in the pipe line in the down-stream side of the Venturi meter (not shown in Fig. 1). Because of the air chamber at this end the pump fluctuations could pass through the meter to a much more marked degree than if the discharge was merely throttled by a valve. Under these conditions tests were run with water supplied by the injector, taking suction

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To be presented at a meeting of the Amer- Society of Mechanical Engineers.

from a special supply tank, with the heater, however, the temperature of the water of necessity varied with the velocity through the meter.

CONCLUSIONS

10. The chief difficulty encountered in making this series of tests was in getting the true average readings of the manometer. With the higher velocities through the meter, the fluctuations could be easily dampened by closing the valves to the manometer tube, but with the lower velocities any error in reading was so large in proportion to the entire head as to make a considerable difference in results. It may be said, then, that the meter is not accurate for velocities of less than 10 feet per second in the throat of the meter, which corresponds to a discharge of 0.03 cubic foot per second, or about 6140 pounds per hour, so that this meter would be best adapted for measuring water for a boiler plant of above 200 horsepower. The coefficients are materially lower below 0.03 cubic foot per second. The principal feature shown by the cooler-water tests (80 degrees Fahrenheit) is the low value of the coefficients of the meter, the average, excepting the values for velocities below 10 feet per second, being 0.942. This coefficient might have been expected, however, as in a small meter the ratio of area of cross-section to surface is much lower.

11. These experiments clearly show that the meter is as accurate for hot water as for cold. The maximum error in discharge, as figured from manometer deflections using the mean coefficients for that temperature, is as follows: 80 degrees, 1.30 per cent.; 120 degrees, 1.5 per cent.; 140 degrees, 1.9 per cent.; 180 degrees, 0.82 per cent. The average error is well within 1 per cent.

12. Of the pumps tried with the meter, the triplex gave by far the best results, and it may be confidently stated that the Venturi feed-water meter would give very satisfactory results in a plant using the power pump. Even with one plunger disconnected, the maximum variation was only 2.4 per cent.

13. In tests with the injector, the weighed calculation from the Venturi formula, using the mean coefficient, shows variations from actual weight of 3 per cent. The average error is inside 2 per cent.

14. The results from 4½x2¾x4-inch duplex pump show up better than might be expected as this pump was in very poor condition, the piston rods being so worn that the pump took air through the stuffing boxes at the water end.

15. These tests represent the worst conditions which would be met with in boiler feed. The pump would start building up pressure, then pause until the pressure had fallen. The check valve, which was located only about 6 inches down stream of the Venturi meter, was opening and closing constantly. For a discharge of more than 0.03 to 0.04 cubic foot per second, the coefficients were very consistent.

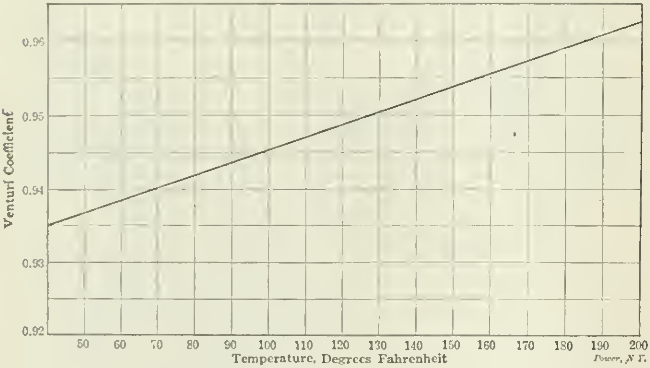

FIG. 2. CURVE SHOWING VARIATION OF VENTURI COEFFICIENT WITH RISE IN TEMPERATURE

16. It must be remembered in considering these tests that the Venturi meter itself probably worked more accurately than the tests would indicate, as every change in velocity through the meter is accompanied by its corresponding change in head on throat and upstream end, and that a continuous recording device attached to the meter would probably cut down the error considerably. It is the opinion of the experimenters that the Venturi meter is a very reliable form of hot-water meter, provided the proper size is used.

17. These tests were conducted for the most part by George Y. Lancaster, a post-graduate student in mechanical engineering at Worcester Polytechnic Institute, and these results are taken from a thesis submitted by him.

## Adjusting Indicator Cord

By JULIAN C. SMALLWOOD

So many of no small experience are the habit of adjusting the indicator co when setting up an indicator upon engine to be tested, by a clumsy cut-ar try method, that it seems to the wri worth while to describe the proper, e way of doing it. The cut-and-try me od referred to consists in placing the gine on one dead center and then ty the cord to the reducing device crosshead, if a reducing wheel is use so that the indicator drum is about inch from the end of its travel. The gine is then placed on the other d center and, if the cord is long enough allow full motion to the drum, it is c sidered all right; if not, the process repeated.

The simplest way to adjust the c length is as follows: Mark on the cr head guides the positions of the cr head at the ends of its stroke. Now, t the flywheel until the crosshead is j half way between these marks. With engine in this position, that is, midstro tie the indicator cord to the reducing after adjusting its length so that paper clips on the drum are diametri ly opposite the pencil point, the la being in contact with the drum. midposition of the drum will then c respond to the midposition of the cr head; the limiting positions of the dr will be equal distances from the adjac stops; and the diagram will be spa with nicety in the middle of the card.

## Massachusetts Boiler Rules th Model

It is reported that Chairman Jos H. McNeill of the State board of bo rules, is in daily receipt of letters fr various manufacturers and persons are employed in the care of steam pl for explanation of the Massachus laws for safeguarding the making operation of steam boilers. He has b sending out many copies of these r to all parts of the country in respons these requests, as well as all over State.

In its recent convention in Detroit, American Boiler Manufacturers' asso tion unanimously indorsed the Ma chusetts rules, and instructed its pr dent to communicate with the mayor the city, advising him to recommend t adoption by the city of Detroit.

A committee of the Canadian Ma facturers' association, appointed to ommend boiler rules for adoption by Canadian government, has also much impressed with the Massachus rules, and will probably adopt them Canada.

# Some Temporary Motor Connections

## Novel Arrangements of Motor Connections to Fulfil Temporary Needs in Small Rapidly Growing Plants where Machines on Hand Must Be Used

BY C. V. HULL

The man who does electrical work for a wealthy corporation often fails to get the real pleasure from such work that he would; anyone who is limited as to expense and working material finds at least as much pleasure and satisfaction in making or improvising his apparatus as he would in installing some piece of specially designed apparatus from the manufacturer. A man who had worked for years for one of the large trusts remarked not long since that he had never made any tools or "rigged up" any apparatus for he found it easier to buy what he needed and put it on his expense account. This man might be "up against it" if he required special material and was not at liberty to purchase "Necessity is the mother of invention," and it might be added that economy is its father. At any rate, the man whose funds are limited often finds a way to use unpromising material to advantage, especially in electrical work. In the large plants conditions are more or less certain and motors and machines are purchased which are specially designed for their work. But those who work in the smaller but rapidly growing plants of the Middle West must often use such apparatus and material as may be in stock or make what is needed. Then conditions arise which demand power from somewhere at once. It is often easier for the superintendent to write an order than for the electrician to execute it.

Changing, moving and repairing machines and motors are the causes of much motor shifting. We have found it convenient to have a 5-horsepower motor with its main switch, fuse block and starting rheostat attached. It is then only necessary to set this outfit on a truck or box and as soon as the circuit leads are connected to the switch it can be put in operation. This saves the time required to set up and wire a switchboard for the motor and when done in that place the motor can be picked up with a hand crane, loaded on a truck and returned to the store room until some emergency demands its use. Frequently a 5-horsepower motor is needed while some heavy work is done or another motor repaired. We find it very convenient to load motor, starting rheostat and fusible switch on a four-wheeled shop truck. This truck can then be pushed about, and the motor easily lined up, with the truck blocked and used as a foundation for the motor. These portable outfits save time when machines are being changed and are very convenient in substituting for other motors that are being repaired.

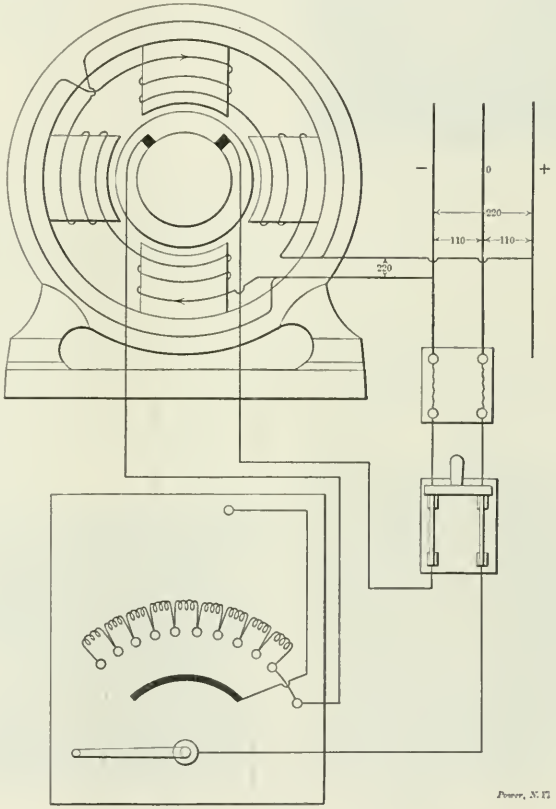

FIG. 1. A 220-VOLT MOTOR EXCITED FROM 220-VOLT LINE AND TAKING ARMATURE CURRENT FROM 110-VOLT LINE

The motors used in this shop are 110- and 220-volt direct-current machines and receive current from a three-wire circuit. At times it is impossible to find proper pulleys or motors of suitable speed in stock. It is often advisable to change the field connections of a 220-volt motor and use it on the 110-volt circuit. It may be that this lowers the efficiency but it accomplishes the result, which is the main thing. Fig. 1 shows the connections of a 20-horsepower 550-volt motor used to operate a radial drill until a suitable motor was obtained. When this motor came into the shop the field coils were connected for 220 volts and the construction of the motor was such that it would have been difficult to connect them for 110 volts. We were unable to find a pulley small enough for the speed that the motor gave on 220 volts. Accordingly the armature was supplied at 110 volts and the field winding at 220 volts, making the machine a 5-horsepower motor at

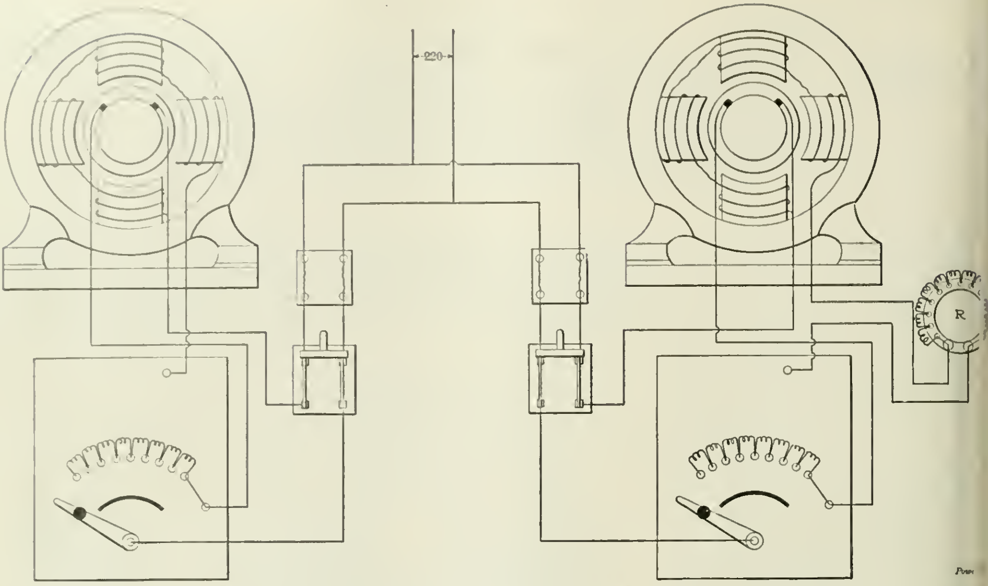

FIG. 2. CONNECTIONS OF TWO MOTORS USED TO DRIVE A COMMON SHAFT; A FIELD REGULATING RHEOSTAT BEING USED TO SPEED UP THE SLOWER MOTOR

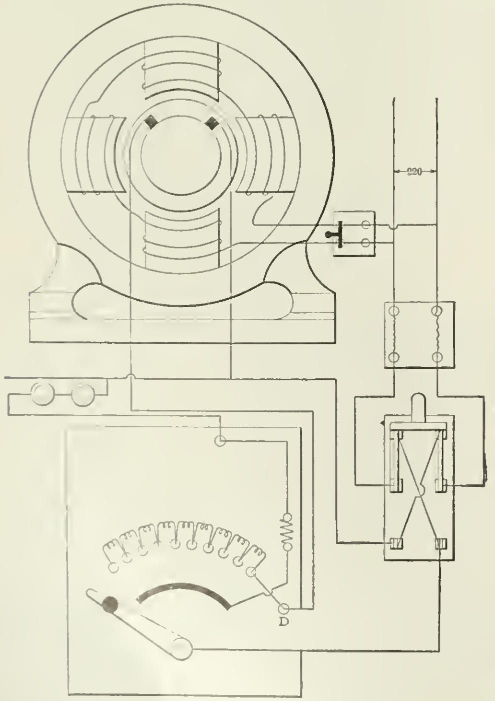

FIG. 3. FIELD CIRCUIT ENTIRELY INDEPENDENT OF ARMATURE CIRCUIT AND STARTER. RETAINING MAGNET EXCITED THROUGH LAMPS

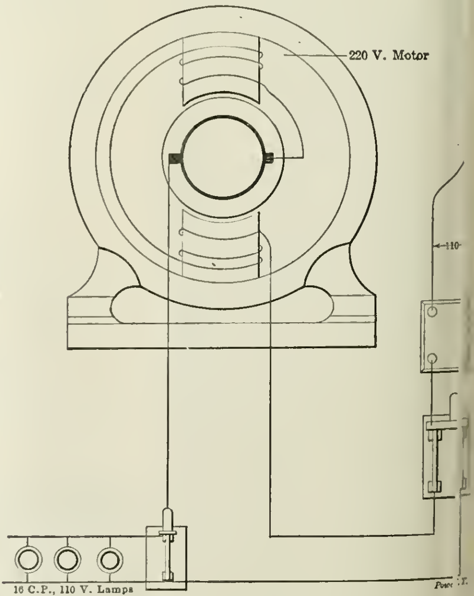

FIG. 4. SERIES MOTOR SUPPLIED AT HALF VOLTAGE; LOW SPEED OBTAINED BY REMOVING SHORT CIRCUIT ACROSS LAMP IN SERIES WITH MOTOR

the proper speed. A 5-horsepower motor starter was used and because the field current was taken from the mains it was necessary to block the lever in the running position. Under these conditions it is evident if the 220-volt supply should fail for any reason, and the 110-volt circuit still delivered current, the rmature would receive current with the ield dead and probably run away. This appened several times but in each case he motor was stopped before any damage vas done. Such work as this is not to e recommended, of course, but in this ase it allowed a much needed machine be put into operation several weeks ef re its proper motor arrived.

In another case the changing and in-tallation of machines required 25 horse- wer from a motor rated at 15 horse- wer, which was driving a line shaft. s this load was to be but for a few lays the superintendent objected to utting the line shaft or to buying a ew motor. Therefore another 220-volt tor was connected in parallel and the w handled a 50- to 100-ampere load icely. Even when the load dropped to amperes the motors worked well. It not often that two motors can be used drive the same line shaft, but in the se of the 15-horsepower motors we ad no difficulty as the two motors emed to have almost the same char- teristics.

It is certain that a series-wound motor best adapted for hoisting service but is possible to obtain good results with shunt-wound machine. Fig. 3 is the ring diagram of a 220-volt 7-horse- wer motor used to operate the foundry st. This motor drives through a worm l worm gear to reduction gearing iving the cable drum. The brushes are t in the best position for hoisting, as it little current is used in lowering the r The field current is taken from the ains and so the field is always ex- d. This requires current when the tor is idle but is better than breaking e field circuit each time the motor is pped. It is necessary to use two 110- lamps in series, as shown, to hold the er of the starting box in the "on" sition. These also serve as pilot lights, they burn as soon as the lever strikes contact and make it possible to tell ther or not power is on. This ar- gement worked so well that it is still peration, though a series motor with ersing switch and automatic starting x was bought to be put in this place d has been in the stock room for some ne.

Fig. 4 is the wiring diagram of a ¼- sepower 220-volt series-wound motor ving the fan of a small portable forge. is supplied at 110 volts and can be nected to any socket by means of an linary socket plug which is connected the fuse block by flexible cord. The ee lamps are used to lower the speed when the fire is burning well, the single-pole switch being opened to remove the short-circuit across the local lamp circuit. Then the fan furnishes just the proper amount of air to heat rivets without burning them.

These diagrams do not conform to the best practice, but they show how we have used available material to get work done on time without waiting for special apparatus. One soon tires of wiring up ordinary shunt-wound motors, but finds pleasure in doing these special jobs. However, as the plant grows, the new machines come fully equipped with motors and sundries designed for them which are, of course, much better than our "utility" work.

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# Catechism of Electricity

## Typical Forms of Alternating-current Generators

1100 *What is the general appearance of a modern alternating-current generator of the belted type?*

A Crocker-Wheeler three-phase machine of this type is illustrated in Fig. 333. Its capacity is 100 kilowatts at 1150 volts and 900 revolutions per minute. It is small for its output, owing to the high speed at which it can be run in comparison with a direct-connected alternator. The bearings being supported from three-arm bearing frames bolted to the main frame does away with the necessity for a heavy base and makes the machine very compact.

1101 *Illustrate and describe the principal parts of the generator shown in Fig. 333.*

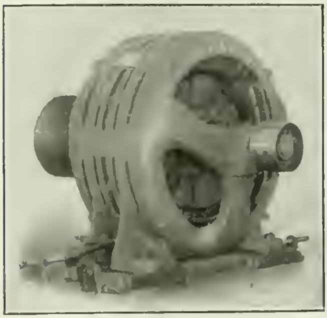

FIG. 333. BELT-DRIVEN ALTERNATING-CURRENT GENERATOR

The stator frame, Fig. 334, is of cast iron and circular in form, a shape which gives strength and rigidity with a minimum amount of metal. The frame is provided with slots for the ventilation of the core. Fig. 333 shows that the feet upon which the machine stands form part of the frame casting. The frame supports the core, which is built up of thin sheet-steel rings with slots punched around the inner periphery. Ventilating ducts are provided in the core.

The armature or stator winding, shown in place in Fig. 335, consists of form-wound coils *a*, which are thoroughly insulated and laid in insulated slots where they are firmly retained by means of magnetic wedges. These wedges are easily removed for repairs, but when in place they close the slot magnetically and thereby permit the use of solid field poles and shoes. The projecting ends of the winding are heavily taped and varnished to increase the insulation and give mechanical protection. The bearing frames give additional protection to the ends of the coils against mechanical injury.

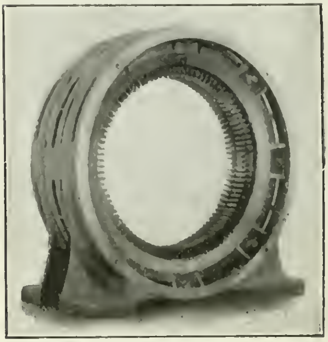

FIG. 334. STATOR FRAME OF ALTERNATOR SHOWN IN FIG. 333

The rotor, Fig. 336, consists of a solid steel casting forming the field magnet poles and hub in one piece. The field magnet coils *c*, etc., consist of flat copper strip or ribbon wound on edge or of square copper wire, according to the size of the machine. Each coil is compressed, baked into a compact unit and made to withstand heavy mechanical strain without injury.

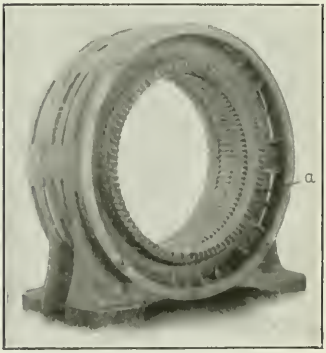

FIG. 335. STATOR OF ALTERNATOR SHOWN IN FIG. 333

The pole shoes *d*, etc., are of forged steel bolted to the ends of the poles. They are shaped to secure uniform distribution of the magnetic flux and also serve to retain the field magnet coils in place.

The exciting current is conducted to the rotor winding through cast iron col-

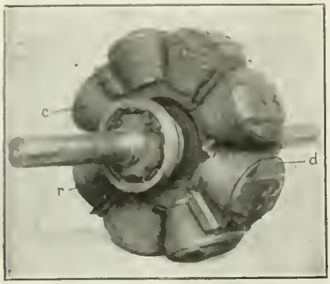

FIG. 336. THE ROTOR OF THE ALTERNATOR SHOWN IN FIG. 333

lector rings *r*, etc., and carbon brushes. The collector rings are located one on each side of the rotor, producing a very compact and symmetrical design. Each ring is supported on a cast-iron hub, from which it is thoroughly insulated, and the hub is mounted on the shaft.

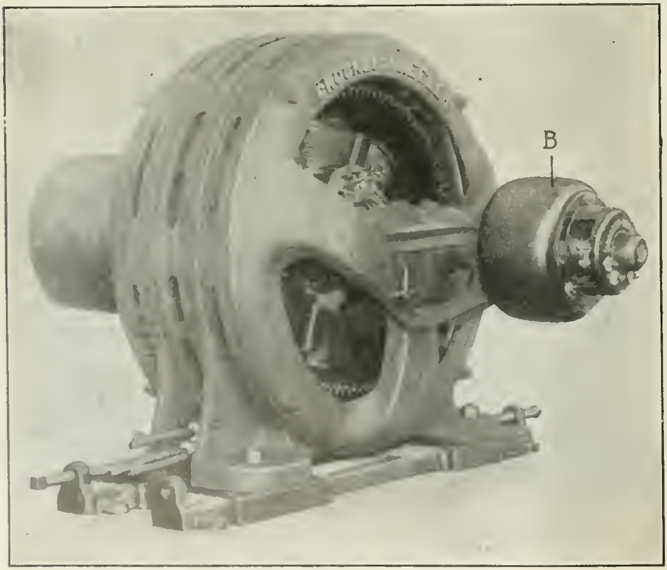

FIG 337 ALTERNATOR WITH DIRECT-CONNECTED EXCITER

The rotor and collector rings are mounted on a shaft of machinery steel which extends beyond the bearings at both ends for the driving and the exciter pulleys.

The bearings are of the ring-oiling type and have removable caps to facilitate the removal of the rotor. The journal boxes are of the sealed type so as to be free from oil slinging and dustproof.

The brush holders are of the radial type with adjustable spring tension and the brushes are self-feeding. The holders are mounted on brush yokes supported on insulated studs attached to the bearing frames.

Heavy slide rails, as shown in Fig. 333, are provided with each machine. These rails fit into accurately planed grooves in the feet of the machine and the belt tension is adjusted by means of adjusting screws.

1102 *What means are employed for exciting the field magnets of the alternator in Fig. 333?*

A 125-volt direct-current generator is necessary for this purpose. This may be an independently driven machine or it may be mounted on the alternator itself, as shown in Fig. 337, and driven by the alternator shaft.

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Failure of a flywheel usually begins by the starting of a minute crack on the under surface of the rim at the point of greatest stress, viz., near the ends of the arms adjacent to the rim joint. The cracks gradually deepen until failure occurs with all its disastrous consequences. These minute cracks are visible to an experienced eye, and careful inspection will aid materially in the prevention of flywheel explosions. In wheels built in sections, care should be taken to see that the bolts are drawn up to the proper tension.

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## Semi-annual Hearing of Massachusetts Board of Boiler Rules

The Board of Boiler Rules in connec tion with the Massachusetts Boiler In spection Department is obliged by la to hold meetings for public hearings c the first Thursday in May and Novemb of each year. At the hearing recent passed, complaints were made of the r quirements of the board with regard t hanging boilers over 78 inches in dian eter, which rule reads: "A horizontal r turn-tubular boiler over 78 inches diameter shall be supported, independe of the boiler side walls, from steel lu by the outside-suspended type of settin Where three supports are necessary each side of a boiler, an equalizer shall l used."

Previous rules simply said that su boilers were to be supported by the ou side-suspended type of setting and owne simply hung the boilers from chann bars running across the boiler wal gaining nothing by carrying the weig around through the channel bars letting the lug bear directly upon the w itself. The introduction of the wor "independent of the boiler side wall precludes this evasion of the purpose the rules.

One of the rules provides that "t temperature of the usual feed water e tering a boiler, except the boiler of steam fire engine, shall not be less th 120 degrees Fahrenheit when the pr sure allowed exceeds 25 pounds p square inch." The inventor of an a paratus for heating the feed supply f steam fire engines remonstrated agai their exemption from the rule.

The discussion turned largely upon t requirements of a manhole in the fr head and of the method of attachm of the through braces about this ma hole.

The rule requires that "A horizon return-tubular boiler having a manh below the tubes shall have one or m stays on each side of the manhole, t rear ends of which shall be attached the rear head of the boiler, and the fr ends shall pass out through the fr head and shall be secured with nuts side and out. The center line of st stays at the front head shall not be low the center line of the manhole."

Whether or not the hearing will productive of any revision of the ru is not yet determined, but unless so very weighty reason can be shown a change, they should be given a l and thorough trial as they are. Th have been evolved by a number of ye of practical application and by a bo made up of representatives of all classes concerned, and are beginning be looked to as of more than local terest and importance.

# Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think,
Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

## A Tank Level Indicator

e have a tank in our basement the of the liquid in which we must tinually watch, so we fitted it up with usual arrangement of a float with a re running over pulleys to an indi- r in the engine room. After having ble on account of the wire breaking, the float or indicator sticking. I put an indicator which gives perfect sat- tion and of which a description folws:

is a glass tube of about ⅛-inch bore l 1 foot or so longer than the tank is p. Glass tubes ordinarily come in 5- t lengths, and if the tank is deeper t at, two tubes can easily be welded t er over an alcohol lamp or gaso- l n torch, or they can be connected by of a short piece of tight-fitting r l r tubing. This tube is fastened in allow groove in a board painted wh and screwed to a convenient place n e wall. The top of this glass tube is l open or a loose plug of cotton wool erted to keep the dust out; to the n is cemented a ½x¼-inch coupling from which a ¼-inch pipe runs to part *C* to *D* and from there to the tank. Parts *C* and *D* are 1½-inch nipples about 3 inches long and closed on each end by a pipe cap drilled and tapped for the ¼-inch pipe. The distance between the bottom of *D* and the bottom of *C* is equal to 1/15 of the difference in hight between the bottom of *C* and the lower end of the glass tube. Before connecting the parts, fill the glass tube with water and let it run into a dish, then measure out two or three times this volume of mercury plus enough to fill the pipe connecting *C* and *D*. Pour this mercury into *C* and connect the parts as shown. *P* is a temporary pipe the top of which must be a little higher than the bottom of the glass tube. When all is done and while the tank is empty, open valve *V* and pour machine oil in *P* until it shows in the glass, making sure that there is no air trapped in the piping. Then close the valve *V* and remove the pipe *P*. Now, after making a mark on the board when the tank is full and another when it is empty and as many intermediate marks as you wish, you will have an indicator that is neat, reliable, and which will require no tinkering.

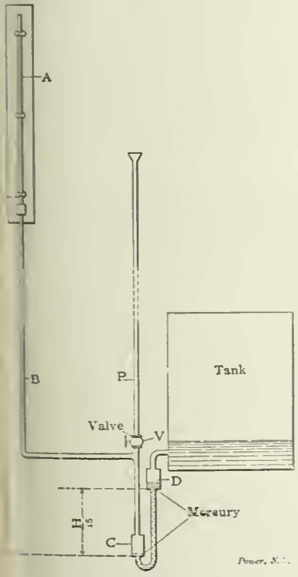


FIG. 1

The principle on which this indicator works is, of course, very simple and yet must be thoroughly understood to enable one to install it successfully. The specific gravity of mercury being 13.58 and the specific gravity of oil being about 0.9 it follows that mercury is about 15 times as heavy per unit volume as oil. Therefore, when the oil is poured into the filling pipe *P* the level of the mercury in the pipe connecting *C* and *D* will rise only about one-fifteenth as fast as the level of the oil rises in *P* and *B*, so that by the time the oil begins to show in the glass about half the mercury will have been forced up into *D*. Then valve *V* is closed and *P* removed. The mercury and the oil are now in equilibrium; any additional pressure on the mercury in *D* caused by the rising of the liquid in the tank forces some mercury from *D* into *C* and this necessarily causes the oil to rise in the glass tube. If the area of a horizontal cross-section of *C* and *D* were very large compared to the area of the bore of the glass tube, so that the glass tube would be full before there would be a perceptible diminution of the difference in level of the mercury between *C* and *D*, then the level of the oil would rise compared to the rise in the level of the liquid in the tank as the specific gravity of the oil is to the specific gravity of the liquid. If the liquid in the tank is water, then, if the indicator is made as directed, the rise of the oil in the tube will be very nearly equal to the rise of the water in the tank.

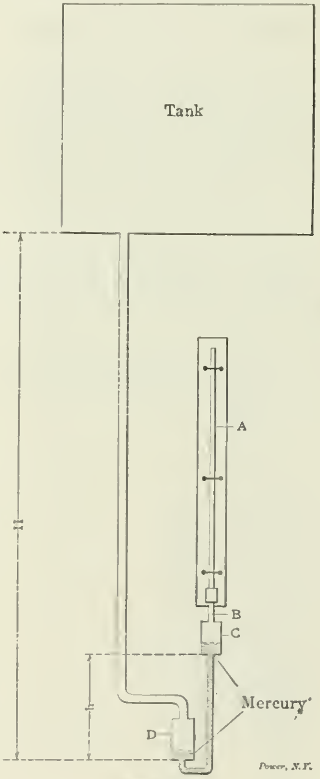


FIG. 2

In our case the tank is filled with brine (specific gravity 1.18) and a difference of 36 inches in the tank shows a difference of 38 inches on the indicator.

By a slightly different arrangement of the parts this indicator can also be used when the tank is higher than the indicator, as shown in Fig. 2. In this case *C* is higher than *D* and *C* is connected directly to the bottom of the glass tube. The difference in level between the bot-

[illegible] the bottom of *D* in this [illegible] depends upon the elevation of the tank and the specific gravity of the liquid it contains according to the formula

$$\frac{h}{H} = \frac{\text{Specific gravity of the liquid}}{\text{Specific gravity of mercury}}$$

$$h = \frac{H \times \text{Specific gravity of liquid}}{13.58}$$

If the tank is filled with water this becomes

$$h = H \div 13.58.$$

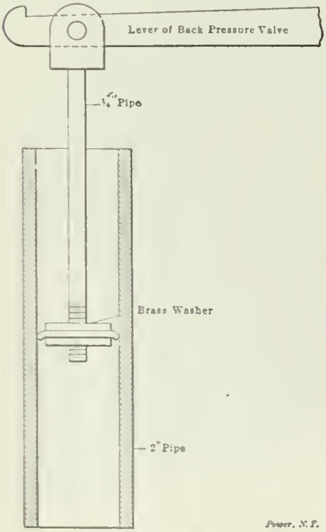
It might be asked why the relative hights of *C* and *D* are to be adjusted so carefully and the answer is that the more carefully this is done the less mercury will be required.

A. E. Mueller.

Mayville, Wis.

## Fixing a Back Pressure Valve

A back-pressure valve that rattled on its seat very badly was cured, as shown by the sketch, after numerous trials with balance weights and springs. This valve was placed on the exhaust line from three high-speed engines, about 8 feet from the floor. A piece of 2-inch galvanized pipe, open at the top and capped at the bottom, about 9 feet long was secured. A 2-inch hole was dug in the floor and the capped end of the pipe was put in plumb under the lever and cemented. This was done for convenience, there being no pillars or wall close enough to bracket the 2-inch pipe to. A piece of 2-inch pipe 2 feet long is just as good if it can be held securely under the lever. This makes the body of the dashpot to hold the water. A piece of ¼-inch galvanized pipe, with the fork from an old beam clamp, was attached to the lever with two pieces of ¼-inch brass plate, cut 3/16 inch smaller than the 2-inch pipe, and a leather intended for a pump regulator made the plunger. The action is as follows:



REPAIR TO BACK-PRESSURE VALVE

On the downward stroke the water with which the 2-inch pipe is filled is forced up the ¼-inch pipe, which must be open at the top. On the upstroke the water flows between the leather and the side of the 2-inch pipe. It did not vary the back pressure any or retard the movement of the lever, but brought it quietly to rest. The only attention necessary is a little water occasionally to make up the evaporation, and the main point in this case was that it saved the cost and time of installing an improved back-pressure valve which was necessary in this plant.

Harold James.

New York, N. Y.

## Water Required to Condense One Pound of Steam

The accompanying table is arranged to give the pounds of water required to condense one pound of steam under varying conditions of vacuum, temperature of condensing water and drop. This table is applicable to all types of steam-condensing plant, care being taken that suitable allowance is made for the "drop," which represents the drop in temperatu between that due to saturated steam any particular vacuum and the temper ture of the condensing water leaving t condenser. Suppose the vacuum temper ture equals 115 degrees Fahrenheit a the condensing water enters the co denser at a temperature of 60 degr Fahrenheit; also that the latter temper ture is increased during its passa through the condenser tubes by, say, degrees, thus leaving the condenser 100 degrees Fahrenheit. Then with vacuum temperature of 115 degrees a an average exit water temperature of degrees, the drop will be

$$115 - 100 = 15 \textit{ degrees.}$$

The drop in a condenser is depend upon the following items:

1. Pounds of steam condensed square foot of tube surface in a surf condenser.
2. Degree of vacuum carried.
3. Temperature of injection or c densing water.
4. Velocity of condensing wa through the condenser tubes.
5. Ratio of tube area to surface tube element.

the greater the heat-transmission ciency between the steam to be conden and the condensing water, the sma the drop becomes, with, of course smaller quantity of condensing water ing required. No definite rules can be given for ascertaining the correct to he allowed for, experience only h a guide as to how close to work to vacuum temperature.

POUNDS OF CIRCULATING WATER PER POUND OF STEAM CONDENSED.

| Vac. | Drop, Deg. F. | Injection Water Temperature, Deg. F. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 |
| 29.0" Vacuum. | 6 | 37.5 | 45.7 | 58.3 | 80.8 | | | | | |
| | 10 | 42.8 | 55.3 | 75.0 | | | | | | |
| | 12 | 47.8 | 61.8 | 87.5 | | | | | | |
| | 15 | 55.3 | 75.0 | | | | | | | |
| | 18 | 65.7 | 95.5 | | | | | | | |
| | 20 | 75.0 | | | | | | | | |
| 28.5" Vacuum. | 6 | 25.6 | 29.2 | 33.9 | 40.3 | 50.0 | 65.7 | 95.5 | | |
| | 10 | 28.1 | 32.8 | 38.9 | 47.8 | 61.8 | 87.5 | | | |
| | 12 | 30.0 | 35.0 | 42.0 | 52.5 | 70.0 | | | | |
| | 15 | 32.8 | 38.9 | 47.8 | 61.8 | 87.5 | | | | |
| | 18 | 36.2 | 43.8 | 55.3 | 75.0 | | | | | |
| | 20 | 38.9 | 47.8 | 61.8 | 87.5 | | | | | |
| 28.0" Vacuum. | 6 | 21.5 | 23.9 | 26.9 | 30.9 | 36.3 | 43.8 | 55.3 | 75.0 | |
| | 10 | 23.5 | 26.3 | 30.0 | 35.0 | 42.0 | 52.5 | 70.0 | | |
| | 12 | 24.4 | 27.7 | 31.8 | 37.5 | 45.7 | 58.3 | 80.8 | | |
| | 15 | 26.3 | 30.0 | 35.0 | 42.0 | 52.5 | 70.0 | | | |
| | 18 | 28.4 | 32.8 | 38.9 | 47.8 | 61.8 | 87.5 | | | |
| | 20 | 30.0 | 35.0 | 42.0 | 52.5 | 70.0 | | | | |
| 27.5" Vacuum. | 6 | 18.1 | 19.8 | 21.9 | 24.5 | 27.6 | 31.8 | 37.6 | 45.7 | 58.3 |
| | 10 | 19.5 | 21.5 | 23.9 | 26.9 | 30.9 | 36.3 | 43.8 | 55.3 | 75.0 |
| | 12 | 20.2 | 22.4 | 25.0 | 28.1 | 32.8 | 38.9 | 47.8 | 61.8 | 87.5 |
| | 15 | 21.5 | 23.9 | 26.9 | 30.9 | 36.3 | 43.8 | 55.3 | 75.0 | |
| | 18 | 22.9 | 25.6 | 29.2 | 33.9 | 40.3 | 50.0 | 65.7 | 95.5 | |
| | 20 | 23.9 | 26.9 | 30.9 | 36.3 | 43.8 | 55.3 | 75.0 | | |
| 27.0" Vacuum. | 6 | 16.1 | 17.8 | 19.5 | 21.5 | 23.9 | 27.0 | 30.9 | 36.2 | 43.8 |
| | 10 | 17.5 | 19.1 | 21.0 | 23.5 | 26.3 | 30.0 | 35.0 | 42.0 | 52.5 |
| | 12 | 18.1 | 19.8 | 21.9 | 24.4 | 27.7 | 31.8 | 37.5 | 45.7 | 58.3 |
| | 15 | 19.1 | 21.0 | 23.5 | 26.3 | 30.0 | 35.0 | 42.0 | 52.5 | 70.0 |
| | 18 | 20.2 | 22.4 | 25.0 | 28.4 | 32.8 | 38.9 | 47.8 | 61.8 | 87.5 |
| | 20 | 21.0 | 23.5 | 26.3 | 30.0 | 35.0 | 42.0 | 52.5 | 70.0 | |
| 26.0" Vacuum. | 6 | 14.0 | 15.0 | 16.2 | 17.5 | 19.1 | 21.0 | 23.4 | 26.3 | 30.0 |
| | 10 | 14.8 | 15.9 | 17.3 | 18.8 | 20.6 | 22.9 | 25.7 | 29.2 | 33.9 |
| | 12 | 15.2 | 16.4 | 17.8 | 19.5 | 21.5 | 23.9 | 26.9 | 30.9 | 36.3 |
| | 15 | 15.9 | 17.2 | 18.8 | 20.6 | 22.9 | 25.6 | 29.2 | 33.7 | 40.3 |
| | 18 | 16.8 | 18.1 | 19.8 | 21.9 | 24.4 | 27.7 | 31.8 | 37.5 | 45.7 |
| | 20 | 17.2 | 18.8 | 20.6 | 22.9 | 25.6 | 29.2 | 33.9 | 40.3 | 50.0 |

To explain the application of the table, assume that a surface condenser has to be supplied to meet the following conditions and that it is required to give the pounds of water necessary per pound of steam: Amount of steam, 10,000 pounds per hour; vacuum, 27 inches, with barometer at 30 inches; condensing water at 60 degrees Fahrenheit. With these conditions a drop of 15 degrees may be safely assumed. Upon referring to the author's table 1, on page 63 of the July 13 number of POWER, the temperature corresponding to a vacuum of 27 inches will be found to be 115 degrees Fahrenheit. With a drop of 15 degrees the condensing water will leave the condenser at a temperature of 100 degrees Fahrenheit. If now the accompanying table is referred to under the section marked 27 degrees vacuum and the line marked 15 degrees drop in the 60-degree injection-temperature column, the figure 26.3 will be found. This means that for every pound of steam to be condensed per hour, 26.3 pounds of condensing water at 60 degrees Fahrenheit will be required. As 10,000 pounds of steam are to be condensed per hour, this will require

$$10{,}000 \times 26.3 = 263{,}000$$

pounds of water per hour, or

$$\frac{263{,}000}{8.33 \times 60} = 526$$

United States gallons per minute.

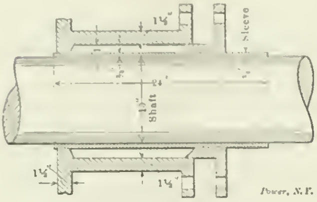
W. VINCENT TREEBY.

Ilford, Essex, Eng.

## Preventing Shaft Wear in Centrifugal Pumps

Calculating the stresses in the shafts of two large direct-connected centrifugal pumps being installed, it was discovered that the shafts had been given a load in excess of that for which they were intended, caused by a change in the dimensions of the flywheels. The shafts were 10 inches in diameter by 12 feet between journals. As the water to be handled carried a large amount of sand, it was feared that the shafts would suffer from cutting as it was evident that a small amount of wear on the shafts would so weaken them that expensive repairs would soon be necessary. As the pumps and engines had already been erected it was decided to use the shafts as they were. Calculations showed that the shafts were strong enough to carry the load if no wear occurred, and the following plan for avoiding wear was adopted, which might be applied to advantage in similar cases:

The size of the shafts was taken, and cast-iron sleeves were made to fit. The sleeves were bored and turned; those on the outer ends of the shafts were made small enough to shrink in place The sleeves which were to go on the shafts between the engine and the pump were made in halves, and fastened in place with ¼ inch screws. The screw holes being so distributed that they weakened the shaft only 1 or 2 per cent, it was estimated from experience with other pumps handling the same sort of water that a very few weeks' wear would exceed that amount if the sleeves were left off. The casings and glands were bored to permit the sleeves to go through them, and the size of the stuffing boxes increased to allow the use of the 1-inch packing originally intended and the glands were made correspondingly larger. This arrangement enabled the use of the shafts indefinitely, for whenever the sleeves became worn it was an inexpensive job to fit new ones.



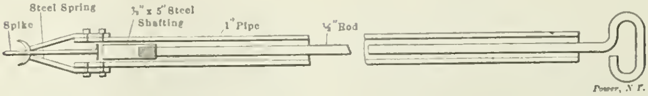
CAST-IRON PROTECTING SLEEVE

H. R. MASON.

Cape Girardeau, Mo.

## Driving Spikes in Ceiling

A simple device for driving spikes or placing bolts into holes in the ceiling or other unreachable positions may be readily constructed, as shown in the sketch. Two pieces of flat spring steel are fastened to one end of a piece of 1-inch pipe about 6 or 8 feet long. A hammer is made from a piece of steel suitable for tempering. A ½- or ⅝-inch rod is screwed into this hammer and extends far enough out of the other end of the pipe to form a handle. The ends of the springs are turned out and pointed, so that they will hold into the wood as the tool is held up, and thus guide the nail or spike while driving, even if the head is considerably smaller than the inside diameter of the pipe.



DEVICE FOR DRIVING SPIKES IN CEILING

GEORGE G. MCVICKER.

North Bend, Neb.

## School House Heating

I am operating a Brice plant heating and ventilating two school houses with 20 rooms each, nine of which are about 40x40x16 feet; the rest are smaller. The power house is 150 feet from the buildings, and the steam is conveyed underground. I have 8 pounds pressure on exhaust-steam coils, and 15 pounds on direct-steam coils and carry 30 pounds steam pressure on boiler and engines. I burn from 2 to 2½ net tons of the best soft coal in 10 hours, and think that I am burning too much coal. I have been after the school board to place a reducing valve on the pipe to the engines so that I could carry 60 pounds on the boiler and 30 pounds on the engines, which is all the pressure they are allowed. I think it would be cheaper to carry 60 pounds on the boilers than 30 pounds. As there are no governors on engines I fire so as to carry only 30 pounds pressure.

The thermostat is run by an air-water motor which controls the heat in the heating and ventilating chambers.

Will a higher boiler pressure, say, 60 pounds or more, help matters?

WILLIAM GELLENDEN.

Ionia, Mich.

## An Engineer Goes Farming

I have quit engineering and taken up a claim of 320 acres of land which will pay me better at the end of five years than working at engineering for the same length of time. But I must have POWER so I can read and keep up with the times. I don't want to be like a great many that call themselves engineers and are running engines here. I saw one 25-horsepower traction thresher engine that only exhausted at one end of the stroke, and the engineer was happy as a lark just as long as the wheel would make a complete revolution. Another engineer could not babbitt a small bearing, and had to lay up two days until a new box came from the factory. Still another could not set a common slide valve or calk the flues, and a certain engineer did not know the reason for his oil pump not working and had to shut down for half a day until he got a lubricator, when the pump plunger needed packing only.

I have made up my mind to drop out of the craft here and take a back seat. This State has a license law, but it is not enforced as strictly as it should be If it was, there might be a better class of engineers here. BERT A. FOX.

# Subjects Under Discussio

Comment, Criticism and Debate upon Various Articles, Letters and Editorials Which Have Appeared in Previous Issues

BRING OUT YOUR IDEAS

## Compression Outside of the Main Cylinder

In the October 19 number Mr. Westerfield, in commenting on my article in the September 21 number, makes the statement that it would not be safe to reduce clearance to an extent less than that usually allowed on account of the danger of the piston coming loose on the rod and hitting the cylinder head, and that with the compression outside of the steam cylinder the piston would strike the head as soon as the nut had begun to work loose; while with the compression in the steam cylinder it would be prevented from striking the head until the nut had probably slackened enough to allow the piston to come off the rod.

It is very easy to see what would happen to the engine in case the piston did come off the rod, and it would seem that the small clearance, with compression outside of the steam cylinder, would be a benefit instead of a detriment in this respect, as the attention of the engineer would be called to a loose piston as soon as the nut had started to come loose, and it could be remedied before any possible damage was done.

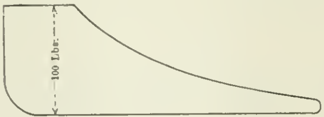
In any event the possibility of a loose piston with engines of modern design is too remote to need to be considered, and there are probably not many engine builders who would care to admit that they would not dare to reduce the clearance on account of the danger of a loose piston.

As to Mr. Westerfield's statement, "with engines of good design and proper attendance, that there is very little danger of getting water in the cylinder," the large number of accidents to engines in large plants in various parts of the country in recent years, where the attendance was of high order and the engines of first-class make, will hardly bear him out. The fact that practically all modern engines are equipped with relief valves would indicate that the builders anticipate danger from this source.

If Mr. Westerfield will take the time to look up some of the recent tests, in which all records for economy were broken, he will find that the engines which made these records were designed in a manner that allowed the clearance to be reduced to a point a great deal less than is usually allowed. The engines which showed the greatest economy, in addition to having very small clearance, were also equipped with tail rods; it is only reasonable to suppose that these features aided materially in the results obtained.

He states that the purpose of compression in the steam cylinder is to bring the reciprocating parts to rest without shock or jar, and to fill the clearance space with exhaust steam instead of having to fill it with the live steam from the boiler. He might have stated further that the compression of the exhaust steam is also supposed to return to the exposed surfaces a portion of the heat which had been extracted from them by contact with the exhaust steam at its relatively low temperature.

There is a considerable number of engineers who do not agree that compression of any kind is necessary in the case of slow- or medium-speed engines, and it must be admitted that they seem to be getting along very well without it too.



Power, N.Y.

Leaving out of the question the cushioning of the reciprocating parts, does compression, as generally given to engines, really serve the purpose of filling the clearance and returning heat to the surfaces to any practical extent?

Considering the accompanying diagram as being taken from an engine running at 100 revolutions per minute, the amount of compression shown is about what is usually allowed in practice. The time from the moment the exhaust valve closes for compression until the piston has reached the end of the stroke is only about 1/50 part of a second. As this pressure is only run up to about 33 pounds, the amount of heat transferred to the exposed surfaces in the short time that the compressed steam is in contact with them will amount to practically nothing; while its value in filling the clearance space amounts to very little also, as there still remains two-thirds of the space to be filled by the live steam from the boiler.

If the exhaust valve were closed early enough to run the compression press up to boiler pressure, the negative w done in the cylinder would probably set the gain many times, and also ca the engine to run badly.

S. Kirl

New York, N. Y.

## Engineers' Wages

It is a sad reflection upon the me status of engineers when it is left to editor of Power to take up the cu for them in the cause of wages. editorial on the subject of "Engin Wages," in the November 2 issue timely and should strike a respon chord in the minds of a large numbe readers.

It is surprising that a large part class of men whose vocation calls such a wide variation of practical kn edge should display such a lack of terest as to the pay they earn, but not get.

On every side one sees this and craft gaining an increase in wages, sh hours and better conditions all aro Is it because the bricklayer or the st fitter has studied more than the engi or is it because they have worked lo or harder for their experience, or cause their business requires more telligence than that of the engineer perhaps it is because they have a lic fee to pay which the engineer does or because they have more expe tools, to buy, even though accordin some persons every engineer should a complete library of mechanical, el cal, chemical and other works, as as "own tools and indicator, bes references, etc.?"

Bosh! Fol de Rol! Likewise poppyc To all these questions the answer is and it requires no thought to see conditions are directly opposite, and they exist.

You may say most engineers steadily the year round. So do most h but I have never known of one t fed less on that account.

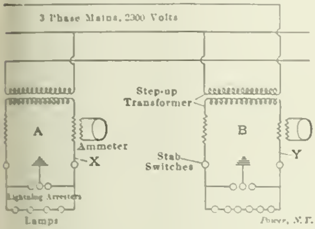
The better-paid craftsmen have no maudlin talk of self-improveme their argument, but have demande better pay and obtained it.

P. J. Qu

New Haven, Conn.

## Transposed Transformer Connections

The experience of Mr. Carl with transposed transformer connections, as told on page 502, under the heading, "What Caused the Lights to Go out?" seems to me to offer an opportunity for some exceedingly interesting speculation and



THE GROUNDED ARC CIRCUITS

tudy in alternating-current phenomena, solution of which cannot fail to be pful to every engineer and electrician ving to do with systems of this kind. e problem appears to be comparatively ple, at first glance, but the deeper the alysis, the more complex it becomes.

In the first place, the interchange of ads at *X* and *Y* put the secondaries of e two transformers in series, which turally resulted in double the normal tential being built up in the combined rcuits, with all stab switches in and the l arc-lamp load on. This is proven by e fact that the lightning arresters flashed en the circuit was closed through the b switches on circuit *B*. The potential the secondary circuit must have been fficiently high to break down the resistance of the air gaps in the arresters, r the latter would not have flashed over ground. Another convincing evidence at the potential was abnormally high the fact that grounds showed up on system that had hitherto given no uble.

I hear someone ask, "What were the lators doing all this time?" I answer question by calling attention to the t that we are facing an unusual conn. The mere fact that the ammeter ircuit *A* showed but two amperes is another evidence that an abnormal ge was present, and the regulators re prevented from performing their per function. In reasoning along this , I am assuming that the stab switches ircuit *A* were inserted first, and that lights on this circuit lit up, temrarily at least. With the insertion of h switches on circuit *B*, the two circits being in series through the transsed connections at *X* and *Y*, the latter ed as an equalizer connection, causing t ammeters to indicate the combined perage of the two circuits. There is l-dly any doubt that, had the stab switches on circuit *B* been inserted first, the ammeter on that circuit would have shown 2.6 amperes, or the difference between the indication on ammeter *A* and the combined amperage of both circuits.

As to the contention of the first electrician that the circuit was open, this would be true, so long as the stab switches on circuit *B* were out, were it not for the grounds which developed on the circuits, which, doubtless, were opportunely located so as to partially bridge the stab-switch connections, and were of sufficient capacity to pass enough current to energize the magnets of the arc lamps to bring the carbons together, and thus, temporarily, at least, strike the arc and cause them to light up.

The moment all stab switches on both circuits were inserted, the circuit was closed, throwing the secondaries of the two step-up transformers in series, building up the voltage to twice normal, as before stated, causing the arresters to flash over to ground, and the accidental grounds to show up. This is where the contention of the second electrician becomes true; so that, from my point of view, both electricians were partially right and partially wrong.

As to what caused the arcs to light up and go out, this might be ascribed to one or more of several causes. Let us not lose sight of the fact that our series circuit was connected to two phases of a three-phase system. These two phases were consequently 120 degrees apart in phase. Therefore, we must assume that, at a certain instant, there must have been a condition of no voltage in the circuit, demagnetizing the arc-lamp magnets and causing the arc to fail. Then again, the current that was passing through the high resistance of the grounds may not have been of sufficient volume to permanently magnetize the arc-lamp coils, resulting in the arc being struck momentarily only. The lamps could get their normal voltage without difficulty, but there would not be sufficient current to keep the lamps permanently in operation.

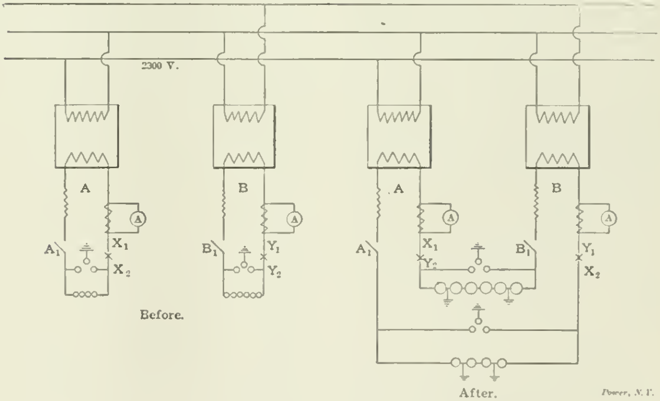
A. P. H. Saul.

Buffalo, N. Y.

Herewith are two wiring diagrams, one similar to that presented by Mr. Carl, and the other of the switching after the leads had been reversed. The only trouble that I can find in the circuit is caused by the grounds that I have represented. If there were no grounds the ammeter would not register with the circuit open, nor would the lights have gone out when the second switch was closed, unless the resistance of one set of lamps were greater than the other, which would have lowered the current supply to the capacity of the smaller lamp. Nor would there have been any flashing on the lightning arrester.

Upon changing the diagram we find that we have a plain open delta circuit (connecting $X_2$ to $Y_1$ and $Y_2$ to $X_1$), but instead of their being a neutral between the transformers, we have six arc lamps in series on the same.

The various grounds are located between the lamps, for if they were not and there was no lamp between the grounds and the transformer, a short-circuit would occur when the switch is closed. The grounds being slight, enough current is carried from one ground to another, but not sufficient voltage, to light the lamp; yet the ammeter will show a reading of this current. If the grounds were good the light would have burned all right. When the switch *B* is closed each ammeter carries the same load, because each instrument has the same relation to the circuit; that is, there will be no more current go through the four lamps than their capacity, and the six lamps will be moderated to that capacity.



WIRING DIAGRAM OF ARC CIRCUITS

The fusing of the lightning arrester was caused by the surge in the line through the permanent grounds of the primary and the temporary grounds in the circuit.

If in the circuit of one transformer, say, two or three grounds are located, as long as they are in the lighting circuit the resistance of one or more lamps is sufficient to keep the ground from showing up. One or two lamps may be cut out entirely by grounds and still not affect the lamps as long as they are for the same voltage as the transformer is producing. But when grounds are located in different circuits, that is, when the grounds of one affect those of the other, there is going to be trouble with the lights, for these grounds are of various kinds, and in burning loose or swinging to ground, keep cutting in and out various portions of the lines and lamps, and a heavy surge of current through the lamps will open that light and close it again to take a less flow of current.

WELDY S. YEAGER.

Colgate, Cal.

## How Changing Shifts Wastes Money

During my 15 years' experience around steam plants, I have always noticed that the fireman, when well paid for his services, tries to do as near right as he can in the boiler room.

I recall to mind a position I held for two years, about 14 years ago, as head fireman of a battery of seven boilers, hand fired. In the summer months it was a good job. During the winter months it was a little harder than some men care to hold down. We had to crowd the boilers hard and do our best firing to keep up the required steam pressure. When we failed, within 10 or 12 pounds the whole outfit knew what was the trouble, and someone would come down to the boiler room and proceed to cuss the firemen.

At no time during the two years I was there do I remember of putting a ton of coal on the fires at one firing, as Mr. Whitham states in his letter; if we had, the mill would have been down inside of 30 minutes.

In this plant we changed shifts at 7 in the morning and 6 at night, requiring 11 hours for the day shift and 13 at night. When the time arrived to wash up, the assistant fireman and ash wheeler got ready to go home, while the head fireman kept up steam; then the two would look after the fires while the head fireman was cleaning up. About this time the opposite shift would come in, and by the time one head fireman was ready to go home, the other was ready to take his place.

If Mr. Whitham and his clients would go into a boiler room of 1000 horsepower, with the plant in need of one more boiler, and fire through the winter months, they would, on the first day of April, get a different view of the case. Did anyone ever see a good fireman that was overpaid? Ten hours is a day's work in Michigan; how many hours is a day's work in Benjamin Franklin's State? Most firemen work 12 hours a day. There is surely something wrong and "My Clients" must be put next.

A. J. HAIGHT.

Kalamazoo, Mich.

## Exciter Trouble

Regarding James A. Walker's exciter trouble, from the information he gives, I think he will find that the commutator is partially short-circuited all around from bar to bar, as this would cause a strong current to be set up through the local circuit provided by the coils themselves, the commutator bars to which their ends are attached and the defective insulation between these bars. I also believe he has too much tension on his brushes. He may be able to get rid of the short-circuits by taking a deep cut from the commutator and if this does not remedy the trouble, he can try a good commutator.

WILLIAM T. GARLITZ.

McKees Rocks, Penn.

## Proper Amount of Lead

In the September 28 number, page 540, Sydney A. Reeve in referring to my letter on the proper amount of lead, states that I did not take into consideration the thermodynamic principle involved. This is true, as I had in view only the mechanical operation of the engine. I do not agree with him, however, that the engine should use more steam when set to take the card showing the later admission, than in the other case where the admission is early.

The amount of the surface exposed to the entering steam will be the same in either case, and as long as the compression remains constant the amount of heat absorbed should remain the same. In either case the space between the piston and end of the cylinder will be filled with the steam at boiler pressure by the time the piston has traveled the short distance necessary for the crank to have reached the point shown, and even if the full pressure was brought onto the piston earlier, it would have practically no effect in transmitting the power to the shaft before the crank had reached this point, which is about 15 degrees past the center.

The only cause for any more loss that I can see possible with the later lead, is the slight loss which might be due to wire drawing as the piston moved forward the slight distance which it does before the full boiler pressure is reached.
What little loss there is in this way I be
lieve would be much more than offset b
the gain in reduction of friction, oil, an
wear on the bearings.

The amount of lead necessary to giv
the valves to produce this result woul
of course, vary greatly with different en
gines. An engine having large port are
small clearance, and quick-acting valve
would probably not require any, especia
ly if the compression was run up withi
½ or ¾ of the boiler pressure; whil
one with large clearance, slow-actin
valves, or relatively high speed, would r
quire a large amount.

As to the reason for giving lead, I b
lieve that too much of it has been give
in most cases for the sake of getting
nice-appearing diagram, and also becau
we have generally considered that the a
mission and steam lines must form a rig
angle at their junction in order to
correct. I have known of a number
cases where the lead was reduced to
large extent and the result was smoo
running, where the engines could not
made to run quietly with early lead, ar
no increase could be noticed in the stea
consumption.

The test on which this letter was bas
was made by the writer several years ag
and, while there were no facilities f
making an accurate test as to the diffe
ence in steam consumption with the di
ferent amount of lead, I am certain th
there was no more fuel used with t
later lead, and the engine ran mu
better.

As to the amount of heat lost in c
inder condensation in a simple nonco
densing engine, I do not know that I ha
ever seen any data on it. It is certai
however, that it is a large source of lo
This fact was brought to my attenti
recently by getting about all of the co
densation of one stroke down the back
my neck as I was passing under the e
of the exhaust pipe which projected out
the side of the engine room. I ma
a number of observations on the su
ject of condensation during the next f
minutes, but none of them would har
be fit for publication.

If it were possible to make the c
inder, piston and valves of an engine
a material having the same noncondu
ing qualities as asbestos, with the nec
sary strength and wearing qualities, w
effect would it have on the economy?

It is hardly likely that any such m
terial could be found, but it seems p
sible, however, that the sides of the p
ton and the faces of the cylinder hea
which are exposed to the action of
steam, could be faced with some fo
of asbestos, or other nonconducting m
terial, which would reduce the loss fr
condensation to a large extent, especia
in the case of an engine having a la
cylinder diameter in proportion to
length of stroke. The area so protect-

in this case would be a large percentage f the total area exposed to the action f the steam.

S. Kirlin.

New York, N. Y.

## Power Required for Working Centrifugal Pumps

During the last year the question, why a centrifugal pump requires more power when working against a low head, came several times, and many engineers re puzzled in finding the right answer. s has suggested the idea to me to pub- ne of the pages from my notebook relates to this subject.

A centrifugal pump at a constant speed ires more power as the head de- ases, because the amount of water de- red increases in greater proportion n the head decreases. By increasing head while the speed remains con- nt we will come to a point where the p ceases to deliver any water. The d at this point will balance the pres- re at the pump and the load on the ip will be a minimum, the pump ply churning the water in the volute. Let us figure out the work done by a mp which has tangential velocity of o feet per second and which is work- g first against 100-foot head and then -foot head. The water-leaving vanes ll have a velocity of 100 feet per nd; the velocity at discharge

$v$ — (*at the head of* 100 *feet*) =

$0 - \sqrt{2gh} = 100 - \sqrt{2 \times 32.16 \times 100} =$

19.8 feet per second.

$v_1$ — (*at the head of* 50 *feet*) =

$00 - \sqrt{2gh} = 100 - \sqrt{2 \times 32.16 \times 50} =$

43.3 feet per second.

The discharge in the first case will be,

— (*quantity*) $= \frac{Tid^2}{4} \times 19.8$ cubic feet per second.

the second case

— (*quantity*) $= \frac{Tid^2}{4} \times 43.3$ cubic feet per second.

Now, $\frac{Q_1}{Q} = \frac{43.3}{19.8} = 2.19$ or, at the head 50 feet more than double the quantity liquid will be delivered.

The work done will be, in the first case:

$= \frac{Tid^2}{4} \times 19.8 \times 62.4 \times 100$ foot-pounds.

the second case

$= \frac{Tid^2}{4} \times 43.3 \times 62.4 \times 50$ foot-pounds.

king the ratio we will find

$= \frac{Tid^2 \times 43.3 \times 62.4 \times 50 \times 4}{4 \times Tid^2 \times 19.8 \times 62.4 \times 100} = \frac{43.3}{39.6} =$

09; thus we see that pumping the water ainst 50-foot head, 9 per cent. more rk will be done and consequently 9 r cent. more power will be required.

In the preceding figures the friction of water in pipes was not taken into consideration, neither the slippage, but these are factors which tend to increase the load on the pump still more as the head decreases.

Edward C. Lange.

Kewanee, Ill.

## Steam Boiler Construction Laws

The recent steam-boiler explosions at the Pabst brewery, Milwaukee, Wis., and at the Amoskeag Manufacturing Company, Manchester, N. H., emphasize the need of stringent laws governing the construction as well as the operation of steam boilers. Boiler explosions are of frequent occurrence and each illustrates some cause. Far too often they are shown to be due to faulty construction. The old-time excuse of low water has given way to analysis, with the result that we are gradually eliminating many serious defects in construction.

In the account of the Pabst explosion it would seem that the construction of the drums was faulty in the tube-sheet reinforcing plate. In the Amoskeag explosion the fact that the tubes were not beaded shows poor construction. The practice of simply expanding the tube was advocated years ago by numerous engineers and boilermakers who believed that the holding power of a properly-expanded tube was more than sufficient to properly stay the tube sheet and that beading injured the tube end. However, practice has conclusively proved that the method was not right, as tube sheets bulged and even gave way because of improper expanding. Therefore, common practice has been for many years to bead the end of fire tubes and to flare the ends of water tubes. This is made compulsory by law in some cases, and is required by boiler-insurance companies before they will accept a risk.

The holding power of a properly expanded tube is sufficient, but are they always properly expanded? As long as no leak shows the work is generally considered properly performed. However, as tests show a variance of about one-third in the holding power of an expanded tube where the work was apparently properly performed, it is safe to assume that the variation is even more with ordinary shop work. Tests show that where the tube is beaded, its holding power is greatly increased. This established fact goes further than an unsubstantiated theory. The necessity of having suitable laws passed in all States to prevent faulty construction is absolute, because it is necessary to contend with ideas of owners and those having in charge steam boilers that fail to measure up with what has been proved to be correct practice.

The lack of shop inspection, such as is provided by law in Massachusetts, or proper supervision by a boiler-insurance company, may be set down as one reason for these deplorable accidents.

T. N. Kelsey.

Lowell, Mass.

## Flat Crank Pins

If Mr. McLaren will read my letter again, very carefully, he will find that I did not say a word about flat crank pins. I quoted an abstract statement from Mr. Taylor's letter and discussed certain phases of the theories involved, not to refute the argument offered concerning the cause of flat crank pins, but to call attention to the fact that there are other than steam forces acting on the crank pin of the ordinary reciprocating engine.

The force exerted on the piston by the incoming steam is modified by the inertia of the reciprocating parts and, as stated in my former letter, "The slow-moving engine, having light reciprocating parts, will receive the maximum pressure at the crank pin much earlier than will be the case with the high-speed engine having relatively heavy parts."

Would Mr. McLaren have us believe that only one engine in 5000 is affected by the force of inertia?

His "fair question" is answered by the diagrams he shows with the attached data. Comparatively high initial pressure, low rotative speed and usually, with that type of engine, light moving parts is a combination that will flatten any crank pin unless the valve setting is such that the steam-hammer effect is softened as much as may be practicable.

Mr. McLaren admits that a tandem-compound engine will receive more even distribution of pressure at the pin than will be the case with the engine having only one piston to the crank. This seems to corroborate my argument wherein I mentioned those engine builders who add weight to the moving parts of their engines in order to equalize the forces acting on the crank pin.

In the April 11, 1889, issue of the *American Machinist*, there are shown three "force diagrams," one each from a Ball, a Buckeye and a straight line engine—if these cuts could be reproduced for the readers of Power it would show what engine designers were doing along this line in those days.

I do not think that Mr McLaren takes the right attitude in saying that "everyone knows," etc. To my mind, the science of steam engineering is so fathomless in its scope and so far reaching in its ramifications that the everyday chap who is just getting into deep water, in his studies, is likely to be discouraged when he discovers that he does not grasp, at all, what Mr. McLaren would have us believe it is a subject that is altogether too simple to warrant discussion.

If all engines were slow speed with light reciprocating parts, or if, as Mr. Mel[illegible]ret infers, "everybody knows" all about the physics in the case, there would be no valid reason for criticizing Mr. Taylor's letter; but the young fellow, from reading the letter referred to, would naturally come to believe that in all engines the force exerted on the piston is immediately felt at the crank, which obviously is not true.

E. G. Tilden.

Downers Grove, Ill.

## Follower Bolts

Professor Sweet, in the November 2 issue, has taken exceptions to my article on follower bolts, which appeared in the October 12 issue.

To the writer it appears that we are both in error in not stating more explicitly the conditions under which the respective types of bolts have been successfully tried.

The type of bolt, as described by the writer in the October 12 issue, was designed, primarily, for heavy-duty work, such as on large mill engines, and it has proved the most successful bolt ever tried in our works for large reversing engines. One engine, in particular, a 55x60-inch horizontal twin condensing engine, running as high as 250 revolutions per minute, with a subsequent piston speed of 2500 feet per minute and reversing in less than five revolutions, gave considerable trouble by having nuts work loose and studs leaking. The stud as shown and described by the writer has met this severe strain very satisfactorily.

The writer agrees with Professor Sweet that for comparatively small engines running "straight away," such as Professor Sweet's "Straight Line," the type of bolt as shown by him will prove satisfactory.

In fact, we have had a "Straight Line" engine in our plant for the past 12 years, and I can verify the professor's statement by saying that we have never encountered any trouble with the bolts, which is truly a creditable record.

But for large and heavy work, such a type would prove impractical. One of the chief difficulties would be the working loose of the brass nut. The stud being made of steel and the nut of brass, the difference in expansion under high working temperatures would be marked. When the piston is assembled the nut may be perfectly tightened, but the brass nut expanding more than the steel stud, the tendency would be to loosen the nut. Once started the nut would surely work off, and if the clearance in the engine cylinder was not sufficient, damage to the engine would surely result. Even in the case of a steel nut in a steel stud it is always deemed advisable to lock the nut with a cotter pin. The experience of Professor Sweet with the "Straight Line" is sufficient proof that his type of stud will answer for the purpose for which it is designed.

Each type of stud has its merits, but they are adaptable to entirely different classes of work.

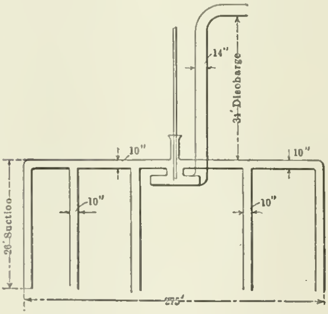
N. L. Daney.

Elyria, O.

## Will a Centrifugal Pump Do the Work?

L. Corwin, in the September 21 issue, asks the above question. I will give him my experience. I have been operating a 10-inch vertical centrifugal pump with 405 feet of 10-inch suction line and a 26-foot suction lift and find that the pump will hold its priming for 48 hours. In priming we operate the primer until the water rises into the horizontal pipe, then we start the pump and it primes itself in 15 to 30 minutes.

When other methods of stopping air leaks on the suction line fail, we apply portland cement mixed to the consistency of batter to the joints and bolts.



Power, N. Y.

WATER-LEVEL DIAGRAM OF PLANT

For lifts of over 70 feet, I think a two-step pump will give satisfaction.

W. N. Gulick.

Tustin, Cal.

## Saving by Throttling Steam

In the issue of November 2, it is suggested that I have mixed up B.t.u. and degrees Fahrenheit, in speaking of superheating steam.

There is another point that should not be lost sight of and that is, the specific heat of steam. My object was to bring out the difficulty of superheating steam.

While taking half-hourly readings of superheat, my assistant noted that a reading showed only 7 degrees and he went out to the boiler room and saw the fire men had most of the boilers filled witl water to nearly the top of a 12-incl glass gage. Lowering the water leve to, and keeping it at, one gage raisec the superheat over 60 degrees.

When feeding the boilers by hand regulation, there was a wide range in superheat.

With water taken care of by a first class feed-water regulator the superhea was kept uniform.

The difference in per cent. of moisture at different water levels could no have been serious, but it made a grea difference in the superheat as measurec by degrees.

The superheater was in direct line o the fire in passing from the furnace t the stack.

From my experience with superheatin steam I have become a little cautiou about saying steam is superheated unles I have some way of demonstrating tha it is an actual fact.

W. E. Crane.

Broadalbin, N. Y.

## Gas Engine Indicating Cap

The writer was pleased to see th article by Mr. Eyerman on gas-engin indicating. I wish we could have mor As the two engines I had in charge wer both of the older type I knew the diagrams were not uptodate, and could b improved upon, but the article wa written to start a discussion to see wh others were finding out by indicating th gas engine. The guess of Mr. Eyerma as to the age of the engine, from whic the cards were taken, is correct; it more than ten years old. This accoun for the low compression. I would mak the same criticism as Mr. Eyerman: t exhaust valve and passages are not co rectly designed as there is back pressu during almost the entire exhaust strok This seems to be a common fault wi most of the earlier engines. This is al shown by cards taken from the other e gine which the writer had in charge.

In regard to the vacuum in the e haust line, I will state that the di grams I took from a 10-horsepower tw cylinder engine showed exactly the san wavy line. This engine was fitted wi two exhaust outlets for testing purpose By opening both outlets, the line on t card straightened out and came close the atmospheric line. The exhaust-pi line was taken down and found to clear. Whether the wave can be entire removed, when a long exhaust pipe necessary, is a question. The exhau passages might have been too small, before stated.

These variations in pressure are pro ably due to the motion of the colun of gas and air in the exhaust pipe.

the opening of the exhaust valve, the pressure within the cylinder is from 30 to 50 pounds. The burnt gases rush out with high velocity, due to the sudden drop in pressure, and strike the long column of air in the exhaust pipe, setting it in motion. It is reasonable to expect that there will be more or less surging of this column of air and gas. Experiments have shown that with an exhaust pipe 65 feet long, a vacuum may be produced in the cylinder.

I wish Mr. Eyerman had given the length of the exhaust pipe, kind of muffler, etc., as this information would prove of interest in discussing this feature of the diagram.

In reply to Mr. Tilden's letter of October 12, the writer does not remember that he made any distinction between the valve setting on a single- or multi-cylinder engine. As far as I know they are set the same. Why any difference? At the same time if Mr. Tilden will read carefully he will find that I said to close the exhaust at the end of the stroke or "at the inboard dead center."

I did not draw upon my imagination in drawing the diagrams referred to in my letter of August 24. Within a few months I have seen an indicator diagram from coal-oil engine that was exactly that shape, and I have seen several others. The pressure at the end of the exhaust stroke is from 30 to 50 pounds, and does Mr. Tilden presume to say that this will drop instantly to atmospheric? Does the exhaust valve open to the limit at once? When does release take place in a high-speed steam engine and why? The gases take an appreciable time to expand and set in motion the column of air in the exhaust line.

If Mr. Tilden will note the diagrams shown by Mr. Eyerman in the October issue, he will see that the exhaust line, as shown on the low-pressure diagram, is not straight, but shows variations. This is not due to the spring, because the writer has taken similar cards, as stated before, and when the auxiliary exhaust was opened the line straightened out.

Ridicule has never won any discussion of practical questions and Mr. Tilden's remarks concerning the 65-foot exhaust pipe do not prove anything against it.

I do not believe that I claimed that could make gas flow from a lower to higher pressure, but is there not a difference between a gas flowing freely in an open pipe from a higher to a lower pressure, and the forcing of the gas from lower to a higher pressure by means of a piston in a closed cylinder? Does Mr. Tilden wish to be quoted as saying that the same "natural" laws will govern both cases or that the gases will act in the same manner?

Gas-engine practice seems to be a mighty hazy proposition" to Mr. Tilden, although investigation will show that nearly all manufacturers are pretty well agreed on certain standard practices. There is not much more variation between gas engines of the same type than is shown in present-day steam practice.

The writer has had too much experience in repairing poorly handled machinery, especially gas engines, to advise anyone to make any changes whatsoever, without carefully thinking it over and consulting some one of equal or greater experience. Many things must be taken into consideration in making changes, as no one part operates alone and changing even the smallest piece may affect an entire mechanism. Many times all that was required to get an engine into running condition was to stop someone from "monkeying" with it and letting well enough alone.

At the same time no progress can be made unless someone is experimenting and trying out new ideas. But this should be left to one having plenty of time and money; it takes both. Nor can you be sure that conditions are staying the same about a plant unless tests and trials of various sorts are made and records kept.

If, after due consideration, a change is thought advisable, be sure to mark each piece in the old position so that it may easily be reset in case the change does not work out to advantage. A little "horse sense" mixed with engineering in any of its phases is an excellent thing.

LOUIS J. BUSCHMAN.

E. Cleveland, O.

## Expert Advice

In a letter under date of October 19, I see the question is still before us. Henry D. Jackson in his reply to my article of September 28, has brought out some interesting points to be answered, especially the saving of $3485.

In the first place, our plant was established with a small beginning some 12 years ago and has been increased from time to time, until today we are among the largest paper manufacturers in the State. The increase of the plant was complicated in many ways, owing to the limited ground space. Second, it called for two separate boiler rooms for mills Nos. 1, 2 and 3, all of which are practically under one roof. Therefore improvements at one boiler room, meant the same in both, doubling the amount to be expended. At mills Nos. 2 and 3, which are operated from one boiler room, it was necessary to fire the Jones underfeed stokers beyond their capacity in an attempt to hold up to the capacity of the mill in tons of paper per 24 hours.

As these conditions meant a loss of fuel and labor, it was decided to install two 200-horsepower vertical Wickes boilers with Murphy furnaces. When installed, it was found that steam could be furnished to the capacity of the mills at a great saving of fuel and labor. Not only this, but a large increase was made in output of paper.

Following is an itemized statement of my estimate as to the savings for one year after the new boilers were started up, July 10, 1909, at mills Nos. 2 and 3.

| | |
|---|---|
| Three tons of coal saved each 24 hours @ $2.36 ........ | $2,584.20 |
| Time saved unloading 1095 tons less coal @ 6½c per ton ...... | 71.15 |
| Sunday labor, cut out two men at $4, 52 weeks ........... | 208.00 |
| One man less on job at $10.50 per week .................. | 546.00 |
| Labor saved on ashes and banking fires, $1.445 per week.......... | 75.65 |
| | $3,485.00 |

As this saving has been effected from the middle of July to the present time, there is no question about the estimate being correct. In fact, we have exceeded the figures submitted. It fully demonstrates to me the great error in not having proper boiler capacity to generate the steam required, and to meet the needs on a commercial basis.

In regard to the question which I called eating up the profits of the company's income, I submit the summary of proposed improvements recommended by the agents of manufacturers of steam appliances, in order that the plant might be uptodate, and all of which should be considered in the construction of a new plant: steam-damper regulator, oil filters and pumping device for lubricating engines, water-softening and purifying system, superheated-steam attachments, more electric engine stops, apparatus to regulate air and gases to furnaces and chimney and coal conveyers with ash removers.

It will be understood full well that the stockholders are after their dividends as often as they come about. Again, the general manager may feel liberal to furnish what may be needed, yet the ultimate aim is to keep all expenditures down to as low a basis as possible in order to show up the increase of dividends.

The operating engineer must take his medicine as dealt out to him by the manager of the plant. If he falls in the hands of a wise and competent manager who is not limited or held back, then the engineer has an even chance with the expert-advice man.

GEORGE H. CHANDLER.

Kalamazoo, Mich.

When observing the glass water gage while the boiler is working, note particularly whether the water in the glass is stationary or not. If the water level does not fluctuate, it is an infallible sign that the gage is out of order. Test the gage and water column immediately, and if draining them fails to clear, the boiler should be shut down until the apparatus for indicating the water level has been repaired.

# Some Useful Lessons of Limewater

## A Practical Method of Coal Analysis; How the Sample to Be Analyzed Should Be Selected; the Chief Ingredients to Be Noted

### BY CHARLES S. PALMER

Although there are many practical subjects which might be taken up in an elementary course of analysis, and although we will try and consider some of these later, yet the next subject which we ought to consider is the general one of coal analysis, and here we come up against the question of selecting a sample. If one's attention had not been called to it, he might suppose offhand that anyone could go out to a pile of coal and carefully pick up a piece which would represent the average composition of the whole pile; but there are so many possibilities of mistakes in this offhand way that it would appear almost laughable to select a sample in this way. To be sure, it is possible that one might select a piece of coal at random which might represent in many respects the average composition of the whole pile, or say of a whole car; but the probabilities of doing so are so slight that this method is really hardly worth discussion.

The only way to be reasonably sure that one has a sample that shall be respresentative of the whole pile is to make the selection of the sample in such a way that an average of the whole pile has a chance to be represented; and the best way to show this is to describe, with some detail, the proper method of sampling a coal pile.

For this, one needs a wheelbarrow and an ordinary-sized shovel. Then he must go to the coal pile and study it carefully to select a side of it, or better still a face of it which would represent a good cross-section of the whole pile. Thus, suppose a pile was originally conical in shape but has been cut away on one side so as to leave a face which is quite steep and perhaps almost perpendicular. Supposing this pile is 10, 15 or 20 feet high, and that the cross-section where it has been dug away is approximately 30 to 50 feet long. Now you want to cast your eye carefully over this and pace it off, marking roughly the position of each footstep. Opposite each footstep one should take say a third of a shovelful and throw it into the wheelbarrow. As a rule there will be more lumps at the bottom of the pile and more fine material toward the top; and one must be sure not to favor the lumps nor slight them. Also, one must use his judgment as to how many shovelfuls he will take from the face of the coal pile, opposite each footstep and in a line running from the bottom to the top of the pile. A rough diagram of this method of sampling the front of a coal pile is given in Fig. 1. When one has gone all over a typical cross-section face of a coal pile, giving each part of the rough checkerboard which is marked out with his eye and with his paces a chance to vote, throwing each part shovelful taken into the same wheelbarrow, he can be sure that the average composition of that wheelbarrow represents approximately the average composition of the coal lying in the face of the cross-section of the coal heap which he has sampled. Of course it will take some experience and some ripening of judgment to do this perfectly, but with a little patience anyone can learn to be a fair sampler and one can collect such a wheelbarrowful in ten or fifteen minutes.

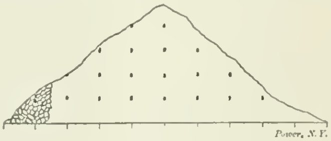
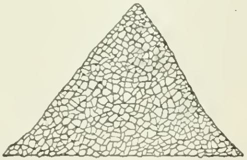
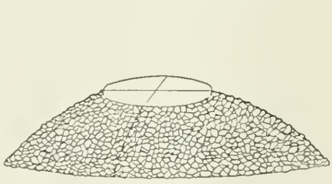

Power, N.Y.

FIG. 1


Cooe of Coal


Flattened Cone of Coal
Marked Off into Quarters

Power, N.Y.

FIG. 2

### DETAILS WORKED OUT

The next thing to do with this wheelbarrow sample is to work it down progressively to smaller and smaller dimensions, and in such a way that the smaller samples into which it is cut down shall represent the average of the wheelbarrow, just as the wheelbarrow represents the average of the whole pile. Selecting a good, smooth, clean, hard surface (which should be first well cleaned off with a broom an brush), dump the wheelbarrow onto with its lumps of coarse and fine coal, an go over this with a hammer, breaking up so there shall be no lumps larger, sa than half of a hen's egg. This pile the should be shoveled up into a heap by pou ing each shovelful onto the center so th a cone is built up in the middle; and each shovelful is poured onto this centr cone the shovel should be tipped so th the contents will slide off from one corn of the shovel in a steady and even strean and also so that this stream of coal sha fall not on one side or the other of th central cone but exactly in the middle, gi ing each particle of coal a chance to sele its own opportunity as to which side the cone it will roll down. After all th coal has been shoveled up into this conic pile, it should be flattened down and d out away from the center, and the who process of coning repeated several tim until one is sure that his conical pile well mixed not only by the shoveling o from the center, but especially by the ev pouring from the shovel onto the conic center. This should then be flatten down by a skilful pressure of the shov on the top of the cone, being careful n to press the cone in any side direction that the cone shall he pushed to one si but rather so that it will separate even in all directions, as shown in Fig. 2.

Now draw two lines at right angles each other across the top and throu the center of this flattened pile of co Thus you have divided the original whe barrow of coal into four parts. Select o of these, which is to be preserved f further coning and quartering, and d away the other three-quarters by cutti down vertically with your shovel, alo the lines, through the pile to the flo Now draw away and brush up the thr quarters, leaving the selected one-quart in which you will hammer the coar lumps down so there shall be nothi larger than small marbles. Mix and co up this pile of coal in the same way th you treated the original wheelbarrowf After this has been coned and shovel and mixed and coned two or three tim flatten it down and quarter it out as y did the larger pile. Now you have quarter which is only one-sixteenth the original wheelbarrowful. This sam should now be pulverized, coned and quartered, and so on, until you get do to a small sample weighing only two three pounds. This sample should be carefully swept up and transferred to a smooth iron plate where it can be carefully pulverized, using either a special flat crusher called a muller (much in use among assayers), or, almost as good, a flat, heavy, round-iron bar or short piece of shafting. In this way the sample can be teased and worked down by continued coning and quartering until it is only three or four ounces in weight and small enough to go into an ordinary pickle bottle. These last samples should be put through sieves, using at first a coarse sieve, say twenty or thirty meshes to the inch; and afterward a finer sieve, of sixty, eighty, or possibly even a hundred meshes to the inch. Of course the parts too coarse to go through the screen at first must be pulverized so that *all* goes through and is mixed with the screened sample.

### THE SMALL LAST SAMPLE

It may seem foolish to go to all this expense of time and labor to get a sample of that coal pile; but when one stops to consider that a chemical analysis cannot be worth any more than the value of the sample which is analyzed; and when one considers also that the chemist is not going to analyze the whole of the three or four ounces of the pulverized coal in the pickle jar, but only a few knifepointfuls, all of which together perhaps would not more than cover a silver quarter, he is startled at the care which is required to prepare the sample for this small last sample which will weigh only a mere fraction of an ounce and still must represent the average composition of that whole coal pile. If one has any doubt regarding the value and the necessity of selecting his sample of the coal pile in this laborious way, all he has to do to convince himself is to compare random samples picked by hand with this sample which has been selected by the shovel and wheelbarrow, followed by repeated coning and quartering. Moreover, if one wants to see the value of this sample which he has selected, all he has to do is to go out and take another wheelbarrow-load sample from the original face of the coal pile, using the same care and the same patience in working it down by coning and quartering; and he will find that the results will vindicate the painstaking way of getting a sample. The only thing which needs to be added is the education of one's judgment in selecting a fair amount of the coarse lumps; for it has been found that in proportion as the original coal pile contains many large lumps, so the first wheelbarrow load selected must be proportionally larger to get a fair average of the whole.

### MAIN POINTS OF ANALYSIS

Having prepared the coal sample, the next thing to do is to study the analysis; and here we can only outline the main points, which we will try to examine more closely in the next lesson. The ordinary coal analysis considers four or five groups of ingredients, namely, first the moisture, second the volatile matter, third the fixed carbon and fourthly the ash.

*Moisture*—This refers to the water which is mechanically mixed with the coal. Of course the coal may be exposed to rain, snow or frost, and thus may collect accidentally considerable moisture for which the user naturally does not care to pay. Most of this moisture can be driven off by heating and drying the coal at a temperature slightly above that of boiling water, 100 degrees Centigrade or 212 degrees Fahrenheit. In calculating the composition of the coal it should be noted that one can figure either from the original moist coal as representing the original 100 per cent.; or he can deduct the moisture from the original weight and figure from the dry coal after the moisture has been deducted. Either method is correct, but one should state which method he is following.

*The Volatile Matter*—This represents that part of the coal which is driven off by heating the coal to a coking temperature in a closed retort. This volatile matter may run from 5 to to to 20 per cent., or more. In the case of good steaming coal it is usually from 10 to 15 per cent. This volatile is low in the case of anthracite, a little higher in the case of bituminous and semi-bituminous coal, and may be very high, up to 30 or 40 per cent., or more, in the case of some of the Western lignites. This volatile matter may consist largely of water, originally chemically combined with the coal, or it may consist largely of combustible gases which carry a great deal of the heat power of the coal. This factor, namely of the heating power of the volatile ingredients of the coal, should be considered, for some samples of good commercial grades of coal are reported which run up to 30 per cent., or more, of volatile. Many bituminous coals depend largely on the volatile for their heat value, and such coals require the best of firing.

*The Fixed Carbon*—This represents the amount of coke material proper which would be left in a closed retort after all the volatile matter had been driven off. This fixed carbon should also be in a condition to burn readily on the grate under the boiler and should not contain much incombustible or graphitic carbon; nor should it contain carbon locked in with the slate or fireclay which goes along with most coals. It is possible for a coal carrying 60 to 80 per cent. of fixed carbon to have considerable of this, say 5, 10 or 15 per cent., so mixed with slate and fireclay that it will not burn readily. Hence, although it is there as fixed carbon, it may not be available for quick burning and heating.

*The Ash*—This represents the worthless mineral matter which is left in the coal after complete combustion. All coals contain some ash, some as low as 4 or 5 per cent., and possibly lower, and some as high as 10 or 15 per cent. A good coal should not show over 8 to 15 per cent. of ash. This consists largely of fireclay or silicate of alumina. In this case the ash will burn out almost to a clean white, but if it contains much iron it will be more reddish and also more fusible.

These four ingredients, namely the moisture, the volatile, the fixed carbon and the ash, make up the main ingredients of the ordinary proximate analysis of coal. We will consider in the next lesson how to get at the determination of each of these ingredients. Sometimes the sulphur in coal is so great a factor that it must be considered especially in coal used for smelting or foundry work. But that point is also connected with the phosphorus present, for sulphur and phosphorus are both hostile to good iron.

## Producer Gas Power, Heat and Fuel for Factory Service

BY JULIUS I. WILE

Producer gas for power has now been in use for over five years in this country, and its reliability as well as its economy for power purposes alone is undisputed, as with it over 20 per cent. of the heat value of the coal fed to a gas producer is converted into effective work, compared to about 5 per cent. fed to a steam boiler and converted into steam, when the exhaust of the steam engine is used for heating.

For factory work, except as an auxiliary power, its use has been heretofore limited as when using steam power the exhaust steam from the engine is used for heating, and where additional heat is required live steam is used direct from the boilers. Although this system is very wasteful, as I will show, it has been heretofore preferred to gas power, because it was necessary to install an independent boiler for steam-heating purposes along with the gas-producer power plant.

The same principle of using the exhaust heat of the engine to heat the building can be and is now being applied to the producer gas engine by leading the exhaust gases from the engine into an air heater, and making up, where auxiliary heat is required, by using either gas from the producer or coal in the air heater. With this system, the full economy of producer-gas power can be obtained, while heat as well as ventilation, which is now becoming recognized as of considerable importance in factory work, can also be obtained, and with an economy of fuel for both power and heating not possible with the steam system.

A gas engine discharges in its exhaust approximately one-third of heat, and at the same time delivers to the jacket water about one-fourth of the heat, originally in the gases supplied to the engine, so that where hot water is desired in factory work, this can be obtained without additional cost. With the heating system just mentioned, which was recently introduced, about 85 per cent. of the heat of the exhaust can be utilized for heating air, and any make-up necessary can be obtained from the gas producer or from coal direct, and 85 per cent. of the available heat converted into work, compared to 50 per cent. when a steam boiler is used. The heater is of cast iron and sectional, built up with the required number of tubes to suit the conditions. The air to be supplied to the building is forced through the tubes at any required speed by means of a fan, and in passing through the tubes is heated to the required degree. The heater, being of cast iron, is used also as an exhaust muffler, and is not affected by the corrosive action of the exhaust gases.

Gas producers can be installed for the price of water-tube steam boilers; the air-heating system costs less than steam piping, gas-pipe connections are less costly than steam-pipe connections, and no stack or chimney is necessary. These economies in installation will offset the additional cost of the gas engine over the steam engine, so that today a combined gas-power and air-heating system can be installed at a cost not to exceed that of a steam-power and steam-heating system. At the same time, savings are made in fuel, attention, and maintenance, and the smoke nuisance, which is often an important factor, is entirely eliminated.

### Gas and Steam Power Costs

Taking the cost of power alone, the total cost of producer-gas power, working 300 days, ten hours a day, and all items considered, such as fuel, attention, oil, water, interest and depreciation, the annual cost per horsepower with gas power does not exceed $25 in 100-horsepower plants and $19 in 500-horsepower plants; while steam power costs $40 in 100-horsepower plants and $30 in 500-horsepower plants, the steam engine running noncondensing.

Where electric power is installed, the cost of power with either gas or steam goes up because of the additional interest and depreciation; loss in the generator and motors must be considered also, but there are many gas-power installations in the vicinity of New York City and in New England which are developing power at a cost of from 2 to 3 cents per kilowatt-hour. When it is considered that gas-engine makers guarantee a kilowatt-hour at the switchboard, with coal at $4.50 per ton, for less than $\frac{1}{2}$ cent at average loads, it is easily seen how such results are obtained; the higher the load factor, of course, the less is the cost of the power to the owner who puts in his own plant. These producer plants can be seen in daily operation; the owners are proud of them and the work they are doing

Where heating of a building is required, the cost of power is reduced by the amount of heat in the exhaust steam or gases that can be utilized. Here also, the combination of a producer-gas engine exhausting into the air heater, making up in extreme cold weather with either coal or gas, gives a substantial saving over the steam engine with its exhaust steam used for heating, making up in extreme weather with live steam. Engineers will agree that on the average 4 pounds of coal per horsepower-hour are needed for an ordinary steam engine when running noncondensing for power purposes. Six months of the year the exhaust can be used for heating, so that when losses in engine and transmissions of the heat are considered, 3 pounds of this coal may be considered as utilized for heating. With 4 pounds per horsepower-hour for six months, and (crediting the engine for the other six months with 3 pounds, charged to heating) only 1 pound for the other six months, the average for power purposes alone throughout the year is $2\frac{1}{2}$ pounds per horsepower-hour. With gas power, including standby losses, $1\frac{1}{4}$ pounds are used the year round per horsepower-hour, but six months of the year more than one-fourth of this amount is available for heating after considering loss in the heater, so that the average for power alone comes down to $1\frac{1}{8}$ pounds per horsepower-hour, and if the other quarter of the heat which goes to the jacket water is used for hot water, the fuel consumption chargeable to power would then be less than 1 pound the year round, compared with $2\frac{1}{2}$ pounds for steam per horsepower-hour.

### Air and Steam Heating Costs

Having made a comparison, and crediting the engine with the heating, consider separately the fuel for the heating of the building. Heating by steam, with a boiler efficiency of 65 per cent., and with other heat losses, a total of 50 per cent. of the heat value of the coal can be considered as available for heating, or one-half of the coal burned under the boiler. With the exhaust-gas heater, a total efficiency, considering all losses, of 85 per cent. is obtained, so that in heating alone, with air heating as against steam heating, a saving of over 60 per cent. of the coal which would be used for steam is effected. With less than one-half the coal used for power and one-half used for heating, the advantages of gas power and air heating over steam power and steam heat are easily apparent from a fuel standpoint, without considering the other advantages such as lower cost of maintenance, absence of danger from explosions, elimination of the stack, and absence of smoke.

### Gas for Fuel Purposes

With a producer-gas installation ther is an added advantage over steam whic' is of importance to the many industrie in which gas is used for heating furnace: for hardening, tempering, annealing soldering, enameling, brazing, heatin kettles, cooking, boiling and coffee roast ing. Coal is generally used instead of ga for such work, on account of the hig cost of gas, usually 80 cents to $1 pe thousand cubic feet but the advantage of gas even at 80 cents over solid fue such as complete control, cleanlines quickness in starting, and rapidity of out put, are such that the use of gas is bein rapidly extended, in spite of its cost.

With a producer-gas power plant, th gas can do the same work as illuminatin gas at 80 cents or $1 (using anthracit pea coal at $4.50 per ton in the producer at a cost of but 15 cents; where there i no gas engine, the interest, attention an depreciation run the cost of the gas u to 25 to 30 cents, depending upon th output. This gas can be used with th same burners or furnaces which are no used for illuminating gas, with insignif cant modifications.

## An Aftermath of the "Bennington Disaster

In the United States circuit court i New York City, decision has just bee rendered in an interesting libel suit fo $100,000 brought by Lieut. Charles Wade against the International Magazin Company, publishers of the *Cosmopolita* In March of 1907, an article appeared i the aforementioned magazine on "Th Growth of Caste in America." The au thor, Charles Edward Russell, wrote o the rise and influence of the spirit snobbery in our private and official lif criticizing the navy personnel bill in pa ticular, and drawing on the facts e tablished in connection with the "Be nington" disaster in 1905. It will be r membered that the explosion of the boi ers, which occurred while the gunbo was in the harbor of San Diego, Ca resulted in the death of 60 men and wounded. Lieutenant Wade was chi engineer of the "Bennington" at the tim of the explosion, and information broug out by the court of inquiry and t court martial which followed, tended show that the disaster was in all pro ability due to gross negligence on t part of the officer in charge, although i both cases the lieutenant was exonerate

In the article Mr. Russell mentioned n names, but the following paragrap quoted word for word, was taken Lieutenant Wade as a direct reflecti on himself—hence the suit for libel:

"But the new system, pure product caste, went into effect, and the blowin up of the 'Bennington' was its first pe et fruit. A young ensign, bookishly lucated in engineering, and trained to 'equally efficient in either position,' epped from the bridge to the engine m, and tried the experiment of cut g out the steam gage and plugging up e safety valve—and all those lives paid e penalty."

t was argued by Lieutenant Wade that had been twice exonerated by boards capable men from all responsibility for e explosion, and the mere fact that was still in the service should be dence conclusive enough to prevent writer, even though indirectly, from ing such a charge at his door.

Much of the evidence which was given the former trials was used to ad- age in the present suit. The same story of how the valve in the gage nection to the boiler had been closed ead of an air valve was repeated and condition of the safety valve re- wed. It developed that for some time re the explosion, the mechanism used pen the safety valve had been out of ssion, and that its ability to open pressure for which it was set, was rmined by the use of a *slice bar* or *l maul*. After the explosion the safety e was examined and layers of rust veen the convolutions of the spring, sufficient thickness to prevent the per opening of the valve, were found. metal in the plate and in fact all of the boiler, with the exception he safety valve, appeared to be in good condition, and the whole of the evidence appeared to indi- that the explosion was due primarily the condition of the safety valve and ntally to shutting off the gage when ng pressure. It was claimed by the ff that the explosion was caused by a lual failure of the crown sheet due n overabundance of oil in the boiler, b the evidence on the condition of the y valve was for the most part ad- d, and to the minds of the jury ked so strongly of negligence and neglect on the part of the engineer in rge, that a verdict in favor of the ndant was unanimously rendered.

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e condenser circulation pump was ted with rocker arms and drag from the engine crosshead. When- the engine was slowed down or d and quickly speeded up, there was always a pounding inside the pump, which could be stopped only by throttling the circulation suction valve and gradually opening it up again to the required admission. The pump being situated below the cooling-water line, was always full of water. An examination indicated the suction valves admitted water too fast for the discharge valves to handle without trouble. Placing washers over the suction valves to shorten their lift effectually stopped the trouble.

# Ammonia from Soot

By James E. Steely

In a recent number the statement was made by Harold James that when soot was mixed with lime or cement, ammonia was given off. The accident by which he discerned this brings to the front an important factor in the combustion of coal. As soon as I read this article I got some soot and treated it with a strong solution of caustic soda, and I also observed the ammonia odor. The origin of the odor is not hard to locate: When any ammonia salt is treated with a caustic alkali, such as lime, caustic soda or potash, the free ammonia is liberated. Since portland cement contains considerable caustic alkali, it will work exactly like lime, thus explaining Mr. James' discovery.

From the foregoing statements it at once becomes apparent that soot and flue dust contain ammonia salts. Now the real question arises, viz: How did they get there? There are two possible ways in which ammonia salts could be formed during combustion: (1) by reactions of the nitrogen in the air with hydrogen in the coal; and (2) by the reduction of the nitrogen in the coal itself. (For the benefit of those who are not familiar with chemistry, I will say that ammonia is a compound of nitrogen and hydrogen containing 82.35 per cent. nitrogen.)

Discussing these possible ways, we are confronted with the following facts:

1. Elementary nitrogen is very inactive. That is, nitrogen as it exists in the air is very difficult to get into a chemical reaction with other substances.
2. Electric discharges in moist air make very small amounts of nitric acid and ammonia.
3. Combustion produces a small amount of ammonia from the nitrogen in the air (Richter's "Organic Chemistry").
4. When air and steam are conducted over white-hot coke, hydrocyanic acid and ammonia are formed.

The reactions (3) and (4) could take place, and in all probability do, but I do not think that these are the cause of the formation of the ammonia salts found in the soot. I believe that most of the ammonia salts are produced from the nitrogen in the coal itself. All coal contains nitrogen in small amounts varying from ½ to 2 per cent. This means that for every ton of coal you buy you have from 10 to 40 pounds of nitrogen, which is equivalent to from 12 to 50 pounds of ammonia, approximately. When coal is distilled in gasworks this nitrogen is changed into ammonia salts and cyanides (compounds of carbon and nitrogen), which reaction also takes place in gas producers. These compounds collect in the water which also comes over and forms the well known ammoniacal liquor. This liquor is one of the principal sources of the ammonia of commerce.

It never occurred to me that the same thing would take place during combustion, but when it is considered that when soot is formed the combustion is not complete, the presence of these salts may be explained. In all probability the nitrogen compounds are distilled off as they are in the gasworks, and the conditions are not suitable for their complete decomposition. Ammonia gas will burn under certain conditions but these are not found in the boiler furnace. Therefore they would pass on and up the stack, or would deposit on the setting of the boiler to a small extent.

The fact that some such reaction as has been described takes place brings out an interesting item in the heat balance. Thus, if the nitrogen went off in the form of ammonia gas, it would take along with it a certain percentage of hydrogen necessary to make the ammonia. This loss would be included in the "unaccounted-for" on the heat balance. In this way 1 per cent. of nitrogen would mean the loss of 0.216 per cent. of hydrogen, which would mean a loss of 135 B.t.u. per pound of coal. If the nitrogen went off in the form of cyanides, 1 per cent. would mean a loss of 0.856 per cent. of carbon, or 124 B.t.u. per pound of coal. Since the coal is burned in a calorimeter in oxygen under pressure, all these nitrogen-hydrogen and nitrogen-carbon compounds are completely burned; therefore we would look for a slightly higher heating value by the calorimeter than it is possible to get under a boiler.

Before I finish, a remark might be made concerning the recovery of these valuable ammonia and nitrogen compounds. For example, if the coal contains 1 per cent. of nitrogen and about 2 per cent. of sulphur, supposing all the nitrogen to be converted into ammonia sulphate, the yield per ton of coal would be about 85 pounds, or with a plant using 100 tons daily it would be more than four tons of ammonium sulphate. This compound is worth something more than $50 per ton as a fertilizer, or in this case $200 per day. Thus it is easy to see that a fortune awaits the inventor who can work out a satisfactory recovery. The conditions for such recovery are very unsatisfactory, but in the face of the foregoing consideration it is worth thinking about by the engineering chemists.

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Full-weight standard pipe should be used for pressures up to 125 pounds, and full-weight extra-heavy pipe for pressures above 125 pounds. Cast-iron standard fittings should be used only for pressures below 100 pounds, medium extra heavy for pressures from 100 pounds to 150 pounds, and extra heavy over 150 pounds.

# POWER AND THE ENGINEER

DEVOTED TO THE GENERATION AND TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.
355 Dearborn Street, Chicago.
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of POWER solicited and paid for Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "POWPUB," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During* 1908 *we printed and circulated* 1,836,000 *copies of* POWER.

*Our circulation for October,* 1909, *was (weekly and monthly)* 135,000.

| | |
|---|---|
| *November* 2 | 42,000 |
| *November* 9 | 30,000 |
| *November* 16 | 30,000 |
| *November* 23 | 30,000 |
| *November* 30 | 30,000 |

*This paper reaches* 42,000 *separate readers each month and* 30,000 *each week.*

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*

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## Indices of Engineering Subjects

An entirely novel paper has been presented to the British Institution of Mechanical Engineers upon the subject of heat transmission. It differs from ordinary papers in being almost entirely an index of the literature of the subject which has appeared since the year 1690, when Newton in his "Principia Philosophiæ" wrote on the subject and showed that heat propagation varied as temperature difference.

There is a big gap to the next author, Fourier, in 1817, after which the frequency becomes rapidly greater. Some sixty-five pages of index of subject matter and authors are in all given, with a brief resumé of the principal laws that have been from time to time enunciated from experimental data. Perhaps the most striking thing shown by the collator of this index has reference to the loss of head of temperature between the hot gas on one side and the water on the other side of a plate.

The biggest drop in respect to a copper plate of 1 inch in thickness is that in the thin film of cooled gas which clings to the plate surface on the fireside. The head of temperature lost in this thin clinging film is 97 per cent. of the whole loss. The corresponding water film on the other side answers for about 2 per cent., while only 1 per cent. is debited to the thick copper plate. Each film is assumed to be only 0.005 inch thick. The argument of course is that gases should travel fast over the heating surface so as to break up such films of gas and improve the boiler efficiency, and much has of late been claimed for such designs as will bring about this, but practical considerations stand in the way of the gas velocities that have been recommended. A carefully worked boiler may give an efficiency of 70 or even 80 per cent. of the heat value of the fuel burned in its furnace. Whence it is easy to see that the forcing of the gases through restricted places at a high velocity and with much friction may very easily demand more power than will be gotten back in better heat efficiency. The author states that in preparing this index over 500 papers have been read and abstracts of the more important ones have been made and are available for reference in manuscript form in the library of the Institution.

It would appear that similar indices of other engineering subjects would be well worthy of making. It is very difficult in ordinary work to look up such subjects in any but a perfunctory manner. An index such as this by Professor Dalby might be gotten out on many other kindred subjects. There might be an index on superheat, one on steam jackets, one on cylinder condensation, on surface condensers and a dozen or a score of the details of steam engineering. Mines of information lie scattered in the volumes of the technical press, in chapters of books and in those proceedings of engineering societies that acc late on a man's hands as unsalable until he throws them all away and on the library.

A few indices like this on heat t mission would save tons of searc The index gives titles, dates, author a reference letter to the library the paper can be seen. It is chronol in sequence and alphabetical in au index.

## Local Meetings of the Mecha Engineers

There is much of interest to the op in the recently adopted policy o American Society of Mechanical neers regarding the holding of r monthly meetings in cities other New York. These are meetings r local branches, or sections, but o society itself, with all its standin prestige, similar in every respect t meetings held in New York. Th has already been successfully inaug in St. Louis and in Boston. In the f city meetings are conducted jointly society and the Engineers' Club Louis. In Boston also there is clo operation with the Boston Society o Engineers. Other cities, where the bership is large and where interest i branch of engineering is active, m expected to follow these exceller amples.

No hard and fast rules governing meetings have as yet been adopte good of the profession being the ur ing thought. Such regulations, i as may be necessary are being w out by actual experience. Ever couragement and assistance is given local members in the conduct of the ings, and in the preparation of and discussions. Papers submitt headquarters are available for all th meetings at the same time they ar sented in New York, and in some earlier. Stenographic reports are and in general the established sta and methods of procedure of the are followed.

Admirable as the New York m have become they are of direct be but a small percentage of the s membership. Even the superior tions of the annual meeting are a to but few. In effect then, as the bers cannot come to the society, ciety is being taken to them. Mem thus takes on a direct interest value which to many it has not her possessed. Not the least advant that members traveling in these d ricts may be sure of a hearty welcome.

While any lowering of the society's tandards is to be deplored, it must be ecognized that subjects which may be f decided local interest to mechanical gineers may have little or no general ue. The action of the society in leavg the selection of papers and discus ns for local meetings largely in the s of the local committee—without ange of rule, however, as regards pubation—is much to be commended. ually admirable is the plan of close coeration with existing local societies so t the work may be helpful to both, and n sense competitive.

On the whole the movement indicates tation to the demand for a broader sion of the society's activities and fulness. It is a sign of progress.

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## Efficiency or Efficacy

A recent suit in the law courts to deter- the responsibility of the power plant fire has raised an interesting dis- n between the meanings of these words.

case was this: An industrial es- ishment had a capacity for about five -car loads a day, and to secure this ess a railway had built a siding from ranch line into the yard of the plant. buildings had shingle roofs, and the e up to line was heavy and against t loaded cars. Hence, the switcher or k-up" engine had to exhaust heavily t push or pull the loaded cars to the r -line switch.

spring morning, when there were no r electric current in the building, a e was discovered on the roof of one structures near the track, and just a r the loaded cars had left the yard. the locomotive engine responsible the fire? If the fire came from a k from the stack, in spite of the sp arrester, had the company owning operating the railway any responsi- for the design and for the condi- of such device?

principles of equity and of the de- f court in such cases would seem ace the responsibility of the damage he invading engine and railway, n be shown that the spark-arresting were inefficient, or if normally ef- when in good condition, were de- by reason of holes in their net- r general lack of repair and up- Two lines of attack and defense t once suggested: the questions of as to the grades, location of build- ing the emission of visible sparks, and ate of the spark arrester of the ding engine; and the questions of theory or design as to whether the device in use were good and up to the requirements of standard and accepted ice of designers of the day. The neering practice of the power plant becomes therefore a party in the defense, to prove that its designs were efficient and satisfactory; the attack must show that such designs were obsolete, had been bettered by newer and better arrangements, and were not efficacious for their purpose.

The principles underlying such a case are of much wider application than to this particular incident. They appear when a plant disaster of any sort occurs. If the boiler burst, was it the management of it or the design of it or the materials of its manufacture which were to blame? If the flywheel broke, was the speed outbreak due to bad governor design, or was the wheel design too weak for the normal speed? When the bridge or other structure falls, can the design be attacked as well as the responsible owner? It would seem furthermore to make for good policy that a community based upon the power plant and underlain by industrial machinery, should be able to compel the responsible owners of such machinery to keep pace with improvements intended to secure economy or safety or comfort.

But this particular incident lays bare a further principle which legislation and law and the molders of public opinion must not be allowed to forget. It is that the terms efficiency and efficacy are not synonymous in applied science. The best dictionaries make them mean practically the same thing, but they do not necessarily carry the same idea. The spark arrester in the locomotive is a device made up of elements intended to allow the smoke and gases which are the products of combustion to escape out at the stack, but to stop and extinguish or cool or comminute such solid particles of ash or coal or coke as would cause fires along the right of way, or discomfort and danger to passengers or train men. The smaller the mass or weight of each flaming or incandescent carbon particle, the less liable is it to set fire to combustibles outside, because of the less calorific power inherent in such reduced mass, and because the contact with the cooler steam and the rushing outer air will so much the more effectively cool it below the point of ignition.

These considerations all point to a small size of the opening in the mesh of such netting as will be used if the latter is to be efficacious. They suggest baffle or deflecting plates or diaphragms to receive the direct impact of such solid masses moving at the high velocities of the locomotive gases. They explain why the basket or horizontal type of netting has received the stamp of approval in the recommendations of the master mechanics of the railways.

On the other hand, the spark netting is introduced into a channel or group of passages intended to give free and rapid movement of hot gases over the heating surface, and to compel full contact of the oxygen of the air with the fuel elements in order that the engine may steam fast enough to make schedule time on the road. If the furnace and heating surface are to be efficacious, there must not be introduced into the draft passages any device to cause friction or stoppage of the area of cross section for such flow.

Here, therefore, are two efficacies which are in opposition to each other; and the designer must effect a compromise, sacrificing part of the complete efficacy of each to permit the other to operate. Here then we have an efficiency secured, but at the cost or sacrifice of highest efficacy of either.

This idea is not novel in other lines. The steam engine as a motor is efficacious: it can always be designed to do the allotted task. But in view of the inconvenient limitations of pressure as the temperature at which such steam is worked is raised, it is not practicable to work it as hot as the air is worked in the gas engine. Hence, regarded as a heat engine, the steam engine is efficacious but not efficient. Efficacy in the transfer of heat from gases to the water of a boiler demands small tubes and many of them, and that the tubes be kept cool; efficacy in passage of such gases and possible flame from a combustion chamber to a chimney calls for large-diameter flues and few of them, and that they be kept hot. Efficiency results when these two contradictions are balanced so as to secure the best attainable maximum for each in the presence of the other. The furnace, combustion chamber and chimney are efficacious in preventing visible smoke when they keep the temperatures in their active zones as high as possible, so that every unit of combustible solid or gas meets oxygen at a temperature at or above that necessary for ignition. The boiler-heating surface is efficacious when it succeeds in cooling down the flame and gases as nearly as possible to that of the contained water, and this is far below the temperature of flaming or ignition. An efficacious smoke preventer is a poor steam maker. Hence, it would seem right to hold the engineer and designer to an efficiency, but not necessarily to compel him to an efficacy. Before he is criticized or sued for his failure to realize someone's ideals, a full weight should be given to the limitations imposed. Probably there never will be a spark arrester in a locomotive front end which will not let through some sparks which will be visible in the dark. Probably there will never be a boiler setting which will not pass some smoke into the chimney when a sudden demand for power comes on, and the intensity of the firing process is suddenly to be increased to meet such a peak in the load curve. The law may properly compel efficiency; it should proceed cautiously in insisting upon efficacy.

In case the feed pipe of a boiler gives out, or water cannot be supplied to a boiler for any reason, the boiler should be shut down at once and the fires drawn.

# Power Plant Machinery and Applianc

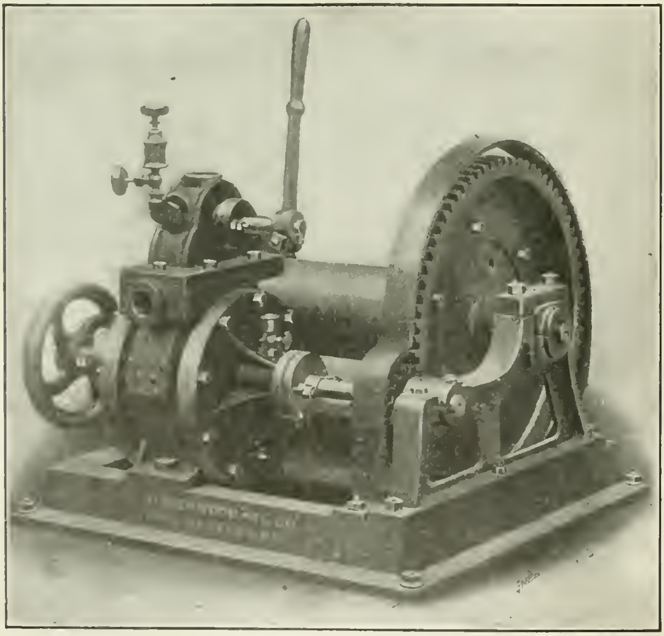
Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

## Rotary Hoisting Engine

A small rotary hoisting engine, suitable for use where small steam power is required for short periods, such as hoisting ashes from the fireroom to the street level, is illustrated herewith.

It consists of a piston head set eccentric to the casing, fitted with movable pistons which are forced out against the cylinder walls by means of a spring. At one portion of its cycle, which is at the point of steam admission, these movable pistons are forced into the piston head almost their entire length. As the piston head revolves eccentric to the cylinder walls, the movable pistons are forced out against the walls, and as the piston revolves in the cylinder, space is provided for the expansion of steam.



LIDGERWOOD ROTARY ASH HOIST

It is operated by a small lever, is reversible and hoists, holds and lowers the load by means of steam only. As there are no centers, it is always ready to start. It is not suitable for continuous operation, on account of excessive steam consumption, and the manufacturer, the Lidgerwood Manufacturing Company, 96 Liberty street, New York City, does not recommend it for use except where the work is of a light nature and of short duration.

## Bristol Portable Electric Pyron
## and Thermoelectric Coupl

A new quick-reading form of B
pyrometer has been designed and

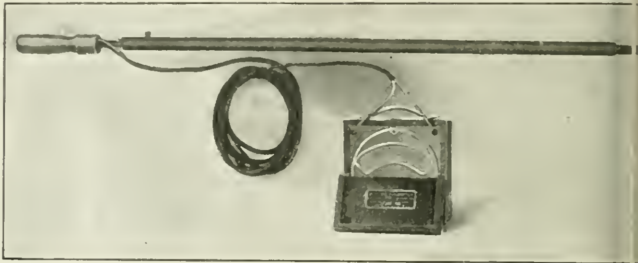


FIG. I. COMPLETE BRISTOL PYROMETER OUTFIT

liminary models have been tested in
service in several different proc
where the temperatures are exces
high and the requirements very s
This special pyrometer consists
patented compound thermoelectric c
used in connection with a special po
instrument. The complete outfit is s
in Fig. 1, and the thermoelectric c
is shown externally in Fig. 2. The c
with the protecting sheath pulled
against a stop, leaving the tip o
thermo couple exposed, is show
Fig. 1.

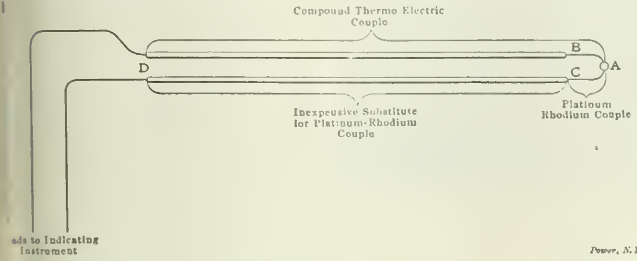
When a reading is to be take
thermo couple is inserted into the fu
or kiln with the tip protected from
chanical injury, as shown in Fig. 2
when at the proper point in the
the iron pipe protecting the shea
slipped back and the tip exposed t
hot gases whose temperature is
measured. After a reading has been
the couple should be quickly withd
and partially cooled off before a
reading is taken.

The compound construction of
couple is shown in Fig. 3. The po
corresponds to the regular junction
ordinary thermo couple and the two ele-
ments which join at the point are
platinum and platinum rhodium, ich
extend to the points *B* and *C*, where ey
are welded to two other wires ma of
inexpensive alloys, which are such hat
the electromotive forces generated *B*
and *C* are practically equal and op sed

hen these junctions are both exposed temperatures not higher than 1200 de- ees Fahrenheit. These inexpensive al- elements are extended to the point *D*, ch is the cold end of the couple.

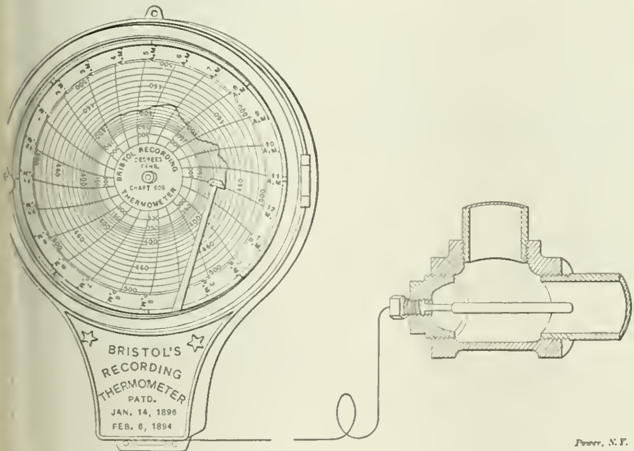
This construction is such that the tinum rhodium tip of the couple *A* may exposed to temperatures up to 3000 grees Fahrenheit, without having the perature of the junctions *B* and *C* eed a safe limit. The temperature at

FIG. 2. THERMOELECTRIC COUPLE


Compound Thermo Electric Couple
B
C
A
D
Inexpensive Substitute for Platinum-Rhodium Couple
Platinum Rhodium Couple
ads to Indicating Instrument

Power, N.Y.

FIG. 3. SHOWING COMPOUND CONSTRUCTION OF COUPLE


C
BRISTOL RECORDING DEGREES FAHR. THERMOMETER
CHART 608
BRISTOL'S RECORDING THERMOMETER
PATD.
JAN. 14, 1896
FEB. 6, 1894

Power, N.Y.

FIG. 4. DEVICE TO A FEED-WATER RECORDING THERMOMETER

*A* may be quickly measured with this special couple as the platinum-rhodium tip is exposed directly to the hot gases in the furnace or kiln. In this way an inexpensive substitute is provided for the expensive platinum-rhodium couples previously employed for the measurement of such high temperatures.

The complete outfit is portable and readings of temperatures in the neighborhood of 2500 degrees Fahrenheit, may be obtained in a few seconds after inserting the tip of the couple to the point where the temperature is to be measured. By using a special form of tip this type of thermo couple can be used to measure the temperature of red-hot surfaces of metal or other material.

In Fig. 4 is shown the method of applying the device to a feed-water-recording thermometer. The average length of the bulb is 5 inches and is best placed at an elbow or tee, as shown. The bulb is connected to the recording instrument by a fine copper capillary tube furnished with flexible steel, lead or copper protection; this enables the recording instrument to be placed on the wall or gage board. This instrument is manufactured by the Bristol Company, Waterbury, Conn.

## Softening the Make-up Water

It is generally agreed that where the boiler feed-water supply is a hard, scale-forming water it will pay to install softening apparatus, but where condensates from surface condensers or exhaust-steam heating systems constitute the bulk of the boiler feed, it is sometimes considered unnecessary to soften or treat the make-up water. This view, however, neglects the fact that even a small amount of impure feed water will deposit scale in the boiler, and that on account of its slow accumulation, this scale will be harder, and since it is apt to be overlooked, more injurious than the softer and more rapid accumulation where the feed is made up entirely of raw water.

Although it would be a relatively costly undertaking to install a water-softening system to treat the make-up water only, and while it is not good practice to attempt to treat the whole body of water after the raw water has been mingled with the condensates, the matter becomes quite different if the raw water can be treated automatically, and in the same apparatus that serves to heat the make-up water, while at the same time being kept separate therefrom until treatment is complete.

An apparatus of this kind, especially designed for use in connection with exhaust steam heating systems and drying plants where the make-up water requires softening, has been recently designed by the Harrison Safety Boiler Works, of Philadelphia, Penn. The water is softened by the hot-process system, utilizing exhaust steam to bring the water up to 210 degrees Fahrenheit, and thus precipitate the carbonates, or temporary hardness, and soda ash to correct sulphates and chlorides, permanent hardness.

The apparatus is so arranged that the reagent is fed continuously in proportion to the inflow of make-up water, and suitable provision is made for the removal of the resulting precipitate from the water by sedimentation and filtration. A special feature is a bypass which comes into play automatically in case the filter should be neglected and allowed to clog, so that there is always a supply of hot, softened water to the boiler feed pumps.

Attached to the heater is the new surplus exhaust separator which the company has recently devised for use on heaters and receivers installed in connection with exhaust-steam heating and drying systems. This separator differs from the Cochrane oil separator heretofore used in being extra large, and in having an outlet at the top for passing the purified exhaust steam to the heating system directly, without need of an independent oil separator. Convenient valves are also provided for cutting off connection between the separator and heater, and between the trap which drains the

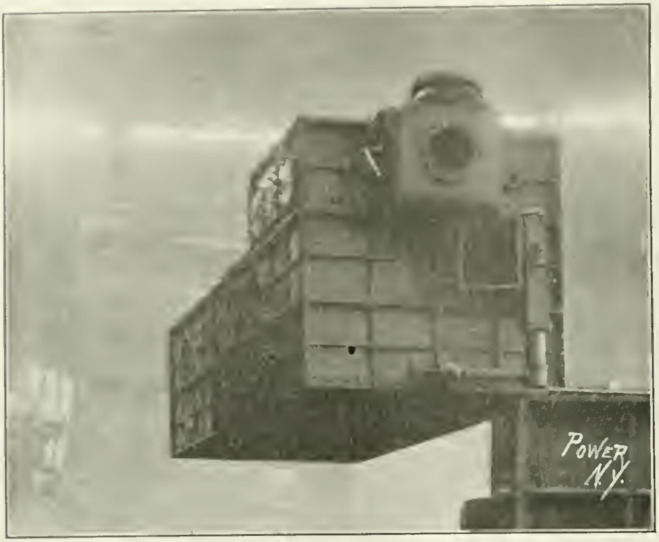


FIG. 1. COCHRANE COMBINATION HEATER AND SOFTENER

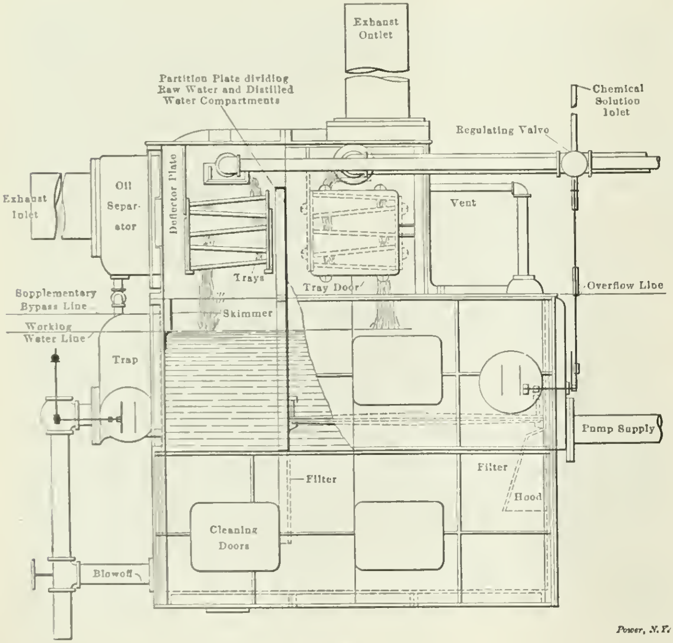


FIG. 2. INTERIOR ARRANGEMENT OF HEATER

separator and the heater, so that the heating body can be cut out of circuit and opened for cleaning and inspection while the heating system continues in operation. This does away with the independent oil separator and trap, and with the valves, tees and elbows required for its installation.

In the apparatus shown in Fig. 1, the returns and treated make-up water are mingled together in the sedimentation chamber and the whole volume is passed through the filter, but where the percent of returns is large it may be advisable give over the entire sedimentation filtering capacity to the make-up wa alone and to pass the pure condensed turns, after reheating, directly to pump-supply chamber. This gives be results than if the two water supplies mingled before treatment.

This apparatus is equally applicable the case of surface condensing ste power plants where the condensate utilized as boiler feed, in which c there is the large volume of conden to be heated and a comparatively sr volume of supplementary make-up w to be heated and softened. The ap ratus can then be so arranged that exhaust steam will first come in con with the make-up water, insuring temperature for the chemical reaction, fore heating the vacuum-pump discha As will be apparent, this apparatus sa a large part of the cost of a sepa feed-water heater and a separate wa purifying system and makes it possibl purify the small amount of raw water merely nominal cost.

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## "North" Hot-Air Blast Smok Consumer

The "North" hot-air blast smoke c sumer has recently been patented Stephen H. North, 410 Midland ave Syracuse, N. Y. The principles of injector and bunsen burner are combi in this idea, but instead of the air b taken from around the conduit it taken through the end. A cylinder Figs. 1 and 2, is supplied with air means of an electric fan which is f into one end of the cylinder. The first enters through the cylinder *A*

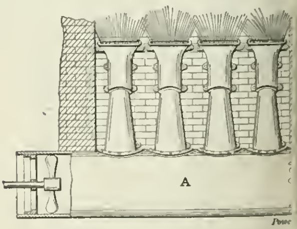
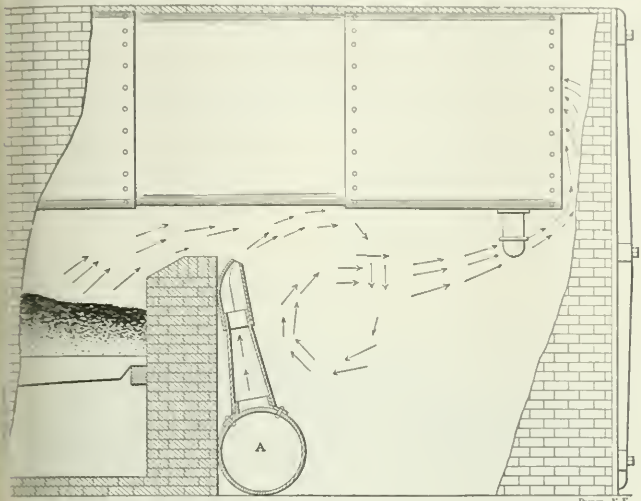


FIG. 2. VIEW FROM REAR OF BRIDGEWA

passes through an orifice into the duit and then into elongated no 7½x½ inches in dimension, which pro a thin column of air from wall to as it escapes into the combustion ch ber at the rear of the bridgewall. A valve is used at the end of the cyli to regulate the air intake.

After the fire is started the no become a cherry red, and it is clai that they remain in that state until fire is banked for the night. The p-ratus is designed to work automatically, th or without an electric fan. It is ilt with taper tubes, so as to give v y to the air as it escapes from the u r end. The cylinder is made of h v steel, and long enough to meet e g conditions. The steel sleeve is ri d to the cylinder which is connected w a conduit. An installation, it is cl ed, is guaranteed for five years, with th exception of the electric fan.



"NORTH" HOT-AIR BLAST APPLIED TO RETURN-TUBULAR BOILER

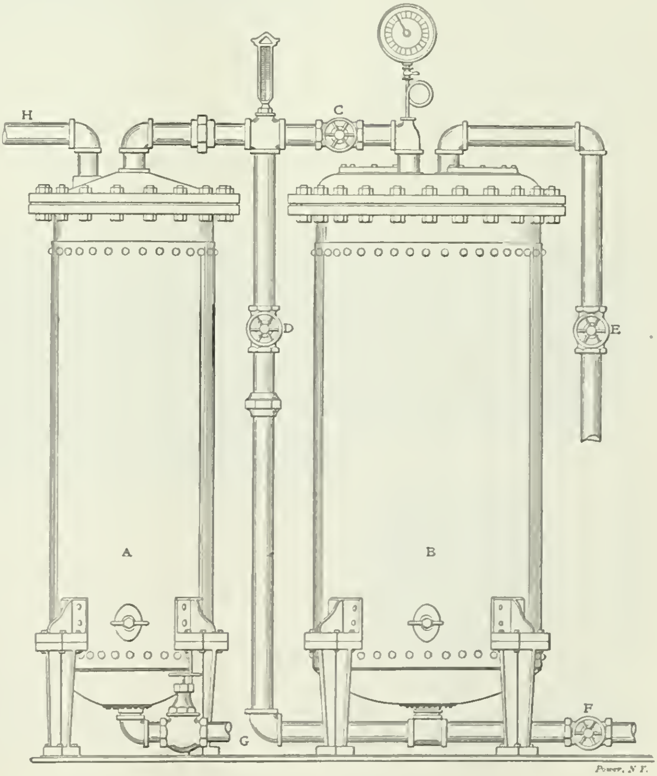
## Iorrison" Water Purifier and Softener

e "Morrison" water purifier and so ner is manufactured by the Steam A ance Manufacturing Company, Ba- ta N. Y. The purpose of this device is furnish a steady flow of soft, clean, cl water from which scale-forming ma ial has been eliminated before the ar enters the boiler. It consists of w metal tanks piped together. The e e does not take up much room, is e s mple to operate and should not get u f order. The operation is as fol-

e water is taken from the exhaust ea r to a live-steam heater, and from the ve-steam heater through the pipe *H* to precipitating tank *A*, passing through wh it enters through the valve *C* to t e lter *B*. It then passes through a filt ng bed and strainer at the bottom an out through the valve *F* to the boil- er. n the passage of the water through the ank, it is claimed that the scale- for ng material is eliminated and that troile from this source does not occur.

T clean the filter, the valves *C* and *F* are osed and valves *D* and *E* allowed to remain open, the water being bypassed and taking a reverse direction through the filter bed and out through the strainer and valve *E* to the sewer. In cleaning the filter, it is not necessary to use the precipitating tank, only in the case of extremely muddy water or water impregnated with foul material.

These tanks are built of boiler iron, having cast iron heads of sufficient strength to withstand the pressure and are equipped with heavy perforated copper strainers. Brass valves and all unions and joints are packed with rubber gaskets, and the strainers are so arranged as to be easily cared for.



"MORRISON" WATER PURIFIER AND SOFTENER

## The American Feed Water Purifier

The American feed-water purifier is designed to *purify* the boiler-feed water by causing sedimentation of the earthly salts, thereby preventing the formation of scale in the boiler. It is placed inside the boiler, and subjects the feed water to extreme temperatures before it comes in contact with the boiler shell.

The American feed-water purifier contains no complex pipes to clog and cause leakage, no valves to get out of order or intricate mechanism of any kind. In form it is an elongated cylinder of elliptical section, divided into three compartments or sediment pans. The partitions separating the compartments are connected by valves of the hinged gravity type, each partition being provided with two valves opening in opposite directions.

Entering through the feed-water line at the intake end, the water backs up against and closes the lower valve of the first compartment, and continues to rise until it reaches the overflow point at the level of the upper valve, whence it flows into the second compartment. Here the same operation is repeated, the water overflowing into the third and final compartment, where it reaches its highest temperature, and from which it passes into the boiler through the outlet.

Precipitation takes place in the different compartments with great rapidity, and the temperature of each compartment being successively higher than the preceding, the salts that fail to deposit in the first and second compartments are said to precipitate respectively in the second and third.

One of the most important features of the purifier is the system by means of which the blowoff is utilized to remove the scale that is formed in the purifier itself.

By shutting off the valve of the feed-water line, and opening the blowoff valve, both of which are conveniently located at the end of the boiler, the blowoff takes place through the purifier, from end to end, in a straight line.

The process is all the more effective from the fact that the blowoff automatically closes the upper valves of the purifier, leaving the lower valves as its only means of escape.

Another important point in connection with the blowoff is the shortness and ample diameter of the line between the feed-water terminus and the head of the purifier. It is impossible for this pipe to clog, whereas so-called internal purifiers consisting of a coil and short reservoir, invariably become clogged sooner or later, and not being connected with the blowoff, are likely to remain so.

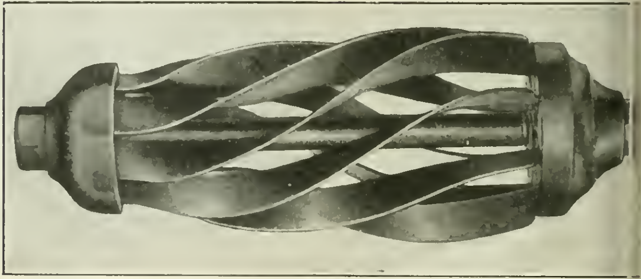
The purifier is also said to reduce priming to a minimum. Its position in the boiler brings its upper surface on a line with the water level. When blowing off, a part of the surface water is carried back through the purifier, and any oil that may have collected on the surface is blown out through the waste pipe along with the water and steam.

The purifier can be used in any boiler, and is easily installed. In boilers of the fire-tube type it rests on the tubes, and is secured to them by means of straps. In water-tube boilers it is supported by cradles.

Its position, as to hight, is determined in both cases by the average high of water in the boiler, the object being to place the upper surface of the purifier as close as possible to the mean water level.

This feed-water purifier is manufact by the Roché Engineering Comp Weightman building, Philadelphia, P

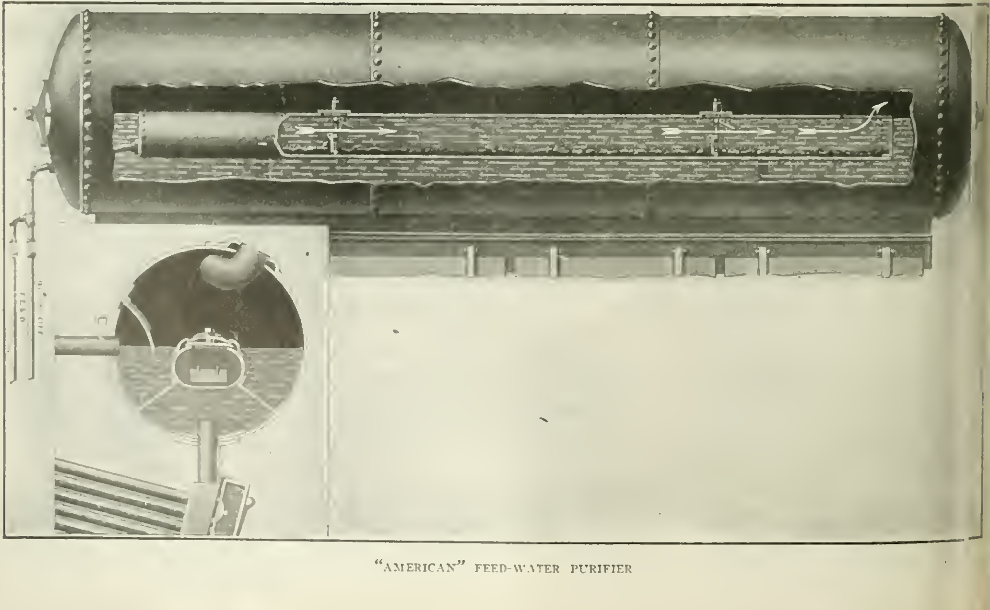
## The Ryerson Adjustable Han Flue Cleaner



RYERSON ADJUSTABLE HAND FLUE CLEANER

The illustration shows a simple an ficient hand flue cleaner which has cently been brought out by Josep Ryerson & Son, Chicago.

Two nuts on a single bolt are all are required to hold the parts toge The eight scraping blades which been provided are made fast at one



"AMERICAN" FEED-WATER PURIFIER

of the cleaner, the other ends being free to move radially inward. This gives the cleaner a degree of adjustability enabling it to meet any ordinary variations in the tube diameter and thoroughly clean the surfaces. The blades are made of spring steel and are so placed as to be easily emovable in case it is necessary to make epairs. It is claimed for this cleaner that he temperatures met with in service will t cause it to lose its temper.

## Society Notes

George A. Orrok will speak to the tudent Section of the American Society f Mechanical Engineers at Columbia niversity on Friday evening, December on "Gas Engine and Blast Furnace ractice."

The annual entertainment and smoker Jersey City No. 10, N. A. S. E., of ew Jersey, was held at their rooms, 148 ewark avenue, Jersey City, N. J., on e evening of November 20. Over 400 embers and their friends, including delegations from New York and Brooklyn, d a royal good time. The entertainment as furnished by "The Bunch."

The Boston members of the American ciety of Mechanical Engineers will ld a meeting on Friday evening, ember 17, at 8 o'clock, in the library the Edison Electrical Illuminating mpany, 39 Boylston street. Prof. I. Hollis, Prof. Edward F. Miller and S. Mann, of Schenectady, will each ad short papers on the "Use of Cast n for Fittings in Superheated Steam es." John Primrose, engineer of the wer Specialty Company, and some hers will present discussion on the r.

The American Association of Refrigeration, affiliated with the International ciation of Refrigeration, the headarters of which are at Paris, France, completed its organization by the ection of the following officers: Honary president, Frank D. La Lanne, esident National Board of Trade, adelphia, Penn.; president, Homer Daniel, Cleveland, O.; vice-presidents, O. McCormick, Chicago, Ill.; Theore O. Vilter, Milwaukee, Wis.; John Starr, New York, N. Y.; W. J. Rush-, Birmingham, Ala.; treasurer, John Field, Chicago, Ill.; secretary, J. F. kerson, Chicago, Ill.

The constitution and bylaws of the ociation provide for two different ades of members: regular members, th annual dues of $10, and donating mbers, paying annual dues from $50 $100. Any person, firm or corporation erested in or closely connected with refrigerating industry is eligible for mbership. Annual dues include anal membership fee in the International Association of Refrigeration, as well as membership in the Second International Congress of Refrigeration, to be held in Vienna, September 29 to October 3, 1910.

The twentieth meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers was held on November 19 and 20, at Lima, O. At the opening exercises Rev. Dr. Bowser welcomed the association to the city, after which the presidential address, "Power Costs for Factories," was read by F. W. Ballard. In this paper methods of arriving at power costs in different departments of an industrial establishment were outlined, an analysis of the benefits to be derived thereby was made and sample record sheets and load curves were presented.

Other papers read at the sessions following were, "The New Laboratory of the Department of Mechanical Engineering at the Ohio State University," by E. A. Hitchcock; "The Darling Oil Gas Producer," by A. B. Davis; "Turbine Pumps," by Wetmore H. Titus, and "Some Notes on Coal and Ash Handling Equipment," by David Gaehr.

At the business meeting held before the regular session Saturday morning, new officers were elected as follows: O. F. Rabbe, of Toledo, president; Grant Miller, of Cincinnati, vice-president, and F. C. Sanborn, Ohio State University, Columbus, O., secretary and treasurer.

The cordial manner in which the society was received at Lima was remarked by all, and an interesting program of visits to local industries had been arranged by the entertainment committee. The plant of the Solar Refining Company occupied the attention of the visitors for an entire afternoon, and it is a notable fact that no society had ever before had access to these works. The immense plant of the Deisel-Wemmer cigar factory was also visited, and by special invitation of the management, opportunity was given of inspecting the works of the Lima Locomotive and Machine Company, the home of the famous Shey-geared logging and mining engines. This plant had many interesting features which engaged the attention of the visitors for several hours. The last plant to be visited was that of the Gas Power Producing Company, where the construction of gas engines and oil-gas producers were shown in detail.

Cincinnati was chosen as the place of next meeting, which will occur in May, on date to be determined later.

The pipe connecting the steam gage should be cleaned out at least once a month by blowing steam through it. When the gage is off, the hole in the nipple should be perfectly clear.

When there are two or more boilers on one line, those not in operation should be shut off from the header.

## Engineering Societies

### AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., Jesse M. Smith, New York, N. Y.; sec., Calvin W. Rice, Engineering building, 29 West 39th St., New York. Next meeting, New York, December 7-10, 1909.

### NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Wm. C. L. Eglin, Philadelphia, Pa.; sec. and treas., John F. Gilchrist, 139 Adams St., Chicago, Ill. Association headquarters, 29 W. Thirty-ninth St., New York.

### ENGINEERS' CLUB OF PHILADELPHIA

Pres., W. P. Dallett; sec., W. P. Taylor, 1317 Spruce St. Regular meetings 1st and 3d Saturdays.

### AMERICAN SOCIETY OF NAVAL ENGINEERS

Navy Dept., Washington, D. C. Pres., Rear Admiral John K. Barton (retired) U. S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N.

### AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, Cleveland, O.

### WESTERN SOCIETY OF ENGINEERS

Pres., Andrews Allen; sec., J. H. Warder, 1737 Monadnock Block, Chicago, Ill.

### ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., George T. Barnsley; sec., E. K. Hiles, 803 Fulton building, Pittsburg, Pa. Meetings 1st and 3d Tuesdays.

### AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., Louis A. Ferguson; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly, excepting July and August.

### ENGINE BUILDERS' ASSOCIATION OF THE UNITED STATES

Pres., A. L. Merriam, Oswego, N. Y.; sec., C. H. Sembower, Reading, Pa.

### UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, W. S. Cadwell, Chicago, Ill.; sec., Thomas H. Jones, 241 Eighth street, N. E., Washington, D. C. Next convention, Buffalo, N. Y., August, 1910.

### NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., William J. Reynolds, Hoboken, N. J.; sec., F. W. Raven, 325 Manhattan building, Chicago, Ill. Next convention, Rochester, N. Y., September, 1910.

### AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next convention, Philadelphia, Pa., June, 1910.

### OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS

Pres., F. W. Ballard; sec., David Gaehr, 1135 Schofield Bldg., Cleveland, O.

### MASTER STEAM BOILER MAKERS' ASSOCIATION

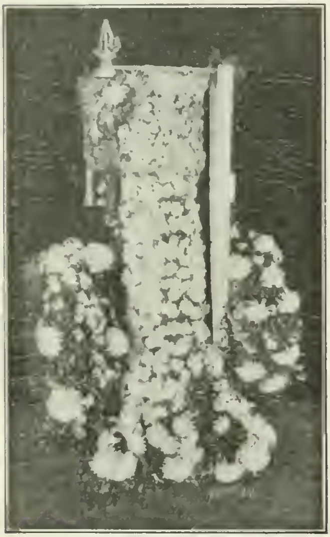
Pres., J. H. Smyth; sec., Geo. M. Clark, 1337 N. Maplewood Ave., Chicago, Ill.

### INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., Robert A. McKee, Peoria, Ill. Next convention, Denver, Colo., September, 1910.

## Obituary

No greater calamity could have occurred to mar the approaching Christmas festivities of the chief engineers of the various pumping stations of the city of Chicago than that which occurred on November 10, by the loss of the father of them all, Thomas Reynolds, chief engineer of the Sixty eighth street water works. The funeral was the largest that ever went through South Chicago, and among the many floral tributes was the one illustrated on this page. It was designed by the chief engineers and represented an engine made entirely of flowers. As will be noted, the governor belt is off the lower pulley, indicating that the governor is out of service, or in other words, the uplifting influence of Tom Reynolds over his brother chief engineers is no longer active. His death is greatly regretted by all.



FLORAL TRIBUTE TO THOMAS REYNOLDS

## Business Items

The Blake Pump and Condenser Company, Fitchburg, Mass., has just installed in the Albany street power station of the Boston Elevated Railroad a 5000-horsepower vertical twin air pump and jet condenser They have also installed a 16x30x34 horizontal jet condenser at the plant of the New England Cotton Yarn Company, New Bedford, Mass.

The McLeod & Henry Company, Troy, N. Y., manufacturer of steel mixture boiler setting material, will in future be represented in Chicago and vicinity by Stephen Christie, who has a wide circle of acquaintance in the engineering profession and a large experience in the boiler and setting business. Mr. Christie's office will be at 171 La Salle street.

Frank J. Corbett, who is well known in engineering circles and a prominent member of "The Bunch" of entertainers, has become connected with the selling force of the brass goods department of Manning, Maxwell & Moore, including the Consolidated Safety Valve Company, the Ashcroft Manufacturing Company, the Hayden Derby Manufacturing Company and the Hancock Inspirator Company. Mr. Corbett will make his headquarters at the general offices, 85-89 Liberty street, New York.

After several weeks of negotiation, a deal has been consummated between the Davis Clutch Company, of Cleveland, Ohio, and the Wooster Machine Company, Wooster, Ohio, amalgamating the two concerns. The Davis Company has been manufacturing an improved design in friction clutches and outgrew its facilities for getting out its orders. By consolidating with the Wooster Machine Company, there will be ample facilities for taking the best care possible of the trade and expediting shipments. The Wooster Company's machine shop and foundry will be equipped with every detail necessary to the production of clutches for gas or gasolene engines, counter or line shafts and special machinery. The officers and directors of the Wooster Machine Company will supervise the conduct of the business as heretofore, and Mr. C. E. Mouck, who managed the Davis Company, will assume charge of the sales department. G. W. Jackson, an expert on clutch mechanisms, who was superintendent of the Davis Company, will take charge of the clutch department.

## New Equipment

The Leon (Iowa) Electric Company will erect a new power house.

The Blommer Ice Cream Company, Milwaukee, Wis., will erect a new factory.

John Schmalz & Sons, bakers, Hoboken, N. J., are erecting a large new plant. Modern power plant is to be installed.

F. W. H. Zimmer, Moscow, Russia, would like catalogs of apparatus for breweries, soap works, goods for railways, tramways and factories.

## Help Wanted

*Advertisements under this head are serted for 25 cents per line. About six wor make a line.*

WANTED—Thoroughly competent stea specialty salesman; one that can sell hig grade goods. Address "M. M. Co.," Powe

AN ENGINEER in each town to sell t best rocking grate for s   n boilers. Wri Martin Grate Co., 281 I   rn St., Chicag

WANTED—An experienced turbine engine to take charge of a new turbine elect power station now being erected; give expe ence and references, also state salary desire Box 80, POWER.

WANTED—In New Jersey, a mechanic draftsman, familiar with general constru tion work, who has had some experience photography; state experience and sala Box 78, POWER.

WANTED—Large engine shop wants p gressive head foreman to increase productio excellent opportunity; position steady; m be an aggressive hustler with experience; g references. Address Box 72, POWER.

SUPERINTENDENT—Qualified to take tire charge of plant manufacturing brass a iron valves, fittings and steam specialt from foundry to finished article; also miliar with high-pressure piping installation give references and full details regarding m chanical and executive experience; good p tion for high-grade man; communicatio strictly confidential. Address Box 73, Pow

## Situations Wanted

*Advertisements under this head are serted for 25 cents per line. About six wor make a line.*

FIRST-CLASS DRAFTSMAN, 7 years' perience in designing and supervising elect plants and gas plants, reinforced concr and structural work, wants position in C cago or near that city. Box 79, POWER.

ELECTRICAL ENGINEER with highest r erences, wishes to form connection with g concern, preferably in or near New Yor three years' experience in Mexico, five ye in Chili; speaks Spanish and German fluentl has had wide experience both in selling a constructing electrical, steam and hydrau machinery; open for immediate engageme Address "H. K. W.," Box 71, POWER.

## Miscellaneous

*Advertisements under this head are serted for 25 cents per line. About six wor make a line.*

PATENTS secured. C. L. Parker, Solici of Patents, 4 McGill Bldg., Washington, D.

ANY FIRM or engineer in charge of steam plant that is troubled with scale in t boilers can get absolutely free, the best in cator and reducing wheel made, with velv lined mahogany case. For particulars, dress Great Lakes Chemical Works, Mani woc, Wis.

## For Sale

*Advertisements under this head are serted for 25 cents per line. About six wor make a line.*

FOR SALE—20x48 Wheelock engine a two 72"x18' high pressure tubular boilers good condition cheap. Address "Enginee Box 2, Station A, Cincinnati, Ohio.

FOR SALE—Two 14x30 Wetherill-Corl right-hand and left-hand engines coupled gether on one shaft, with two flywheels 10 by 29 in.; in perfect condition and can seen running. Box 81, POWER.

FOR SALE—Cheap six 66"x18' 0" seco hand tubular boiler shells with sixty-six tubes, good for 125 pounds steam pressu also four 42" steel stacks 90' 0" long a one 72" stack 90' 0" long heavy plate. dress Box 76, POWER.

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# nstalling a Power Plant Under Difficulties

## Account of Difficulties Encountered in Transporting Apparatus Five Miles through Mud; Also Method of Welding a Broken Flywheel

### BY WARREN O. ROGERS

Nestling in the valley formed by two es of the Blue Ridge range of mount- s, near the town of Webster, N. C., the temporary power plant of the Con- idated Nickel Company.

The present plant consists of four icks 7x20-foot return-tubular boilers, h of 200 horsepower capacity, and one oo-horsepower extra heavy-duty Hamil- n Corliss engine. When the present elting plant is completed, which will at a cost of $600,000, there will be a al of eight boilers, having a capacity 1600 boiler horsepower.

As the plant is to be used for the re- tion of nickel ores the three gen- t rs, built by the Western Electric pany, are of special design, each hav- two commutators so as to handle the rage load of 6800 amperes without ng. In fact, the entire electrical ipment is of special design, extra- avy busbars being used, the slate chboard panel being 4 inches thick d the circuit breaker the largest ever de in the United States. The gen- t rs are guaranteed to withstand an rload of 150 per cent. for ten seconds, per cent. overload for two hours and a total of 20,400 amperes at all times.

is not so much the size, or design of t power plant, that this article has to d with, but rather with the transportation difficulties encountered from the time the engines and boilers were shipped from the factory until they were safely housed in the power plant, the construction of which necessitated the building of a sawmill, the cutting of green timber and preparing the same, while the sand used in the cement and concrete work was carted for a distance of five miles.

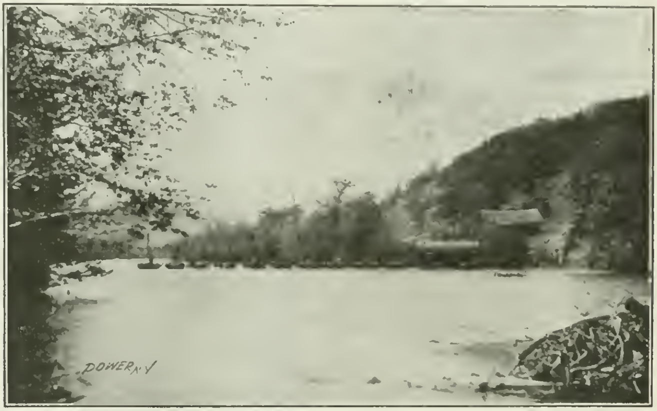


FIG. 1. BOILER AND TWENTY-OX TEAM CROSSING RIVER

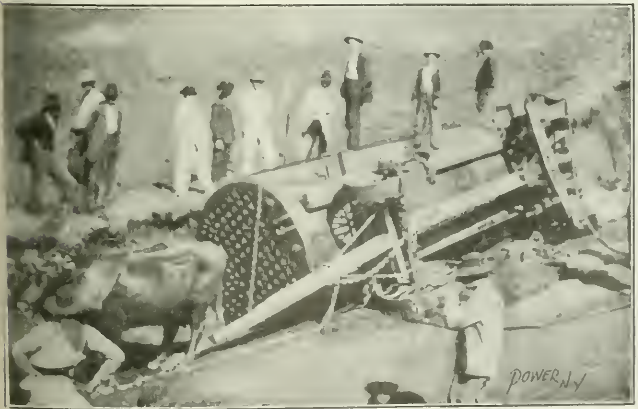


FIG. 2 A DISCOURAGING SITUATION

### TEAMING THE BOILERS

The boilers arrived at the railroad station at Sylva, N. C., without mishap. Each boiler weighed 17 tons, and as the soil of North Carolina has a peculiarity of its own; that is, after a rain the mud crusts over, and while looking solid on top merely conceals the under layer of mud, making treacherous teaming for heavy loads. Special teams were shipped to Sylva to transport the boilers and engines from the railroad station to the site of the plant, a distance of five miles. Not only was there much to contend with from inexperienced workmen, but steep hills, mud holes, two rivers 200 feet wide to ford, there being no bridges, were met with and overcome. Considerable ingenuity and perseverance were required to move the boilers, it requiring three weeks to transport one boiler five miles, another 32 hours, the third 39 hours and the fourth encountered all kinds of troubles, due to continuous rains and miring of the trucks.

In Fig. 1 is shown one of the boilers on a special wagon to which are yoked twenty oxen crossing one of the rivers. At the right of the illustration, it will be observed that the road runs parallel with the river, which necessitated a sharp turn in order to descend the steep bank 12 [illegible] This was accomplished by [illegible] swinging the wagon and the load around at almost right angles before the ascent to the [illegible] could be made with the aid of "deadmen" on the side, [illegible] block and tackle at the [illegible] swinging it one way at a time, and holding the boilers and wagon by the [illegible] "deadmen." The state of the road can be imagined if one can conceive of making progress of but 110 feet in two days' time, owing to the necessity of

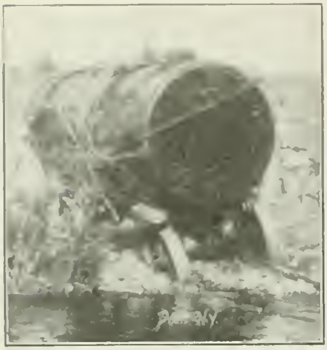


FIG. 3 ALMOST IDEAL GOING

jacking the wagon up out of the mud holes, no sooner getting out of one than into another. Today the trail is strewn with timber, slabs and broken tackle used

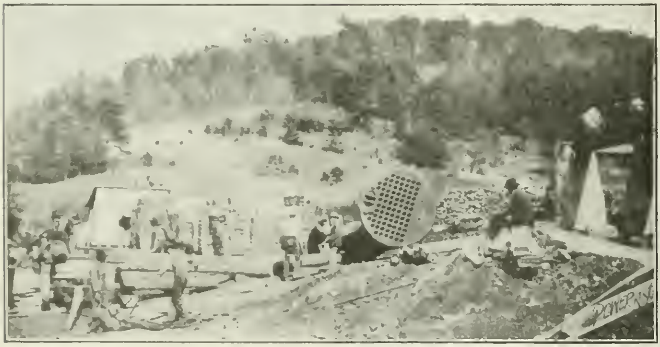


FIG. 4. ARRIVAL OF THE FIRST BOILER

in the transportation of the boilers and engine.

### A Spill

In Fig. 2 is shown what got to be almost a habit. In this particular instance the boiler was being eased down a steep hill, on what appeared to be apparently good road, but the wheels on one side broke through the crust over the mud, the "deadmen" on the opposite side gave way, the boiler and wagon tipping over on their side. The agility of one of the mountaineers who was on the under side of the boilers enabled him to escape death by jumping under the wagon as it tipped, which left him in the road without injury.

Fig. 3 shows a stretch of extra good going. The wheels on one side of the wagon have sunk a trifle, but when compared to what had been encountered, and what was met with after, the condition was almost ideal.

As it was impossible to get the boilers, while on the wagon, directly to the boiler-room site, they were unloaded at the base of a small hill and rolled into position on timbers, as shown in Fig. 4, ropes being placed around, and under the boilers, and oxen attached to the same, thus hauling the boilers up the incline without difficulty.

### Another Spill

The Hamilton Corliss engine was shipped from the factory at Hamilton, O., the flywheel being loaded on special flat cars in order to permit it passing through the tunnels to be met with *en route*. Even with this precaution a detour of 500 miles had to be made in order to avoid tunnels through which the wheel could not pass. Other than this no trouble was encountered until the car, on which two half sections of the flywheel were loaded, reached a point 300 feet from its point of delivery, where, owing to a sh curve in the track, the car tipped a li then a little more, the wheel secti gradually leaned toward the inside of curve, when, with a crash, wheel, car all tipped over, leaving the flywhee wreck.

The double wheel, 24 feet in diame had a 74-inch face and was made in sections, each weighing 11 tons. The u section of the ditched wheel was u jured, but the top section was broke

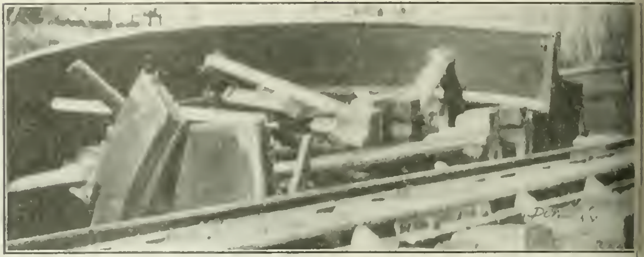


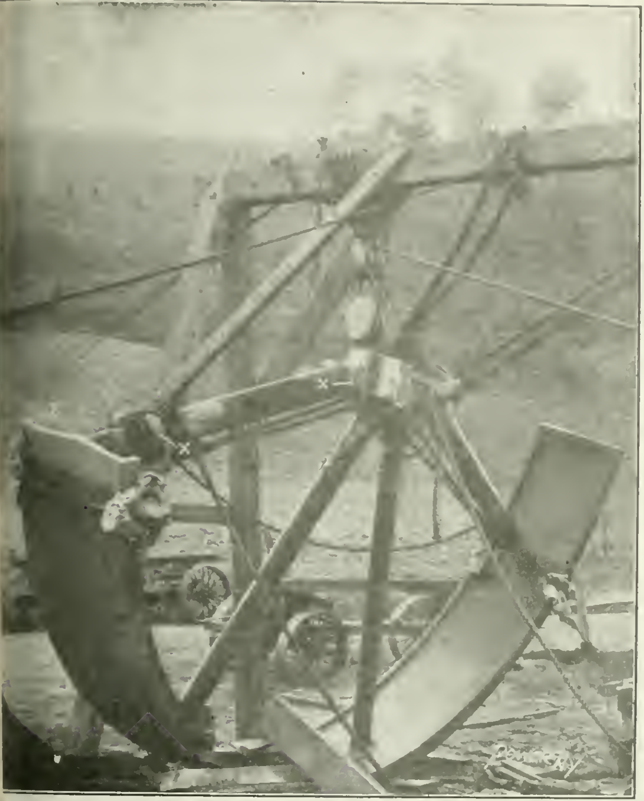
FIG. 5. SHOWING BROKEN FLYWHEEL SECTION

four pieces, one spoke in two places a piece out of the rim 4 feet long. 5 shows the wrecked wheel as it lay a the accident, also the broken parts.

One can well imagine the feeling those who were interested in instal this machinery. After overcoming stacles due to tunnels, and delays transportation, to have the wheel br at its journey's end was a little m than was anticipated. If a new sec were to be ordered it meant delay shipping, delay in transportation more delay in teaming from the rail station to the plant, besides the ch that a repetition of the same acci might occur.

### Welding the Wheel

It was, therefore, decided to repair wheel by welding the broken parts gether by the Thermit process. Exp on such matters declared that it could be successfully accomplished on suc large wheel, the makers of the en agreeing with them, but Cha Theodore Hennig, Ph.D., metallur chemist and designer of the plant, was superintending the work, tho otherwise. The spoke was first wel as shown in Fig. 6 at *X X*, the bro edge of the rim showing at *Z*. It then blocked as shown in Fig. 7, a we section of the spoke showing at *X*, the weld of the rim at *Y*. This par the work was carried on successfully far as the welding went, but an u pected rain storm came up during cooling process and the wheel, being posed to the elements, due to the s built over it burning down from the heat, developed a longitudinal crac



FI 6. METHOD OF SUSPENDING WHEEL SECTION, ALSO SHOWING WELDED SPOKE

t rim 3 feet long from the sudden g of the metal. This taught the that when welding large castings p them from rain and water before late.

hough this mishap was a decided k, and somewhat checked all tend es to boisterous exaltation over the ss of the weld itself, work was at begun to patch and strengthen the r This was done by reinforcing it w a ½-inch steel plate, 7 feet long, bent up at the sides to conform to t ge of the inside of the wheel r and secured by bolts as shown in 8 Owing to the rough surface of h wheel, spaces were left between the r and the plate, and, fearing the bolts w work loose when the wheel was n operation, type metal was melted an run in between the two, making a joint. This put the wheel out of a ce, of course, and to counteract this eff another plate was secured on the p site side in like manner and type m poured in to fill up the space, thus pr ically balancing the wheel.

ter the wheel was placed on the shaft a homemade grinding machine was rigged up It consisted of two arms, fitted to the shaft, one on either side of the wheel, similar to the method of fitting an eccentric strap to the eccentric of an engine, the arms being free to turn on the shaft On the outer end of the arm adjustable boxes were fitted, in which the emery wheel shaft ran This wheel was belted to a small engine used to run the emery wheel, which ground the metal on the face of the rim to a true surface by being worked back and forth over the rim. The edge of the rim was trued up in like manner

The plant has just been started, and as the flywheel has been insured for $50,000 by a prominent flywheel accident insurance company, the inspector stating the welded sections are the strongest part of the whole wheel, the indications are that the welding was not only an ingenious, but thoroughly good job. It required several days to get ready to patch each break, the welding process requiring less than one minute each.

### MORE TROUBLES

This did not complete the succession of troubles by any means, for, while no more apparatus was broken, there were other encounters that kept everyone wondering what would happen next. After the wheel was repaired the sections were loaded on trucks of special design, and the start made from the railroad track, where the repairs had been made, to the plant five miles distant. In Fig. 9 is shown one method of righting a capsized flywheel section and wagon. In this particular instance, as in others, the wheels on one side of the wagon broke through the

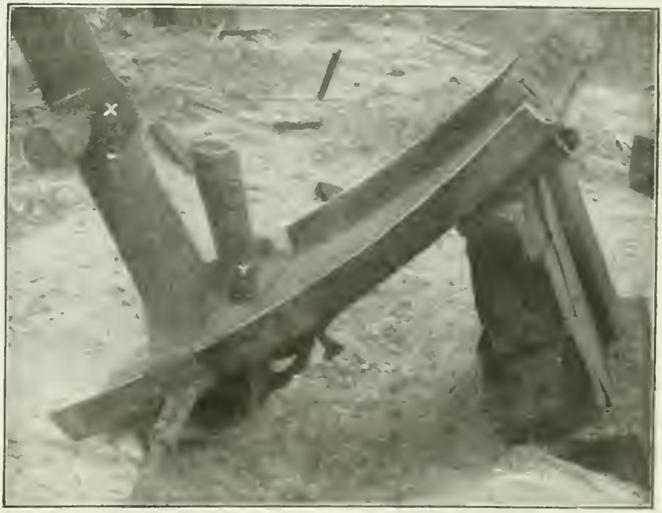


FIG. 7. NEAR VIEW OF WELDED RIM AND SPOKE

[illegible] moving an under [illegible] of mud. The use of "leadmen" as shown enabled the mountaineers, under proper direction, to right matters, when the tortoise like pace was resumed.

FIG. 8. SHOWING REINFORCEMENT PLATE ON THE RIM

The crank shaft, weighing 23 tons, was stuck for 10 days in one mud hole, and one method of getting ahead frequently employed was to attach six yoke of oxen to the lead, and using block and tackle to hoist and pull the wagon out of the mud, which was the worst known in that section for years, there having been but 11 days of pleasant weather in two months. Two weeks were required to get one section of the wheel from the railroad station to the power plant. The work was done by mountaineers and their oxen, some of which came from a distance of 40 miles. With no mechanical education or even common-school learning, only six out of the hundred men being able to write their names, mechanical experience was sadly lacking.

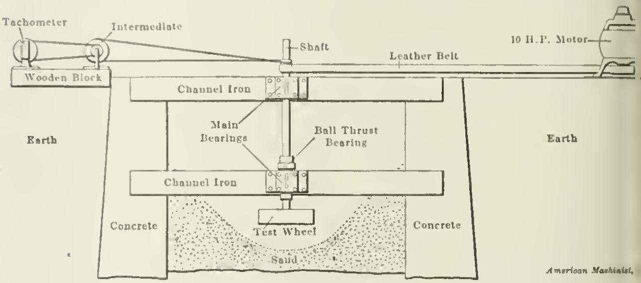
FIG. 9. CAPSIZED SECTION OF FLYWHEEL

Considerable credit should be given Mr. Hennig, and his associate in direct charge of the work for the manner in which difficulties and obstacles were overcome, all of which emphasize the fact that "where there's a will there's a way."

# Flywheel Testing Pit at Purdue University

By C. H. Benjamin

A new plant for the testing at high speed of flywheels, pulleys and other rotating pieces has recently been installed at Purdue university. Some former experiments along these lines have shown the unsafe character of means hitherto employed for preventing the dispersion of the fragments. Following the lead of a German experimenter, who has used a similar device for testing emery wheels, it was decided to use a vertical shaft extending downward into a pit and carrying the test wheel at its extreme lower end. The figure shows the apparatus as constructed and installed.



LONGITUDINAL SECTION OF FLYWHEEL TESTING PLANT AT PURDUE UNIVERSITY

A pit 7 feet deep and 8½ feet in diameter (see cut) is inclosed by a concrete wall, varying in thickness from 6 inches at the top to 1 foot at the bottom. S-able steel channels are inserted in p integral with the wall of the pit and ca the bearings for a vertical shaft 3 inc in diameter. The weight of the shaf carried by a ball thrust bearing, and i driven by a pulley at the upper end. motive power consists of a 10-horsepo direct-current motor, capable of variat in speed from 800 to 240 revoluti per minute. An open leather belt tra mits the power from the motor to operating shaft. The speed of the s pulley is registered by an ordinary pen lum tachometer driven by round c through an intermediate shaft. tachometer is calibrated at frequent tervals while testing, comparing each r ing with that of a center tachometer plied directly to the top of the shaft. calibration shows practically unif readings and no appreciable slip.

Test wheels of any diameter up to 6 can be supported and rotated at the l end of the shaft. Loose sand serves receptacle for the flying fragments, prevents mutilation of the pieces.

As a preliminary to further work the apparatus, sixteen 24-inch pulley various materials were tested to dest tion last spring. When in use, the pit covered by planking loaded with s iron. The experiments thus far show the apparatus to be convenient safe. There is little disturbance ca by bursting of the wheels and fragm embed themselves in the sand without ther injury. The speed can be readily trolled by the motor, and the tachon is so located as to be read without danger to the observers.

It is expected that this plant will be to further use the coming year for ex ments on various flywheel joints—*A can Machinist.*

Before breaking any steam-pipe j s to make repairs, or to renew gas ts, etc., the dead section should be ell drained. Workmen have been sc ed when breaking joints due to some s-sure still remaining in the line afte he main valves were closed. Draw the es and avoid a similar injury.

# A Faulty Heating System

By A. J. Dixon

The heating system in a populously anted public building had become an remitting source of exasperation, alike those occupying quarters in the building and to the engineer and attendants in arge of the apparatus, on account of its r-present propensity to get out of der and refuse to properly perform its ction in a dozen or more different and ely separated places at the same time. prominent feature of this heating outcomprised an equipment of thermostats r automatically regulating the admisn of steam to the various radiators heating coils, the controlling medium ng air compressed to about 15 pounds e per square inch. The admission of compressed air to impingement upon diaphragms by which the steam valves re actuated, and its release therefrom, s controlled by somewhat complicated chanisms under the immediate influence of the thermostats, and to the everlasting proneness of these contrivances to become inoperative by reason of the moisture in the saturated air fouling and obstructing the minute ports and passages therein, was generally due the failure of the heating apparatus.

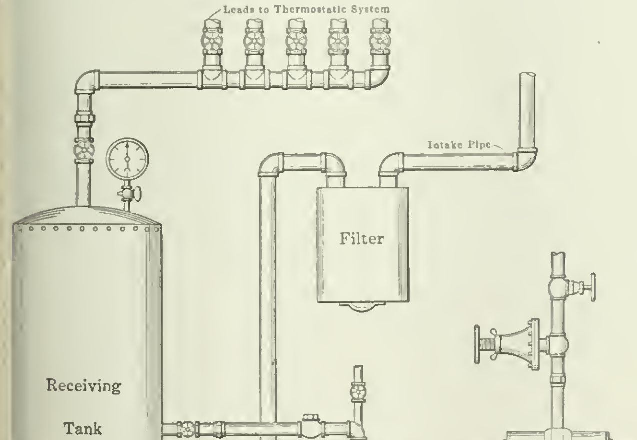


FIG. I. ORIGINAL ARRANGEMENT OF AIR-COMPRESSING PLANT

The equipment for compressing and storing the air, and its manner of distribution, as planned in the original installation, is shown in Fig. 1. The presence of an excessive quantity of moisture in the air flowing through the five leads to the various branches of the system furnished ample evidence of the fact that but a very small percentage of the water, with which the air passing through the intake pipe was laden, was being precipitated in the receiving tank, and likewise made it plainly apparent that a more adequate means for disposing of this moisture would have to be provided before the thermostatic system could be depended upon to properly regulate the temperature of the building. The engineer in charge of the plant, therefore, cast about for an available method for improving the situation, and after pondering various schemes that were advanced, he finally hit upon the device illustrated in Fig. 2.

A tee was inserted in the short riser from the main reservoir, and a $1\frac{1}{2}$-inch branch and riser was carried therefrom to a vertical hight of 130 feet, where it connected with a precipitating tank located upon one of the upper floors. The object aimed at in conveying the air to this hight above the plane of distribution was to provide ample opportunity for the entrained moisture to separate by gravitation from the column of air in its ascension through the long vertical passage, the supposition being that the precipitation produced in this manner, combined with the final separation effected in the upper tank, would result in eliminating the water vapor to such an extent as to provide a practically dry supply of air. Subsequent events proved this surmise to be eminently correct, for after the installation of the contrivance shown in the sketch no further trouble was experienced on account of water interfering with the action of the thermostats.

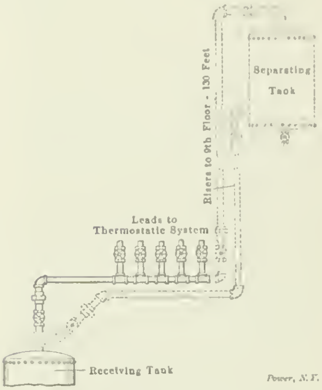


FIG. 2. DOTTED PORTION SHOWS SCHEME FOR REMOVING MOISTURE FROM AIR

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The engine was a 2000-horsepower triple-expansion. Something had gone wrong in the intermediate valve chest, and the trouble appeared to be a bent valve stem and jammed up valve. These were repaired and put together, but when it came to setting the valve, it was impossible to adjust it correctly. The new valve and stem checked up in every way with the old ones. The eccentric seemed all right, for the key could be seen in place. Finally, in desperation, the eccentric was taken off and the trouble found. When the eccentric was originally set on the shaft, a flat keyway was cut. The key was set on it and the two parts of the eccentric bolted together on the key while thus in place. With the extra strain due to the breakage of the valve, the eccentric must have been forced, with the key out of its place. As it was turned over the keyway and the key still showed in its place, it was natural to infer it had not shifted on the shaft. It is probable the bolts holding the two halves of the eccentric were a trifle slack or perhaps they may have stretched a shade under the strain to allow the movement.

# Simple Curves Instead of Table

## Engine Performance Better Shown by Curves Than by Figures; The Willans Straight-line Law for Total Steam Consumption

### BY F. R. LOW

Are you rather out of patience sometimes at the curves and diagrams which appear in POWER, and do you glance over them with scant attention and pass on to something more attractive?

Is it because you have not got the curve habit, because you do not realize how much can be expressed, and how simply, about the varying relations of two quantities by letting vertical distances represent one of them and horizontal distances the other, and drawing a line through the points where the two quantities, laid out to scale in these directions, meet?

The steam engineer has a familiar example of the possibilities of the graphic method in the steam-engine diagram which shows at a glance the manner in which the pressure in the cylinder varies during the revolution. Suppose you knew all this, how much pressure was lost between the boiler and the cylinder, how much more it fell off as the piston speeded up, at what point in the stroke the cutoff happened, how the pressure fell during expansion, when the release occurred, what the back pressure was when the exhaust valve closed. You could not begin to tell it, or write it, or make tables to show it anywhere nearly as simply and plainly and concisely as it is told and shown in the little diagram drawn by the steam-engine indicator.

Suppose a test has been made of an engine at different loads. The results can, of course, be tabulated as in Table 1, so as to show fairly well the manner in which the steam per horsepower-hour varies as the load increases, but see how much better the curve in Fig. 1 shows it than does the table. Here at a glance it is shown not only that the consumption per horsepower is much greater at the lighter loads, but that the case gets rapidly worse as the power diminishes, indicated by the steepness of the curve at the left. The lowest consumption per horsepower is when the load is 100 horsepower. After this the loss of efficiency by the diminished expansion increases the total consumption faster than the horsepower increases and the curve runs upward.

TABLE 1

| H.P. | Steam per H.P.-hour. |
|---|---|
| 10 | 50 |
| 20 | 38 |
| 30 | 30.8 |
| 40 | 26.4 |
| 50 | 24.2 |
| 60 | 23.2 |
| 70 | 22.6 |
| 80 | 22.4 |
| 90 | 22.2 |
| 100 | 22 |
| 110 | 22.2 |
| 120 | 22.6 |

Such a diagram is very simply made. Let us try laying out the test reported in Table 1. Take a sheet of paper ruled into inches, and with each inch subdivided horizontally and vertically into tenths, as in Fig. 1, which is one-third the natural size. Such paper is procurable from dealers in engineering supplies, and a common size is 16x20 inches. The highest horsepower which we have is 120, so that if we allow an inch to each 10 horsepower we can get the full horsepower scale in along the narrow side of the sheet. Let the lower left-hand corner be the zero point of load and mark the heavy inch lines 10, 20, 30, etc., up to 120, as in Fig. 1.

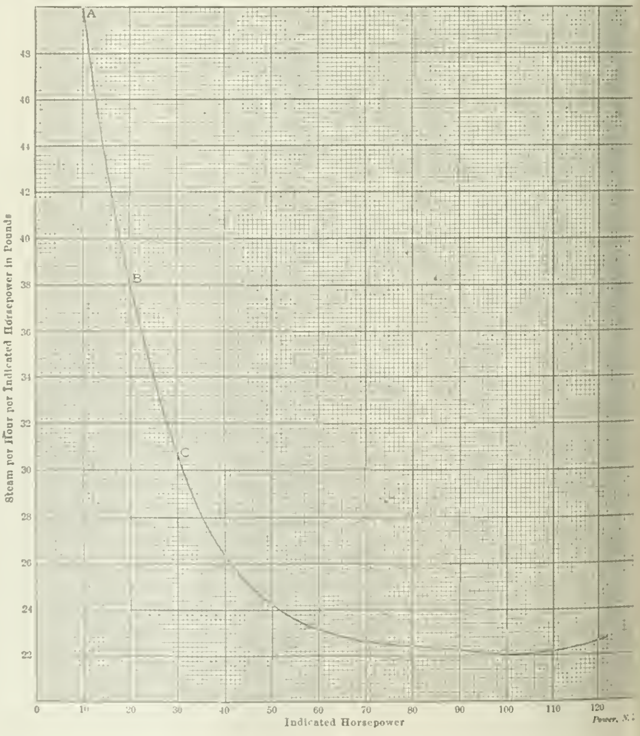


FIG. 1. DECREASE OF STEAM CONSUMPTION AS THE LOAD INCREASES

The highest steam consumption is 50 and the lowest 22, so that vertically have to provide for a range of 50 — 2. 28 pounds. If we use a scale of 2 pou to the inch, the diagram will be 14 inc high. Start one inch above the bott so that the curve will not run into base line, and number the successive he lines 22, 24, 26, etc., up to 50, as sh at the left in Fig. 1.

At 10 horsepower the engine took pounds of steam per horsepower-hour. the point A, where the vertical line fo horsepower crosses the horizontal line 50 pounds, make a dot. The point B just as easily located at the crossing the ordinate (vertical line) for 20 hor power and the horizontal for 38 pour

Ten of the small divisions into wh the inch is divided vertically repres two pounds, five of them one pound, one of them one-fifth, or 0.2 of a pou locate 30.8 pounds, then, we must it the point at C, four spaces above the of the left-hand scale. It is marked

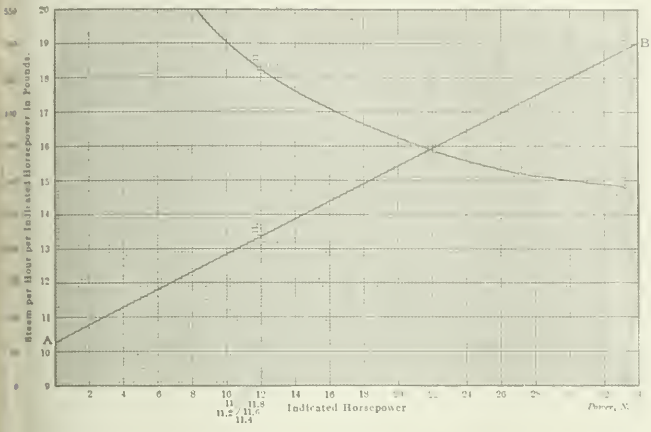


FIG. 2. CURVE FROM COMPOUND WILLANS ENGINE

the vertical line for 30 horsepower se this is the consumption given for load.

e rest of the points are located in ame way and a smooth curve drawn gh them. It is not usual that all points will lie upon so smooth a , but in that case, the smooth curve ld be drawn among the points so that lie to an equal average distance on side from it. This can be done by ng a cardboard or thin ruler. It will times happen that all but one or two points will lie upon a smooth curve, which case the presumption is that was something the matter with those ular tests.

s curve shows at a glance that the ne is working at its best efficiency, is using the least amount of steam indicated horsepower when the load horsepower. So did the table; but curve shows more plainly than did table the manner of the variation and one comes to know a lot of such and to compare their characteris- ey become very interesting. Some much flatter than others, giving a range of loads through which the can be run with little change of cy. A modification of the diagram s some light upon this, too.

Fig. 2 is a curve from a compound s engine plotted through observa- points for four different loads. The re as follows:

TABLE 2.

WILLAN'S COMPOUND

| | |
|---|---|
| pressure, lb. gage | 150 |
| um, inches (about) | 28 |
| er of expansions | 10 |
| Revolutions per minute | 400 |

| I.H.P. | Water per I.H.P.-hour. | Total Water per hour. |
|---|---|---|
| [illegible] | 18.25 | 216.50 |
| [illegible] | 15.83 | 349.73 |
| [illegible] | 15.18 | 411.47 |
| [illegible] | 14.83 | 492.12 |

The horizontal scale is two horsepower to an inch, so that one of the small divisions represents 0.2 of a horsepower.

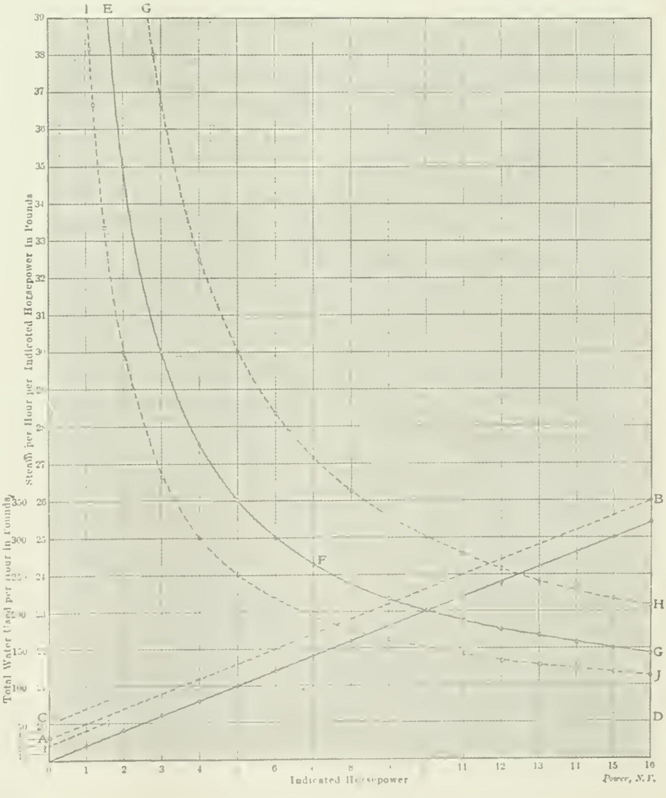


FIG. 3. THE WILLANS LINE

The odd-numbered horsepowers are not marked, but it is easy to see that they come half way between the marked ordinate. I have marked the ordinate for 11 horsepower in the margin, also the intermediates between 11 and 12, 11.8 horsepower would be on the ordinate so marked, 11.83 is 3/20 of the next space to the right, for the whole space represents 0.20 and 11.83 is 0.03 beyond 11.8. There is not much use to try to plot the horsepower to 1/100ths, but it does no harm to plot it as nearly as you can. Drawing the curve through the points indicated shows it to be quite some flatter than that in Fig. 1, and that it is still descending, i.e., the engine will evidently carry a greater load with as good or better efficiency, so long as these conditions are maintained. Notice that the number of expansions is kept constant, so that the initial pressure must increase with the load.

As he describes in a notable paper, presented to the Institution of Civil Engineers, in 1888, it occurred to Mr. Willans, the inventor of the Willans engine, to plot the total water consumed per hour, as well as the water per indicated horsepower. These values are given in the last column of Table 2, and when they are plotted upon the diagram they will be seen to lie practically upon the straight line *A B*, Fig. 2. They are plotted to the vertical scale of 50 pounds to the inch, the outside scale in the left hand margin.

These points would not lie upon a straight line, as they do in test after test, if there were not some reason for it. Let us see what its significance may be.

Take another sheet of paper and, making the lower left-hand corner the zero of both, lay off a vertical scale of total water per hour at 50 pounds to the inch, and a scale of horsepower horizontally at one inch per horsepower. Suppose an engine took 20 pounds of steam per horsepower, whatever its load, and plot the Willans line, Fig. 3. The data would be as follows:

| H.P. | Total Water per hour. | Water per I.H.P.-hour. |
|---|---|---|
| 1 | 20 | 20 |
| 2 | 40 | 20 |
| 3 | 60 | 20 |
| 4 | 80 | 20 |
| 5 | 100 | 20 |
| 6 | 120 | 20 |
| 7 | 140 | 20 |
| 8 | 160 | 20 |
| 9 | 180 | 20 |
| 10 | 200 | 20 |
| 11 | 220 | 20 |
| 12 | 240 | 20 |
| 13 | 260 | 20 |

As the increase is uniform, 20 pounds for each horsepower, the line rises upon the paper the same amount for each equal movement to the right. When you go to the right an inch for another horsepower, you go four spaces vertically for another 20 pounds of water; and the result is that the points lie upon a straight line. All you have to do is to locate a point for 260 pounds and 13 horsepower, and the point o for zero horsepower, and a line connecting them will pass through all the points. The water per indicated horsepower-hour (column 2 divided by column 1) is constant at 20 and the efficiency curve would come down to a straight horizontal line *C D*, on the 20 level of the water per indicated horsepower hour scale, showing that, in accordance with our original assumption, the engine would take as much steam per unit of power developed at one load as at another.

According to this assumption, all the steam used would go to making power. At one-half horsepower 10 pounds of steam would be used, at one-quarter horsepower 5 and at no horsepower no steam. But in the actual engine some steam gets through without developing any power. The steam required is always more than is accounted for by the indicator diagram. It is condensed upon the surfaces and evaporated during exhaust. Suppose that it took 30 pounds of steam per hour thus to take care of the needs of the running engine irrespective of the work, and that the engine still took 20 pounds per horsepower produced in addition to this. Thus at no load the consumption would be 30 pounds and at 13 horsepower 360 + 30 = 390 pounds. The data would be as follows:

| I.H.P. | Total Water per hour. | Water per I.H. P.-hour. |
|---|---|---|
| 0 | 20 | Infinite |
| $\frac{1}{4}$ | 25 | 100 |
| $\frac{1}{2}$ | 30 | 60 |
| 1 | 50 | 50 |
| 2 | 70 | 35 |
| 3 | 90 | 30 |
| 4 | 110 | 27.5 |
| 5 | 130 | 26 |
| 6 | 150 | 25 |
| 7 | 170 | 24$\frac{2}{7}$ |
| 8 | 190 | 23.75 |
| 9 | 210 | 23$\frac{1}{3}$ |
| 10 | 230 | 23 |
| 11 | 250 | 22$\frac{8}{11}$ |
| 12 | 270 | 22.5 |
| 13 | 290 | 22$\frac{1}{7}$ |
| 14 | 310 | 22$\frac{4}{13}$ |
| 15 | 330 | 22 |
| 16 | 350 | 21$\frac{7}{8}$ |

The second column is made by adding the 30 pounds of useless water to t second column of the preceding tal, and the third column is made by dividi the total water per hour as given in second column by the indicated hor power (first column). I have put in fr tional horsepower at the commencem to show how the water per indica horsepower goes up when the load is lig because all the loss is loaded upon a sm amount of power, while of the water quired for the large powers it is a mu smaller proportion. The Willans line n becomes *A B* of Fig. 3, and the efficie curve takes the form *E F G*, instead the straight horizontal line *C D*, wh we got when the Willans line ran the zero of the scale.

You will have no trouble in plott this. Everything is smooth sailing u you come to the 24$\frac{2}{7}$ pounds at 7 hor power. Ten of the little spaces repres a pound; then 10 ÷ 7 = 1$\frac{3}{7}$ of th represent $\frac{1}{7}$ of a pound and 2 × 1$\frac{3}{7}$ 2$\frac{6}{7}$ of them represent $\frac{2}{7}$. So I m the dot at *F*, 2$\frac{6}{7}$ spaces, as nearly a can judge, above the 24 line. For fraction like this, just multiply the nun ator by 10 and divide by the denomina and you will have the number of divisi necessary to represent the fraction w the scale is 1 inch = 1 and the inch divided into tenths as in this case.

I have plotted two other curves, *G H*, above the solid one upon the sumption that the additional steam 50 pounds instead of 30 as in *E F G*, the other, *I J*, upon the assumption t it was 30. You see that as the extra ste becomes smaller the curve tends to flat comes smaller the curve tends to flat out, becoming a flat, straight line w the extra steam becomes zero and Willans line starts from the zero pe

This straight-line law does not hold an engine in which the varying loac met by changing the point of cutoff. a well made test the points lie more ne ly upon a straight line than one wo expect. As the load increases, the due to the lessening range of expans is at first offset by the lessened cylir condensation, but the sacrifice of exp sion gets more serious as the ratio of pansion decreases, and a point is arri at where it more than offsets the g from a lessened range of temperature the cylinder.

The steam turbine follows the Wil law very closely, working the steam it does through a definite range of pansion. It is only when the secon y valve opens and lets steam directly the low-pressure stage that the curve f total water consumption departs terially from a straight line, and this e carried back to zero load shows by s hight above the zero of the total w r scale at zero load what the internal lo s of the machine probably are. Fig. is an excellent example, plotted from a st of a 5500-kilowatt Parsons turbine.

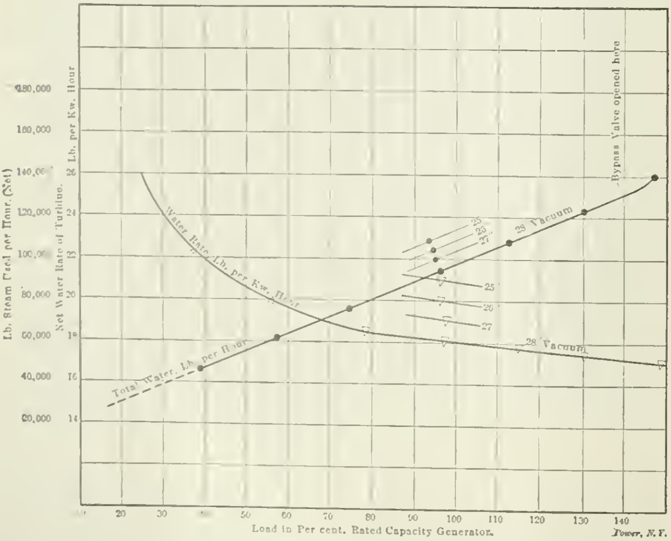


FIG. 4. STEAM TURBINE TEST PLOTTED ON THE WILLANS PLAN

## "Tom" Sawyer on Wet Steam

By F. L. Johnson

One day as I sat watching the exhaust pes and chimney caps on the tops of f a hundred buildings plainly seen m the office window, I began to wonder the temperature range had really anying to do with the economy of the comnd engine. I knew that it was heresy n to wonder if it were not possible to t the same brake horsepower out of a of steam in a single cylinder that ld be got with two or more cylinders, en my reverie was broken by the ence of Sawyer.

Say," he said, before he even started take a seat, "do you know I saw someg the other day that has puzzled me a le lot and mixed me all up in my s about steam pressures and the like? What has upset me is this: In an esishment where a great number of maes were being operated the proprietor convinced that he could buy the m necessary to run his engine for money than he could make it. In t particular case the regular boiler, crying seventy-five pounds pressure, was a t forty feet from the engine, while t proposed boiler, carrying ninety p nds, was several hundred feet distant.

After all of the piping work had been c p'eted and nothing remained to be d to change from the old system to t! new except to open one valve and c e another, the man in charge of the w k went among the machine attendants i e place, telling each that a change in th steam supply was to be made, and that a e new pressure was higher than th ld, the engine would probably run a faster than before, and he asked to be on the watch and prepared the change. As most of the men engaged in 'piece work,' the news welcome.

rning to the engine room, the opr proceeded to make the change. he valves were near each other, one losed while the other was being p ed.

nally, the change was complete, the iler shut off and the steam going t engine through the new pipe. This p was well drained and traps had been r ded to take care of all of the conti n that might occur. A steam ga which was connected to the pipe the engine, registered eighty-five ds.

iling to notice the increase in speed was expected from the increase in pre re, the operator wondered if he had e wrong in expecting a change, and asoned with himself like this: If e ad on the engine had been reduced the eed would have increased some, for w tall throttling governors a change in the oad on the engine will make a slight change in the speed, and increasing the pressure is equivalent to reducing the load and the engine should speed up.

"Going into the workrooms, he was greeted with howls of derision, showers of dirty waste, bundles of rags, blocks of wood and anything that was throwable. Going back to the engine room, he started a new fire under the old boiler and changed the valves back to their former positions. Immediately the engine speed increased and sounds from the workrooms indicated that the speed was more satisfactory.

"Suspicion suggested that the steam gages were off, but changing one for the other showed that they corresponded very closely and that the reason for this behavior of the engine lay outside of the gage reading. And the cause is what gets me.

"Here was an engine that did more work with steam at seventy-five pounds pressure from one source than with steam at eighty-five pounds pressure from another source. This is no 'fairy story;' it is a plain statement of the facts in the case.

"Of course the eighty-five-pound steam was wet, but ample drain pipes took care of all the water and delivered steam as dry as drip pipes could make it, but the engine would not keep up the speed and the question that comes to me now is this: If thirteen per cent. increase in steam pressure reduced the speed of the engine two per cent., how much increase in pressure would it take to stop it entirely?

"I know that a great deal depends on the character of the steam used and that a whole lot of economy is claimed for superheated steam, and I have seen indicator diagrams taken from cylinders with and without superheated steam and the difference in the steam line of the diagrams was remarkable. Where ordinary dry steam was used there was quite a fall in pressure between admission and cutoff, while with superheated steam the line looked as though it might have been drawn with the aid of a ruler, or that the indicator piston stuck at the top of the stroke and stayed there until cutoff took place.

"When I was in a position where I could make experiments along the several lines in which I take so much interest now, I did not think of them and I have often thought that if a small condensing plant should need my services I would get into the harness again for a few years more, for the purpose of getting at the truth, or the lack of it, underlying a whole lot of ideas on the value of certain practices in steam-engine management.

"Of course, like several other people who for the lack of a more euphonious and less complimentary title, are styled cranks, I expect that the day is not so far distant when steam engines will be about as common as horse cars. But that belief does not prevent me from wanting to know whether I have been right and when the truth is found I can throw out my chest and say 'I told you so,' or must admit with 'Joe' Cook that my hypotheses were based on untenable premises."

Just here we were interrupted by the entrance of a man with a new coal-treatment scheme for which he had been offered $75,000,000 by the janitor of the Salvation Army building, which offer was indignantly refused because there was more in it.

In this new scheme run-of-mine anthracite (whatever that is) is taken as a basis. This coal is ground, then mechanically mixed and chemically treated, after which it is made into briquets which, when burned under a boiler or in a cook stove or heating furnace, will last twice as long and give out twice as much heat as the same weight of the best coal. Par value of the stock, one dollar; but a limited number of shares of treasury stock were to be sold at fifty cents for the purpose of raising money to purchase necessary machinery, etc.

Sawyer, saying that he would come in again in a few days, took his way to the elevator, softly whistling, "I'm Glad I Met You."

## What Steam Engine Pistons Endure

The steam-engine concern with which I am connected had a letter from a customer who complained about the wearing out of their pistons, and suggested a change.

In looking over the history I found that the engine was 12-inch stroke, ran 300 revolutions a minute, and had been running nine years.

There was nothing unusual in this, as no doubt all builders can show as good, or better, records; but assuming, as probable, the engine had run 10 hours a day for 300 days in the year, that piston had traveled no less than 184,000 miles in the cylinder. Probably readers will not want to credit this until they have confirmed the figures.

This seemed to be such a revelation to me that I began investigating, and found that one party had one of our engines of 16-inch stroke that was put running January 1, 1893, and has run 24 hours a day for 6 days in the week, 200 revolutions per minute, for over 16 years, making a journey all told of over 606,000 miles. Is it any wonder that pistons and rings and cylinders wear out?—*American Machinist.*

Stop valves should never be located in a position that will permit a head of water to accumulate on the seats when the boilers are idle.

# Another Flywheel Accident

By W. H. Wakeman

Fig. 1 illustrates the valve gear side of a small high-speed engine which drives a dynamo in a mill that is operated 24 hours per day. There are two flywheels on this engine, one of which carries a [illegible] governor in the usual way. The belt is on this wheel.

This wheel gave no sign of trouble until it suddenly came off from the shaft one night, while running at full speed, as shown in Fig. 2, which illustrates the other side of this engine, with the dynamo omitted for convenience. When this wheel struck the floor it required an instant to secure a hold, then it bounded forward at a high speed until it came in contact with a nearly vertical belt which carries a heavy load. The shock broke the belt but the impact, taken in connection with the swift motion of this belt, was sufficient to throw the flywheel back nearly to the engine. When its momentum was spent it ceased to revolve and fell flat without doing further damage.

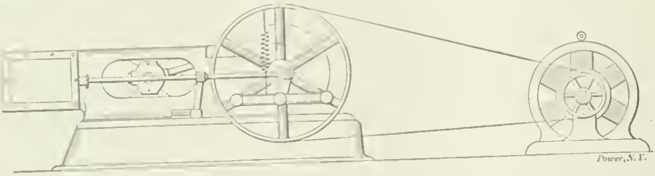


FIG. 1

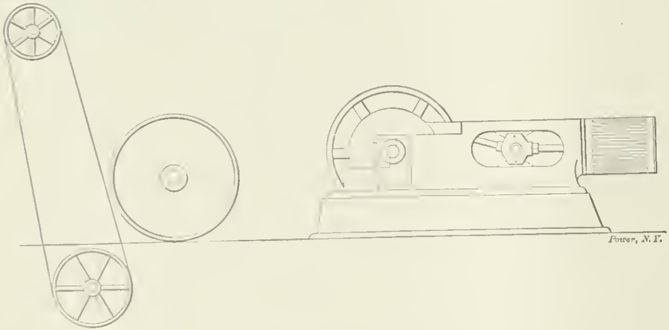


FIG. 2

The chief engineer remarked that the flywheel which carried the belt was firm on the shaft hence there was no need of shutting down the dynamo, therefore the engine continued to run as if nothing had happened until the electric lights were no longer needed, when it was shut down and the wheel replaced. An inexperienced engineer would undoubtedly have shut off steam and thus left the place in darkness (except where gas lights were available), until an examination could be made, and the damage ascertained, but long experience with steam machinery under various conditions in connection with steady nerves enabled this engineer to keep his machinery in motion to the satisfaction of all concerned.

The sudden disappearance of every light in a mill is sure to cause more or less trouble and the result may be a disastrous panic among the operatives, therefore every possible effort ought to be made to prevent shutting down a dynamo while the machinery is in full operation. If it becomes necessary to shut off the flow of current before the end of a shift, notice ought to be given to the foreman of each room. There may not be time enough to do this in all cases, but the need of such action ought not to be forgotten or overlooked.

There are two plans for fastening a loose wheel without delay. One is to use a prick punch on the shaft until it looks like a pepperbox, assuming that the hub is bored out larger than it ought to be, and that the roughened surface will enlarge the shaft. This is not a good idea because in order to make it effective the wheel must be driven on the shaft, and the principle involved is not desirable. Even if it is possible to do this without disfiguring the hub, the two parts are not in perfect contact, hence the wheel will probably work loose again.

The best plan is to make a larger key, but this would usually cause too much delay, therefore a liner made of tin or thin sheet iron may be put under the key, and if it is the right thickness to make a tight fit, the wheel will be held in place indefinitely.

# A Convenient Power-plant Reco

The accompanying chart shows
method employed by a certain engin
in Massachusetts in keeping a record
the operation of his plant, which in t
particular case furnished power to a c
ton and silk mill. It will be noted t
the amount of water and coal used, a
the cost of operation per kilowatt-hour
given in a form convenient for ready r
erence. When the owner of the
wishes to know what his power is cost
him, it is usually a matter for the bo
keeping department to determine fr
the reports handed in by the engin
This, of course, takes considerable ti
and ordinarily the data would not be
ranged in such convenient form fo
comparison from week to week of
operation of the plant for an entire y
The chart is not only a convenient
erence for the management, but is
of great help to the engineer, for at
end of the week or month he can com
the data obtained with those of previ
weeks or months and at once form
conclusion as to the efficiency of op
tion. The value of the chart is at
apparent and the adoption of similar m
ods of keeping power-plant records w
undoubtedly prove of value to o
plants.

# "White Coal" with a Vengea

In the mountainous countries of Eu
they have a way of referring to the w
power which is so abundant and so
portant a factor as their "*houille blan*
or white coal.

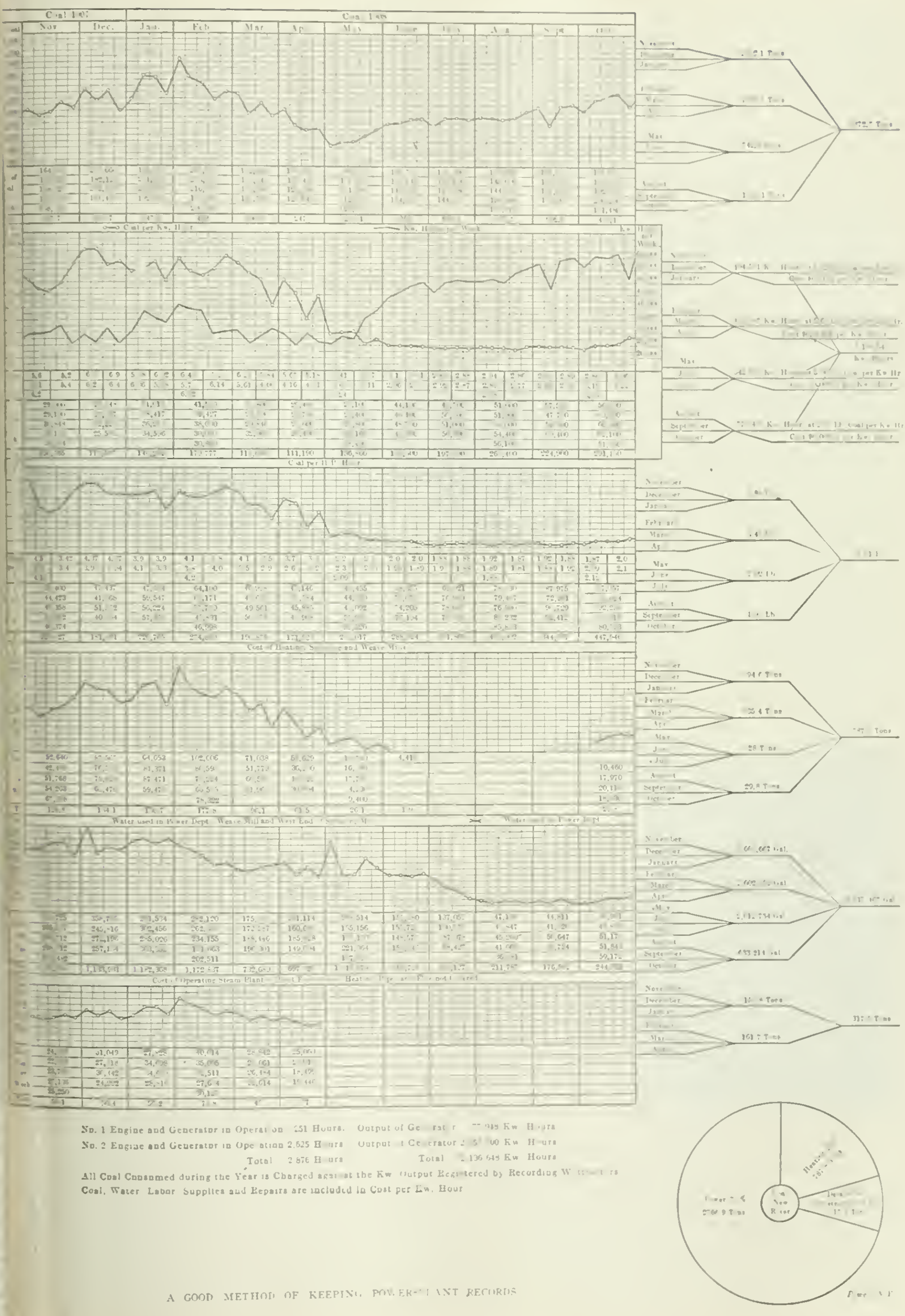
During the recent visit of Presi
Taft to Wilmington, Governor Kit
told a story which may be made the
of a claim on the part of North Car
to a still better warrant to use this
with reference to power.

Two North Carolinans on a visi
London were bragging about the S
"Yes," said an Englishman, sittin
the same table, "but the trouble is
haven't any really great industry in
South."

"What are you talking about?"
claimed one of the North Carolina
"We have Colonel Crawford's dairy
in our town, that turns out a mi
pounds of butter and a million po
of cheese every week."

"A million pounds of butter and a
lion pounds of cheese—impossible!"
claimed the Englishman.

"Well, I'll leave it to the Colonel," id
the one Carolinan, turning to the o r
"I know Colonel Crawford has a d ,"
replied the Colonel, "but I can't say
how much butter and cheese he t
out every week. I do know, how r,
that he owns twelve sawmills and th he
runs every one of them with butterm



No. 1 Engine and Generator in Operation 251 Hours. Output of Generator [illegible] Kw. Hours

No. 2 Engine and Generator in Operation 2,625 Hours. Output of Generator [illegible] Kw. Hours

Total 2,876 Hours. Total [illegible] 136,649 Kw. Hours

All Coal Consumed during the Year is Charged against the Kw. Output Registered by Recording Wattmeters

Coal, Water, Labor, Supplies and Repairs are included in Cost per Kw. Hour

A GOOD METHOD OF KEEPING POWER-PLANT RECORDS

Power, N.Y.

# Defective Boiler Tubes and Their Renewa

## Common Causes for Failure of Fire or Water Tubes, with Complete Directions for Renewal and for Beading or Flaring Ends of the Tube

### BY M. KENNETT

Probably the most troublesome element of both the fire-tube and the water tube boiler is the tubes. Even in boilers which are worked very moderately, they frequently require repairs, due either to leakage at the ends, or to some one of the many other ills to which they are subject. In the smaller installations, such as the ordinary factory or isolated plant, conditions are usually less severe, and consequently the tube trouble is correspondingly less than in the large power station where the boilers are almost constantly worked at their full capacity, and where, for at least part of the day, they are heavily overloaded during the hours of peak load. In such stations it is not at all uncommon to have to replace one or more tubes almost every time a boiler is laid off for cleaning.

The operation of removing a defective tube and replacing it with a new one is a very simple one, and for that reason, it is frequently undertaken by the engineer himself, or assigned to some of the boiler-room crew. The amount of slipshod work done along this line, however, emphasizes the fact that the importance of first-class work is not realized, or that the proper methods to be pursued are not understood. Judging from the class of work usually done, it would seem that the impression prevails that as long as the tube is in place and does not leak, there is nothing more to be desired. Nothing could be further from the truth, as aside from the appearance of the work, it is frequently done in such a manner that it becomes necessary to renew the tube much sooner than would have been the case if the work had been properly done in the first place. In fact, when a number of tubes have been renewed in this indifferent manner, the safety of the boiler is seriously impaired.

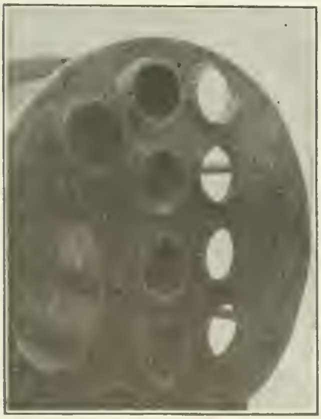


FIG. 1. OLDTIME METHOD OF RIVETING FLUES

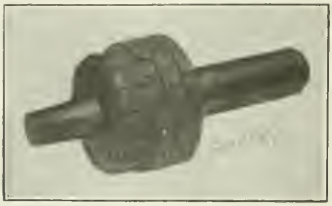


FIG. 2. PROSSER OR SECTIONAL EXPANDER

#### TUBES AND FLUES

In the earlier days of steam-boiler practice, the flues, as they were called, were of comparatively large diameter, ranging from about 8 to 16 inches in diameter, and the thickness of the walls varying from ¼ to ⅜ inch according to the diameter of the flue and the steam pressure carried. Nozzles were flanged in, in the rear boiler head, and out in the front head, and the flues were securely riveted into these, as shown in Fig. 1, which is a photograph of a boiler equipped with 6-inch flues. Modern requirements, however, demanded a greater steaming capacity for a given size boiler, and the demand for higher pressures steadily increased, and as a result, it was found advisable to replace the large flues with a greater number of smaller ones, thereby increasing the heating surface, and also providing a tube which, due to its smaller diameter, was capable of withstanding the higher pressure without being too heavy. The sizes which have now become generally recognized as standard for the usual sizes of stationary boilers, range from 2 to 4 inches, although quite a number of 6-inch flues are still used and are giving excellent service. In speaking of the various sizes, it has come customary to designate all si less than 6 inches as tubes, while th of 6 inches and over are called flues.

Of course, owing to their smaller di eter, the walls of these tubes are m thinner than those of the large flues w being in a standard 4-inch tube onl trifle more than ⅛ inch thick. The companying table gives the diameter thickness of the standard tubes fro to 6 inches in diameter.

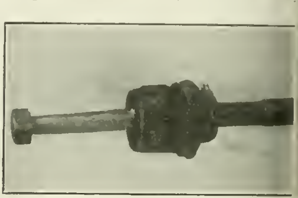


FIG. 3. DUDGEON OR ROLLER EXPANDE

DIAMETER AND THICKNESS OF STANDARD TUBES.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Outside diameter | 2 | 2¼ | 2½ | 3 | 3¼ | 3½ | 4 | 5 |
| Birmingham gage | 13 | 13 | 12 | 12 | 11 | 11 | 10 | 9 |
| Thickness, inches | 0.095 | 0.095 | 0.109 | 0.109 | 0.120 | 0.120 | 0.134 | 0.148 |

#### TYPES OF TUBE EXPANDER

The old method of riveting the t into nozzles flanged in the boiler l obviated much of the trouble du leakage, but with the modern tube of than 6 inches in diameter this is practical, and some other means of ing a secure and steam-tight joint to be devised. This is done by expar the tube ends tightly into the tube l in the head, or tube sheet, by mear a special tool known as an expande roller. There are two types of this the Prosser expander shown in F and the Dudgeon or roller expa shown in Fig. 3. The Prosser, or tional expander as it is sometimes c consists of a number of segments together by a light spring band, forced out by a taper mandrel pa through the center. In using the the head is inserted in the tube en nd the taper mandrel is driven in by a ew sharp blows from a fairly heavy han er This forces the segments apart an x- pands the tube end tightly into its le. The shape of the segments is such hat a slight shoulder is formed on eac ide of the tube sheet, which lock the tube in place and prevent it from working back and forth through the tube sheet due to xpansion or contraction. This tool is uite extensively used in locomotive prac ce, but not to any extent in stationary rk. In the writer's opinion it has some ry decided advantages over the roller xpander, and it is being used much more xtensively in locomotive work during he last few years than it has been here ofore. In using it in the larger sizes, y from 3 inches up, the heavy blows necessary to set the tubes out properly h it, are frequently objectionable, and boilers having cast-iron headers would r its use.

The Dudgeon, or roller expander, is one almost universally used in sta nary practice. It consists of three rdened-steel rollers held loosely in ts in the head, or "cage," and a tapered l mandrel passing through the center. sing it the cage with the rollers in inserted in the tube end and the drel is driven in quite lightly with a mer, thus forcing the rollers out htly against the tube. The mandrel given a turn or two by means of a rt bar inserted in the holes in the end of it, and is then driven in a le more, and another turn or two n it. As the mandrel is turned the ers revolve around the inside of the e and stretch or roll the metal out, s expanding the tube tightly in its e in the tube sheet.

### FIRE TUBES SHOULD BE BEADED

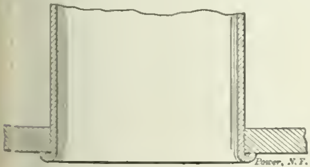


FIG. 4. FIRE TUBE BEADED OVER

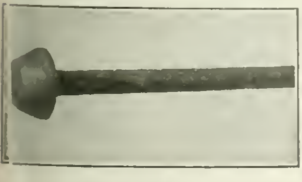


FIG. 5. FLARING TOOL

When a tube has simply been expanded in the tube hole in the boiler head or the header, it is quite evident that there is nothing to prevent the pressure of the steam forcing the header or tube sheet off it but the friction due to the tight fit. This pressure is considerable. For instance, on a 4-inch tube at 125 pounds pressure it amounts to 1570 pounds, and as the factor of safety on any element of boiler should not be less than 5, this gives a pressure of 7850 pounds which this joint should be capable of sustaining in order to be considered safe. It must be conceded that this is entirely too much to trust to friction alone in so important a place, especially when the various strains to which the joint is subjected by expansion and contraction are taken into consideration, and the vibration to which every boiler is subject. In fire-tube boilers the tube ends should always be beaded over, as shown in Fig. 4, in order to increase their holding power.

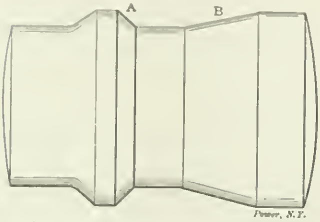


FIG. 6. COMBINATION ROLLING AND FLARING TOOL

### FLARING WATER TUBES

In many types of water-tube boilers, however, it is impossible to bead the tubes, as they are not sufficiently accessible, being at the back of the headers or water legs, where the space is quite restricted. These should always be flared about 1/8 inch in diameter in order to make them more secure. This can be done in several ways, the flaring tool shown in Fig. 5 being quite efficient. It consists simply of a steel plug having the proper taper, which is driven in the end of the tube, thereby flaring it to the desired extent. Another good method is to replace one of the rollers in the expander with one like Fig. 6. With this head the rolling and flaring are done in one operation, the two straight rollers expanding the tube, while the special roller flares the end, at the same time producing the ridge shown at the rear face of the tube sheet in Fig. 7, just as a Prosser expander would do. The object of the flange *A* on the roller is not, primarily, to produce this ridge back of the tube sheet, but it serves to hold the special roller in place by locking it behind the inside face of the tube sheet. If it were not for this, there would be nothing to hold the flaring face *B* of the roller up against the tube end with sufficient force to flare it.

### PROJECTING TUBES A COMMON FAULT

One very common fault in putting in tubes is that of allowing the ends to project through the tube sheet too far, and then expanding them with a tool, the rollers of which are so short that they do not extend out as far as the end of the tube. This condition will prevail with practically all the standard rollers if the tube projects as much as an inch or more. As the tube holes are necessarily somewhat larger than the tubes, the result is that when the tube is expanded the end is drawn in to some extent, as shown in Fig. 8, and there is very little to hold such tubes in place. Furthermore, it is impossible to flare or bead such tubes without splitting them. There are several types of expanders having specially long rollers which are intended for use on such tubes, but the proper plan is to cut the tube to the proper length before putting it in, or to cut it off by means of a tool made for the purpose, after expanding it.

### TUBES HOLDING BY FRICTION UNSAFE

This matter of flaring and beading the tube ends is of the greatest importance. In many types of water-tube boilers the various drums and headers are held together solely by the tubes themselves, and in many cases there are short sections of tubes, or nipples as they are called, which in addition to the steam pressure are called upon to support a considerable portion of the dead weight of the boiler, and special care should be taken to properly flare these. The writer experiences the greatest difficulty in convincing the average engineer and boilermaker of the danger of relying on friction alone to hold the various parts of a boiler together, and it is incomprehensible why there should be so much indifference, if not downright opposition to the proper flaring and beading of the tubes. That there are thousands of boilers in service today in which the tubes are simply expanded, must be acknowledged, but that fact does not in any way reduce the danger. There are also thousands of boilers in service today, in which there are lap-joint seams, yet the danger of

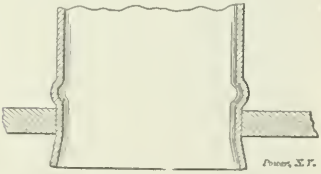


FIG. 7. APPEARANCE OF TUBE AFTER USING COMBINATION TOOL.

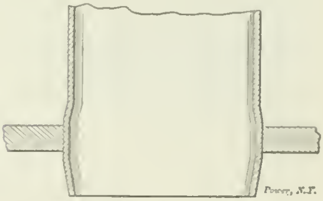


FIG. 8. RESULT OF EXPANDING TUBE PROJECTING TOO FAR THROUGH THE SHEET

[illegible] is fully appreciated. A number of accidents due to the neglect of the flaring or beading of tube ends may be cited. One in particular was the case of a large water-tube boiler which was erected in a large power station by the builder's own erector, who neglected to properly flare the nipples referred to above. When the final hydrostatic test was applied before the setting was built around it, the pressure, together with the weight of the tubes and headers, pulled the latter entirely off of the nipples, and they fell to the ground. Had they withstood the test and the boiler been put in service, this would undoubtedly have occurred sooner or later while under steam pressure, and the results would probably have been serious. In another case this did actually happen to the mud drum of a boiler in which the short nipples had recently been renewed without having been properly flared. In still another case the upper drum of a boiler in which the parts are held together only by the tubes, was stripped from the tubes and projected through the air quite a distance, doing considerable damage.

In renewing the tubes of any boiler, it is not so serious a matter to neglect the flaring or beading of a few if they are scattered about, as the surrounding tubes will relieve the ones in question of any undue strain. The trouble is, that especially in water-tube boilers in large power stations, the tubes are constantly being renewed, and in a short time the entire lower rows are composed of new ones which have not been properly flared, and as a consequence the boiler is materially weakened.

When the construction is such that the tube ends are readily accessible, such as the Cahall or Cook vertical type, or the Sterling for instance, the flaring can easily be done with the peen of a ball-peen hammer, by striking the inside of the tube end lightly all around, being careful not to split it. The use of the flaring tool, or special roller previously described, is far preferable, however.

Another reason for beading the tubes of a fire-tube boiler, is that the projecting ends of the unbeaded tubes are exposed to the direct action of the fire in the rear, and being very thin, they are soon burnt until they have no strength or elasticity, or what is commonly called "life." These tubes soon begin to leak, and the action of the soot and ashes, together with the water from the leakage, causes the ends to waste away rapidly, and no amount of rolling will keep them tight, the result being that they soon have to be replaced by new ones. In one case with which the writer is familiar, the tubes had been leaking from this cause for some time, and at times the leakage was quite bad. The action of the draft drew the moisture inside the tubes, and the result was that they became wasted for some little distance from the ends, probably 6 or 8 inches. These tubes were 4 inches in diameter, and the pressure carried was only 110 pounds; notwithstanding this, however, the tubes were so weakened that one of them collapsed, and the escaping steam and hot water scalded the fireman so badly that he died shortly after reaching the hospital.

## Causes for Tube Renewal

Some of the most common causes necessitating the renewal of tubes in the horizontal tubular boiler are: persistent leakage at the ends, which cannot be stopped by rolling; corrosion and pitting, caused by the use of either very pure or corrosive feed water; occasionally grooving and cracking in a girthwise direction close up to the head.

In the water-tube boiler the most common causes are: bagging or burning; splitting at the seams, or the bursting of the bags just referred to; pitting and corrosion; warping of the lower rows.

## Leakage in Horizontal Tubular Boilers

In the horizontal tubular boiler leakage occurs most frequently at the rear end. It is sometimes caused by cooling the boiler down too rapidly, when the sudden and unequal contraction may cause a slight leakage, but this is not serious and can be stopped by a light rolling. Of course, low water will also cause the tubes to leak, but if they are not burnt, this can also be stopped by rerolling. The most serious and troublesome leakage, however, is caused by an accumulation of scale or mud on the rear head between the tubes. This prevents the free circulation of the water around them, and as a consequence they become overheated and leak. As long as this condition prevails, no amount of rerolling will keep them tight for any length of time. More tubes are ruined in this way than from any other cause. The only radical cure is to remove the scale, which can be done notwithstanding the claims of many engineers to the contrary. Instead of taking the necessary steps in this direction, however, the tubes are usually rerolled and the leakage stopped for a few days, only to reappear. The tubes are then rolled again and the leakage stopped for a few days more, and so on until after a few rollings the tube ends are so thin that it is found necessary to retube the boiler, or at least to replace the leaking tubes.

As soon as leakage of this nature occurs, a thorough inspection of the rear head should be made. In all probability the spaces between the tubes will be found to be choked for from an inch or so to as much as a foot or more from the head. The amount of scale which the boiler will stand without leaking, depends largely upon the extent to which it is forced. If its capacity is ample for the work to be done, so that only a moderate fire is carried, this accumulation so times becomes so bad that the tubes e embedded in a solid mass for a foot r more from the head before serious le age results. On the other hand, if boiler is forced to any extent, tro may be expected from an accumula of an inch or less.

It is fully realized that in many ca it is impossible to lay a boiler off l g enough to thoroughly clean it, but in m st cases much more could be done tow keeping these spaces clear than is usu attempted. The rear manhead sh be removed at each cleaning, an stream of water from a hose should played down between the tubes. will in most cases keep the spaces c from any heavy deposit, and at ev opportunity it should be thorou scraped with a long slender bar flatt and sharpened at the end for the purp

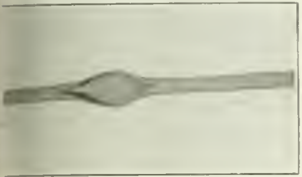
## Corrosion and Pitting

Corrosion is usually caused by water which contains some acid or o corrosive element. It is impossibl give any general remedy for this, cept to try to ascertain the source of contamination, and if possible remov or to obtain the feed from some o source. In some cases when the w is obtained from ponds, it becomes taminated from surrounding cinder ba slack piles, etc.

Pitting is sometimes produced by same causes as corrosion, but more quently by the use of very pure water, such as the returns from hea systems. Pitting differs from wha usually understood as corrosion, by tacking the metal in small spots ins of over a considerable area. He boilers are especially subject to it account of the large percentage of re water handled. It seldom produces serious results, as the spots are so s that even though one should pene the tubes or shell, only a slight would result. It is frequently very noying to have this occur, however it necessitates shutting down for rep A quick temporary repair can be ma the hole is in such a position as t readily accessible, by drilling it out tapping it for a ¼-inch pipe plug. the hole is on the underside of the a flat iron band can be made in h and clamped on the tube with a of packing under it. If the tube i such a position that it cannot be rea for either of these repairs, it ca plugged until a convenient time for newing it. In the tubes which ca be reached this pitting can be stopped a great extent by scraping out the pits, id rubbing in a thick paste of red lea or graphite and linseed oil. The metal st be thoroughly dry, however, or the te will not stick. When the trouble is ue to returns, it may be greatly reduce by ng iron tubes instead of steel when ey are renewed.

### GROOVING AND CRACKING OF TUBES

This may occur close up to the head. t is not a very common occurrence It lly affects the lower tubes at the r end, and is the result of pumping ratively cold water into the boiler such a way that it comes in con t with the hot tubes. The very com n practice of pumping cold, or slightly d, water into the blowoff might roduce this result, by chilling the t s at their hottest part and causing t contract, thus inducing a severe in them. In the old iron boilers, were almost invariably fed in this rough the mud drums, it was a mmon occurrence to find the girth cracked between the rivet holes bottom, where the shell plates had chilled by the comparatively cold water spreading over them. The ly is to heat the feed water to as temperature as possible, and then charge it into the body of water boiler in such a way that it will to mingle with it before coming in with the heating surfaces. In way the feed attains practically the temperature as the water in the r before it strikes the hot plates, and lling effect is greatly reduced.


) TUBE WHICH OPENED AT WELD

### NG AND BURNING IN WATER-TUBE BOILERS

water-tube boilers the tubes are sub- to much more trying conditions in the fire-tube type, being exposed are to the direct action of the t part of the fire. This type of r is used very extensively in large r stations, where mechanical stokers stalled, and very hot fires are car- In such stations the renewal of on account of bags is almost a ccurrence. Of course, a bag will duced on a water tube by an ac- lation of scale or grease, just as it il n the shell of a fire-tube boiler. observation, however, it is the writer's belief that in many instances the are so hot, that the water in the m rows of tubes is flashed into sea so rapidly, that it cannot force its y through the somewhat long passage the steam space quickly enough to av the formation of steam pockets at the bottom of the tubes. Even though the circulation through the tubes may be excellent, the water next to the tubes is evaporated so rapidly that instead of a solid body of water in the lower tubes, there is probably a foam, consisting of water and globules of steam. This condition is favorable for the thin walls of the tubes exposed to the furnace, to instantly become overheated, resulting in a bag. As a rule these are not serious and cause no interruption in the regular run of the boiler. In fact, their existence is not usually known until the boiler is laid off for cleaning, and the tubes are inspected. When this occurs, the best and cheapest thing to do is to replace the tube with a new one. In many plants of moderate size, where operating conditions are not so strenuous, small bag will appear from time to time. In these cases the tube can usually be saved by simply driving up the bag exactly as would be done on the shell of a fire tube boiler. The writer is familiar with cases where this has been done as much as three years ago, and the tube is still in service. In these smaller plants it is not at all uncommon to put the boiler back in service without either replacing the tube or driving up the bag. This is poor engineering as the pocket is very apt to collect scale and sediment, and a disastrous rupture may occur.

The lower rows of tubes are frequently covered with tile, the primary object of which is to abate the smoke. In addition to this they also protect the tubes to a marked extent when very hot fires are carried. One disadvantage in their use is that they are apt to cause the tubes to leak slightly when the boiler is cooled down rather rapidly, as they hold the heat longer than the rest of the tubes, and the unequal contraction has a tendency to force the lower tubes through the tube sheets, causing a slight leakage.

### SPLITTING AT SEAMS

In spite of the utmost care in the manufacture and inspection of tubes at the factory, a seam will occasionally open while in service, as the result of a defective weld. As a precaution against this, and also to reduce the trouble due to bags, extra-heavy tubes are frequently used for the lower rows when the pressure exceeds 125 pounds. This may be of some benefit, although it is to be doubted, but the only way to avoid trouble due to defective welds, with any degree of certainty, is to employ only seamless tubes. These are drawn from solid billets and consequently have no welds; furthermore, the process of drawing them produces tougher and denser metal than the welded tubes are made of. Fig. 9 is a photograph of a tube which opened at the weld after having been in service for some two years. After the accident the defective weld was plainly evident. In fact, it was so bad that the metal did not seem to have been welded at all at this place. Just why it held for about two years, and then suddenly failed while in regular service, is one of the many mysteries of steam boiler behavior, but it serves to illustrate the folly of relying upon welds when there is no necessity of doing so.

### WARPING OF LOWER TUBES

This seems to be an evil for which there is no remedy, but the number of tubes which have to be replaced on this account is comparatively small, so that it is not a very serious matter. The worst feature is that when a tube warps badly, it sometimes pulls the end partly out of the tube sheet, thus necessitating its renewal.

### EXTERNAL CORROSION OF WATER TUBES

Of course water tube boilers are subject to the same corrosive action as fire-tube boilers, but in addition, there is a greater tendency toward external corrosion, which is responsible for many failures. The fine fly ashes collect around the tube ends, and in some types lie on the tiles and partly cover some of the tubes. In many cases these are not cleaned off thoroughly, as they should be before the boiler is washed out. The result is that the water used in washing, works in between the headers and hollow staybolts and is absorbed by these ashes, which when wet have a highly corrosive action on the tubes. It is not at all uncommon to keep a boiler off for cleaning purposes for two or three weeks, and during this time, if the ashes are wet, corrosion is going on constantly. It can readily be seen that under these circumstances it will not take very long to seriously affect the thin walls of the tubes. The remedy is to thoroughly clean off all ashes and soot and to avoid allowing the water used in washing to run down on the tubes.

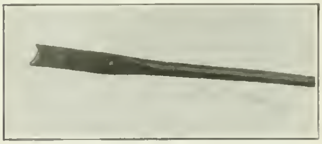


FIG. 10 RIPPER OR PLOUGH CHISEL

### REPLACING TUBES

When it does become necessary to replace a tube, the first step is to remove the old one. This is usually the most difficult part, especially in a horizontal tubular boiler, as the tube is covered with scale, which adds to the difficulty of removing it through its own tube hole. When the defective tube is located in such a position that it can be removed through the manhole, it is a simple matte[illegible] it off [illegible] inside the [illegible] with a sharp cold chisel and remove it through the manhole, afterward cutting [illegible] the ends remaining in the tube sheets. Unfortunately, however, in the great majority of cases it is necessary to remove the tubes through the holes in the sheet.

To do this, first cut off the beading with a sharp cold chisel, then with the "ripper," or [illegible], illustrated in Fig. 10, cut out a strip 4 or 5 inches long and the width of the tool, which is about 5/16 inch. As will be noted in the photograph, this tool is simply a flat chisel about 1 1/2 inches wide and 5/16 inch thick. It is made convex, or crescent shaped, on the end and is ground perfectly square, or blunt similar to a calking tool. If no ripper is at hand and only a few tubes are to be cut out, a diamond point chisel does very well for cutting out this strip, but great care must be used to avoid cutting the tube sheet. After this strip has been removed, fold in the edges of the tube, so as to loosen it in the tube sheet. Fig. 11 is a photograph of a tube which has been removed in this way. Of course this must be done at each end. Then push or drive the tube out through the front tube sheet as far as possible, which will usually be very little. Now the hard work begins, as the scale adhering to the tube makes it difficult to withdraw it. Take a hitch around the projecting end, and with a block and tackle, or better still a chain block fastened to a wall or some solid post directly in front of the boiler, pull on the tube, at the same time hammering on it and working it around with a pipe wrench or chain tongs. This will cut and hammer the scale off sufficiently to allow the tube to be drawn out through the hole in the sheet. While this is being done a helper should hold up the rear end by means of a rod passed through the back tube sheet, or by a rope sling from the inside of the boiler. Sometimes the scale is so thick and hard that it is simply impossible to remove the tube in this way. In this case it becomes necessary to cut out several good tubes, removing them through the manhole, in order that the defective one may be removed in the same way.

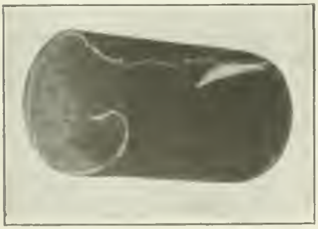


FIG. 11. METHOD OF CUTTING AND FOLDING IN TUBE END FOR REMOVAL

In ordering the new tubes, the length should be accurately measured on a strip of wood or a piece of pipe passed through the old ones, allowing from 1/8 to 3/16 inch on each end for beading over. If more than one boiler is to be retubed, measure each one as it will probably be found that there is a difference although they are all supposed to be the same.

The ends of the new tubes are supposed to have been annealed before delivery, but it is doubtful if this has been done, so it is a good plan to heat them to a dull red and bury them in lime, allowing them to cool very slowly. This will make them much easier to expand and head, and will reduce the liability of their cracking during these operations.

Having prepared the new tubes, and removed the old ones, remove all burs and sharp edges from the tube holes with a half-round file and insert the tube. As the holes are necessarily slightly larger than the tubes this is an easy matter, but care must be taken not to allow either end of the tube to drop, as this would dent or crush it where it passes through the tube sheet. Now carefully equalize the projection at each end and secure the tube in this position. This can be done either by driving in little wedges made by flattening nails or by turning over a couple of little lips on each end of the tube with the peen of a hammer. If the hole is more than 1/16 inch larger than the tube, cut strips of copper or soft sheet iron about 3/4 inch wide and just long enough to pass around the tube neatly, and use these to shim up the space.

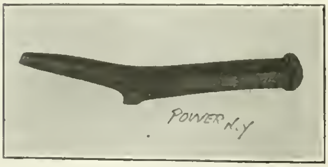


FIG. 12. BEADING TOOL

All is now ready to expand and bead over the ends of the tube, and while this is a simple matter it must be done with care, as a great deal of damage can be done by an inexperienced man with a tube roller. First expand the tube just enough to hold it in position, no attempt being made to make it steam tight. Then with the peen of a hammer bell out the ends, striking light blows and turning the metal back all around the circumference carefully so as not to crack it. This bead is then finished and set up tight against the tube sheet with the beading tool shown in Fig. 12. The tubes are next given a final rolling to make them steam tight.

A common mistake is to roll the tubes too hard. This thins the ends and also hardens them, so that they are apt to crack in subsequent rolling or bea g that may be necessary. Recently ıe writer found it necessary to condem ıʒ tubes in a water-tube boiler, simply cause they had been rolled too h They had been in about a year, and d been rolled so hard that a dee shoulder had been formed where the ers worked. They had never leake given any trouble, but at the time of

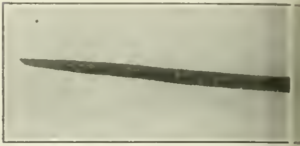


FIG. 13. LONG WEDGE USED TO FOLD TU

inspection they were found to be cra on the inside in a girthwise direction at the outer edge of the tube sheet. number of cases, these cracks had penetrated, but no serious leakage resulted as yet. The probability is, the metal had been so hardened by excessive rolling, that the slight n ment produced by the expansion and traction caused the cracks to develop

In removing the tubes of a water boiler, the process is practically the s but the tubes are more easily taken As the ends are not so easily rea however, a ripper is almost a nece for splitting the tubes. The ends then be folded in by means of the slender wedge shown in Fig. 13. A plan is to cut two deep notches ir end of the tube about an inch apart then with a bar force the part of projecting end of the tube between notches, away from the tube shee header, using the edge of the han as a fulcrum for the bar. This pro a slight space between the tube an tube sheet, into which the wedge ma started, and when it is driven home is plenty of space left, so there i danger of scoring the tube sheet wit ripper.

If the defective tube is in the l row, as is usually the case, its re may be facilitated by cutting the tub two or three sections with a three- pipe cutter, and removing the ends the tube sheets from inside the fu From this point the operation is the as that described for the horizontal lar boiler, except that instead of be over the ends, they are flared by of the methods described in previous graphs.

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A 22-inch double-leather belt wa in stalled at the Union Mills, Brookly in 1876, to operate a main drive wh it was called upon to transmit 100 horse-power. This belt is still operating as good condition apparently as when it was installed.

# Burning Natural Gas as a Boiler Fuel

## Results Obtained in Actual Practice with Two Types of Burner Show the Value of Natural Gas as a Fuel as Compared to Good Bituminous Coal

BY DAVID MOFFAT MYERS

The following tests and observations re obtained in plants in West Vir a and Kentucky and include tests two kinds of burners and experi ts with draft regulation. Determi- ns of the amount of gas per boiler rsepower-hour and its cost, together flue-gas analyses and other condi- s, were made.

TABLE 1. DATA AND RESULTS FROM EVAPORATIVE TESTS WITH NATURAL GAS.

Tests Nos. 1, 2 and 3 to determine B.H.P. developed and efficiency of boiler and burner. Tests Nos. 4 and 5 to determine effects of re ng air supply and running with white flame

| Items. | Test No. | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3† | 4 | 5 |
| er heating surface, sq ft | 1,141 | 1,500 | 1,182 | 1,182 | 1,182 |
| r | Hor. Tubular | Water Tube | Hor. Tubular | Hor. Tubular | Hor. Tubular |
| TOTAL QUANTITIES. | | | | | |
| e of trial | June 27, 1907 | July 6, 1907 | Mar. 19, 1909 | Mar. 22, 1909 | Mar. 19, 1909 |
| tion of trial, hr | 7 | 7 | 7 | 3 | 3 |
| al weight of water fed to boiler, lb | 42,034 | 36,038 | 33,194 | 15,694 | 14,818 |
| r of evaporation | 1.0925 | 1.0904 | 1.1506 | 1.1539 | 1.1537 |
| valent evaporation from and at 212 deg. F., lb | 45,922 | 39,296 | 38,193 | 18,109 | 17,096 |
| consumption, cu.ft | 49,600 | 51,200 | 43,752 | 20,340 | 18,952 |
| pressure, inches of mercury | 1.6 | 1.66 | 2.3 | 2.27 | 2.3 |
| consumption at atmospheric pressure, cu ft | 52,328 | 54,032 | 47,033 | 21,815 | 20,373 |
| HOURLY QUANTITIES. | | | | | |
| s consumed per hour (at pressure given above), cu.ft | 7,086 | 7,314 | 6,250 | 6,780 | 6,317 |
| consumed per hour at atmospheric pressure, cu ft | 7,475 | 7,719 | 6,719 | 7,282 | 6,791 |
| valent evaporation per hour from and at 212 deg. F., lb | 6,560 | 5,614 | 5,456 | 6,036 | 5,699 |
| AVERAGE TEMPERATURES, PRESSURES, ETC. | | | | | |
| am pressure by gage, lb | 70 | 75 | 44 | 53 | 44 |
| perature feed water entering boiler, deg. F | 155 | 158 | 92 | 91 | 89 |
| perature escaping gases from boiler, deg. F | 595 | 511 | 452 | 422 | 455 |
| e of draft between damper and boiler, in. of water | 0.20 | 0.375 | 0.10 | 0.31 | 0.10 |
| perature of air entering burners, deg. F | ......... | | 66 | ......... | ..... |
| erature of outside air, deg. F. | ......... | ... | 50 | ......... | ...... |
| HORSEPOWER. | | | | | |
| r horsepower developed | 190 | 162.7 | 158 | 175 | 165 |
| ed horsepower at 12 sq.ft. per horsepower | 95 | 150* | 123 | 123.5 | 123.5 |
| entage rated horsepower developed | 200 | 108 | 128 | 141.5 | 133.5 |
| ECONOMIC RESULTS. | | | | | |
| r evaporated under actual conditions per cu.ft. of gas as fired, lb | 0.84746 | 0.70386 | 0.759 | 0.773 | 0.782 |
| ter evaporated from and at 212 deg. F. per cu.ft. of gas as fired, lb | 0.9258 | 0.7675 | 0.873 | 0.8903 | 0.9022 |
| er evaporated from and at 212 deg. F. per cu.ft. gas at atmos. press., lb | 0.8776 | 0.7273 | 0.812 | 0.829 | 0.839 |
| EFFICIENCY. | | | | | |
| orific value of gas per cu.ft. (atmospheric pressure), B.t.u. | 1,145 | 1,145 | 1,123 | 1,123 | 1,123 |
| rmal efficiency of boiler and burner, per cent | 74 | 61.4 | 69.8 | 71.3 | 72.1 |
| COST OF EVAPORATION | | | | | |
| of gas per 1000 cu.ft. delivered in fireroom at above pressure | $0.10 | $0.10 | $0.10 | $0.10 | $0.10 |
| of gas for evaporating 1000 lb. of water from and at 212 deg. F. | $0.0926 | $0.13 | $0.1115 | $0.1123 | $0.1110 |
| required per boiler H.P.-hour, cu.ft | ... | ... | 39.5 | 38.8 | 38.3 |
| FLUE GAS ANALYSIS. | | | | | |
| rage $CO_2$ | 8.06 | 6.2 | | 8.9 | 8.0 |
| age O | 6.2 | 8.5 | | 5.0 | 7.2 |
| age CO | 0.2 | 0 to 0.1 | | 0 | 0 |

*This rating based on 10 square feet of heating surface per horsepower.
This test includes noon hour during which two of the four burners were shut off
NOTE—"Gas as Fired" was measured at mercury pressure given for each test.

The data from the tests are given in ble 1, tests Nos. 1 and 3 being made on izontal tubular boilers and test No. 2 an Atlas water-tube boiler to deter- ne the boiler horsepower developed and t thermal efficiency of boiler and burner. ts Nos. 4 and 5 were made to deter- ne the effects of reducing the supply air and running with a white flame.

In tests Nos. 1 and 2, burner consisting of four 1¼ inch pipes, small holes in 3½ inch caps on ends, inside of 6-inch pipe, were used. In test No. 3 four Gwynn burners, 5 inches inside diameter, were used, and in tests Nos. 4 and 5 four Gwynn burners were also used. In Table 2 the samples of flue gas were taken during tests Nos. 1 and 2, respectively, of Table 1. All of the tests were started by the alternate method.

In Table 2, samples Nos. 4, 5 and 6 of test No. 1 were taken during the boiler test, but the best combustion was obtained when samples Nos. 1 and 2 were taken, with the damper set for the smallest draft, i.e., 0.15 inch. The other tests show too much air (oxygen) in the gas for highest results. To insure best results a draft gage should be permanently attached and the damper set accordingly. Also when one or more gas jets are shut off, the air pipes should be stopped up or closed.

The low efficiency in test No. 2, Table 1, 61.4 per cent., may be chiefly attributed to considerable dust on the boiler tubes which were not properly cleaned; and to the fact of insufficient combustion space, the gas flames being directly thrown against the cold boiler tubes, thus chilling much of the unburned gas to a point below its ignition temperature.

In Table 2 under test No. 2 samples Nos. 1, 2, 3 and 4 were taken during the efficiency test and show a lower grade of [illegible] the Atlas water-tube boiler in test No. 2 had the greatest air in the gases. The damper was found set for 0.375 inch draft in the uptake as compared with 0.2 inch in the uptake of the tubular boiler. Therefore, after the efficiency test, the damper was set to reduce the draft from 0.375 to 0.25 inch and the combustion tested. Samples Nos. 5 and 6 show considerable unburned gas, CO, or incomplete combustion, although the air supply (O) was sufficient to burn the gas. The reason for this is, that before the gas has had time to burn it has been forced into close contact with the comparatively cold boiler tubes, which lowered its temperature below the ignition point, and it therefore passed unburned as a dead loss out of the stack. Therefore, with the present arrangement of burner it is necessary to flood the gas with a great excess of air in order to burn it.

### COMPARATIVE COSTS OF VARIOUS FUELS

Comparative costs of making steam with run-of-mine coal at $1.50, slack coal at $1 per ton, and natural gas at 10 cents per 1000 cubic foot are as follows:

TABLE 2. FLUE GAS ANALYSIS.

TEST No. 1

| Sample | $CO_2$. | O | CO | Flue Temp Deg. F | Draft in Uptake In. of Water. |
|---|---|---|---|---|---|
| 1 | 9.6 | 3.8 | 0 | 590 | 0.15 |
| 2 | 9.6 | 3.2 | 0.2 | 610 | 0.15 |
| 3 | 6.6 | 9.2 | 0 | 650 | 0.50 |
| 4 | 8.2 | 5.4 | 0 | 600 | 0.20 |
| 5 | 8.0 | 6.2 | 0.4 | 600 | 0.20 |
| 6 | 8.0 | 7.0 | 0.2 | 600 | 0.20 |
| TEST No. 2 | | | | | |
| 1 | 6.0 | 8.0 | 0 | 510 | 0.375 |
| 2 | 6.6 | 9.0 | 0.4 | 490 | 0.375 |
| 3 | 6.0 | | | | 0.375 |
| 4 | 6.2 | | | 520 | .... |
| 5 | 7.4 | 7.6 | 0.8 | | 0.25 |
| 6 | 7.8 | 7.4 | 0.4 | | 0.25 |

| | |
|---|---|
| Gas-fired horizontal tubular boiler of test No. 1 evaporates 1000 pounds of water from and at 212 degrees at a fuel cost of .............. | $0.0926 |
| Gas-fired Atlas water-tube boiler of test No. 2 ............. | 0.13 |
| Run-of-mine coal ($1.50 per 2000 lb.), 12,000 B.t.u. burned under ordinary conditions, 60 per cent. efficiency ............... | 0.107 |
| Slack coal ($1.00 per 2000 lb.) 12,000 B.t.u. burned under ordinary good conditions, 60 per cent. efficiency | 0.0715 |

From the above it is seen that slack coal under these conditions is a much cheaper fuel than either mine-run coal or natural gas, labor not considered, i.e., if properly burned slack coal would replace the gas under the boiler with a saving of about 30 per cent. in fuel cost.

### SUMMARY

Natural gas burned under crude methods with no great care or science results in

1—High thermal efficiency as compared to the burning of coal and a very high rating of the boiler. With only fair conditions a thermal efficiency of 70 per cent. can be maintained together with a boiler output of 100 per cent. above normal horsepower rating (12 square feet per horsepower), so that a boiler horsepower may be had for 6 square feet of heating surface with tubular boilers.

2—The cost of labor for gas firing is reduced to a minimum, one man being capable of looking after ten boiler units.

3—The fuel cost per boiler horsepower per hour with natural gas depends, of course, upon the local price per thousand cubic feet and upon the design of installation and degree of combustion.

### COST OF NATURAL GAS PER BOILER HORSEPOWER PER HOUR

Taking typical conditions as actually found in the natural-gas region, with gas at ten cents per thousand cubic feet and burning it under practical conditions, the fuel cost of evaporating 1000 pounds of water into steam from and at 212 degrees the writer has found to be $0.0926 in Kentucky, with boiler working 100 per cent. over rated capacity at 12 square feet per horsepower; and $0.1000 in West Virginia, with boiler working 41.5 per cent. over rated capacity at 12 square feet per horsepower.

Calling ten cents per 1000 pounds evaporation a safe average and allowing 10 per cent. for variable loads including noon hour, etc., which is a very high allowance, the commercial figure that can be counted on would be eleven cents. The cost of gas per boiler horsepower per hour is therefore,

$$\frac{34.5}{1000} \times 11 = 0.38 \textit{ cent} = \$0.0038.$$

### STANDBY LOSSES

The standby losses in gas burning may be either greater or less than with coal burning. If there is no provision on the gas burner for throttling the air supply in proportion to the flow of gas, a very great loss results when the gas is turned low, owing to the large volume of surplus air supply. If, on the other hand, this is properly regulated, the gas-fired boiler would suffer a much less loss of efficiency at small fractional loads (such as at night in many plants) than the coal-fired boiler would suffer under parallel conditions. In the matter of starting up or cutting out a boiler, the gas boiler has the advantage in a quicker building up of combustion conditions and the practically instantaneous stopping of combustion when desired.

### GENERAL CONDITIONS FOR COMBUSTION

It is important that the gas should have considerable space in which to mix with the air and burn in some form of brick combustion chamber before being forced into intimate contact with the cooling surfaces of the boiler tubes. This combustion space or chamber may be simply the long run the flames would naturally get in flowing from one end to the other under the shell of a horizontal boiler, care being taken to give 3 to 4 feet depth of combustion chamber. It is also an excellent idea—and one that is practised to allow the mixture of gas and air impinge on a bridgewall or baffle, wh tends to a more thorough mixture . higher temperature. In doing this, c must be taken to prevent the concent tion of the resultant heat on any one s or small area of the boiler shell.

With a water-tube boiler, if a dut oven furnace is not convenient, the sp below the former coal-grate level be added to that above, instead of fill up to this point, thus making the c bustion space for the gas equivalent to fire box plus the ashpit of the coal ting. The gas flames may then be rected downward by means of the bur tubes or introduced at the bottom of chamber to obtain the full effect of combustion space.

### CHEMICAL COMBUSTION

Flue-gas analyses will run as show the tests given herewith. It will be n that the volumetric sum of $CO_2$ + ( CO will not equal 21, or nearly 21, a the combustion of many coals. Thi due to the very high percentage of hy gen in natural gas. Thus much of oxygen is absorbed in burning H to which condenses and therefore does show up in the Orsat apparatus a product of combustion. This accounts the difference between 21 per cent. the sum of $CO_2$ + O + CO.

### REDUCTION OF AIR SUPPLY

The writer made experiments in ting down the air supply in the cas a horizontal tubular boiler with the sult that the $CO_2$ was gradually incre from 7.5 to 9 per cent., at which p smoke was produced. This boiler equipped with four Gwynn burners of 5 inches inside diameter.

Special tests, see tests 4 and 5, made to determine the effect of pro ing a white flame by reducing the supply with a consequent increase of as compared to the effect of a m blue and white flame with more air lower $CO_2$.

### WHITE AND BLUE FLAMES COMPAR

The white flame gave over 6 per more boiler horsepower, but the effic was lowered from 72.1 to 71.3 per This slight drop in efficiency without determinable CO loss may be expl by the probable loss of unchanged na gas of the $CH_4$ variety which would be detected by the Orsat apparatus. would likely be caused with a smal cess air supply when insufficient bustion space or baffling is provide allow complete mingling of the na gas with the oxygen during their age under the boiler shell. In other w under these conditions the air and tend to travel in streaks or strat that some of the gas does not come intimate contact with the air or ox which latter, however, is present in ient quantity for complete combustion. In a better design of furnace provided with an ample brick combustion chamber and baffle arrangements for changing the direction of, and mixing the air and gases, the efficiency as well as the capacity of the plant should be increased, when a white flame replaces a blue, or blue and white, flame, or when the air supply is reduced within reasonable limits This dea is confirmed by the manager of a ant equipped with good furnaces, who stated that the use of the white flame reduced in the long run a small but real uction in his gas bill as compared with the blue flame.

### Gas vs. Coal Burning

Averaging the results of a number of s and allowing for commercial conditions, it may be stated that with fair conions of design and operation a boiler rsepower-hour can be obtained from cubic feet of natural gas rated at 1123 1145* B.t.u. per cubic foot. In the ts the lowest value was 37.3 cubic feet der fair conditions, and the highest was cubic feet per boiler horsepower-hour der poor conditions. The lower figure s with gas measured at 1.6 inches of rcury pressure at the meter, and the her figure at 1.66 inches of mercury ssure, in other words, the measurets were taken under actual comrcial conditions.

aking 13,500 B.t.u. coal fired under rrespondingly fair working conditions, a long-run efficiency of say 62 per cent., would mean

$$\frac{13,500 \times 0.62}{965.7} = 8.48$$

nds of water per pound of coal from at 212 degrees Fahrenheit, or

$$\frac{34.5}{8.48} = 4.07$$

nds of coal per boiler horsepower per r. Hence, under fair commercial con- ons with the normal efficiencies of the fuels applied to their respective cases, cubic feet of natural gas or 4.07 nds of coal produces one boiler horsewer-hour. Therefore one pound of coal ls

$$\frac{40}{4.07} = 9.83$$

ic feet of gas, or one ton (2000 ds) of coal equals 19,660 cubic feet gas in fuel value under usual working itions, labor not included. The labor and its effect on any specific problem be separately calculated.

Without consideration of the usual effincies of the respective fuels, a cubic t of natural gas compares to coal as 00 to 13,500, or one pound of 13,500 t.u. coal equals 12.27 cubic feet of gas, one ton (2000 pounds) of coal equals ,540 cubic feet of gas.

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*These are the "high values" of the gas, allowance being made for hydrogen loss.

# Primer of Electricity

## The Electromagnet

In the last primer lesson it was explained that the amount of magnetic flux produced by a coil of wire with current passing through it was directly proportional to the ampere turns of the coil and the area of the path through which the magnetic flux passed, and inversely proportional to the length of the magnetic path, these relations holding good so long as the flux does not pass through any magnetic material. (Iron and steel are the only magnetic materials that it is practical to use commercially.) When the flux passes through iron or steel, the relations are somewhat changed owing to the facts that iron and steel are much better magnetic conductors than air or any other material, and have the peculiar property of changing their magnetic conductivity with changes in the magnetic density of the flux. When the flux density is very low, the flux will vary directly in proportion to the ampere-turns of the coil which produces the flux (this coil is known as the "exciting" coil or winding).

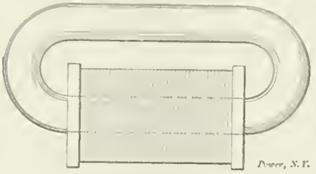

Power, N.Y.

FIG. 17. MAGNET WITH COMPLETE IRON CIRCUIT

For example, if a magnet were made as indicated in Fig. 17, so that the magnetic flux produced by the exciting coil had a complete circuit through iron, and if the core were very soft wrought iron or soft annealed steel, the flux in it would vary in direct proportion to the ampere-turns of the coil until the density reached something like 50,000 lines of force per square inch of core cross-section; then an increase of, say, 10 per cent. in the ampere-turns of the coil would increase the magnetic density in the core only about 8 per cent. As the density is pushed higher and higher by increasing the ampere turns of the exciting coil, the increase of flux produced by each increase of ampere turns becomes smaller and smaller; thus, when the density reaches 100,000 lines per square inch of core cross-section, an increase of 33 per cent. in the ampere turns of the exciting coil will cause an increase of only about 2 per cent. in the magnetic density (and, consequently, in the total flux passing through the core).

The magnetic conductivity of any material is called "permeability," and the permeability of a substance is equal to 1 ÷ its reluctivity; the reluctivity is equal to the reluctance per unit of length and cross-section. For example, if one is measuring in inches, the reluctivity of a substance would be equal to its reluctance × its cross-section in square inches ÷ its length in inches

The mathematical values of the reluctivity and permeability of materials are not of practical importance; that is, it is not necessary to bother with figuring reluctivities or permeabilities in ordinary everyday working with electrical machinery. All one needs to understand is the physical significance of these things. The physical effect of varying permeability in an iron core is to diminish the effectiveness of an increase in the exciting force as the magnetic density in the path becomes high, as just explained.

In practice, it is much simpler and quicker to consider merely the fact that in order to produce a certain magnetic density in a certain material, a certain number of ampere-turns must be provided in the exciting coil *for each inch of length along the magnetic path*, and do this for each kind of material that is included in the entire magnetic circuit To illustrate, Fig. 18 represents a magnet of the horseshoe type in which the cores are of wrought iron (the portion surrounded by the winding is a core; that part connecting the cores is the yoke), the yoke is of cast iron and there is a gap between the poles. In order to produce a given density in the cores, a certain number of ampere-turns per inch length of core will be required, and

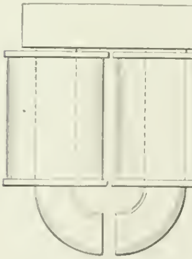


FIG. 18. HORSESHOE MAGNET WITH SMALL AIRGAP

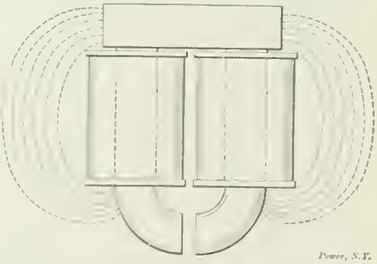

Power, N.Y.

FIG. 19. A ROUGH ILLUSTRATION OF MAGNETIC LEAKAGE

[illegible] of the yoke and of the airgap. Suppose, for example, that the cross-section of each core was ½ square inch, the cross-section of the yoke was 1 square inch and the cross-section of the gap was ½ square inch; further suppose that each core, including its polar extension, was 3 inches long, that the distance from core to core in the yoke was 2 inches and that the length of the airgap was ¼ inch. If all of the flux in the cores passed through the yoke and the airgap, and if the density in the cores was 60,000 lines per square inch, that in the airgap would be the same and the density in the yoke would be 30,000 lines per square inch.

To produce a density of 60,000 in soft wrought iron requires 6 ampere-turns per inch of iron length; to produce the same density in air requires 18,798 ampere-turns per inch length of path, and to produce a density of 30,000 lines per square inch in cast iron requires 23 ampere-turns per inch length of path. Applying these figures to the case assumed, the results come out as follows:

| | Path Length | Density. | Excitation per Inch. | Excitation Required. |
|---|---|---|---|---|
| Cores | 6 | 60,000 | 6 | 36 amp.-turns |
| Yoke | 2 | 30,000 | 23 | 46 amp.-turns |
| Airgap | ¼ | 60,000 | 18,798 | 4700 amp.-turns |
| | | | Total. | 4782 amp.-turns |

Now, if each coil contained 1594 turns, the two would contain 3188 turns and in order to get a total of 4782 ampere-turns, the current through the coils would have to be

$$\frac{4782}{3188} = 1\frac{1}{2}$$

amperes.

### Magnetic Leakage

The foregoing example is based on the assumption that all of the lines of force produced by the exciting coils pass through the yoke and the airgap. With an actual magnet this would not be true, because magnetism cannot be confined to any particular path outside of the coil which produces it. It will pass through air, as already explained, and through all other substances thus far discovered. And, like an electric current, it passes through whatever paths are open to it in inverse proportion to the resistance (reluctance) of each path. Therefore, with a magnet of the sort shown in Fig. 18 a part of the magnetic flux produced by the exciting coils would pass through the surrounding air back to the yoke, as indicated roughly by the dotted lines in Fig. 19, and the density in the yoke, therefore, would be considerably less than 30,000 if the density in the cores was 60,000; and the density in the airgap would not be quite 60,000, because some of the lines pass back to the yoke without crossing the gap.

This straying of the magnetic flux through paths where it is not wanted is called "leakage," and its exact value is extremely difficult to calculate or even to estimate. Only by making tests of actual apparatus can the leakage be ascertained; therefore, when one wishes to build any electrical apparatus containing a magnet, the magnetic leakage must be estimated from results obtained with similar magnets or else ascertained after the thing is built, by actual measurements.

# Why Use a Rheostat in the Alternator Field Circuit?

By J. E. Latta

Some months ago the statement w. made in an article by William Weste field to the effect that cutting out r sistance in the rheostat in the field ci cuit of an alternating-current dynan lightens the load on the exciter. Th was criticized in the October 26 numb by T. M. Utley, but I think probably N Westerfield meant that the load may th be lightened if, when the resistance of t alternator-field rheostat is reduced, t exciter voltage is also reduced (by cu ting in resistance in the shunt-fie rheostat of the exciter), so as to ke the alternator-field current unchange and if this is what he meant, his stat ment is entirely correct and contains suggestion of considerable value to c erators of alternating-current generato

It being true that the exciter load m be reduced in the manner stated, the que tion might arise as to why it is nece sary to use any rheostat at all in t field circuit of an alternator. A part answer to such a question may be h by reference to the curve shown in F 1. This curve was obtained in the f lowing manner. A shunt-wound dire current dynamo, built to carry 24 a peres at 125 volts when operated at f load, was run without load and the fie current was increased by nine succes e equal steps from zero to the value nee d to develop a pressure of 140 volts ac s the brushes. At each step the term il volts and the field amperes were recor l. The field amperes were then laid off n the horizontal scale of Fig. 1, and e

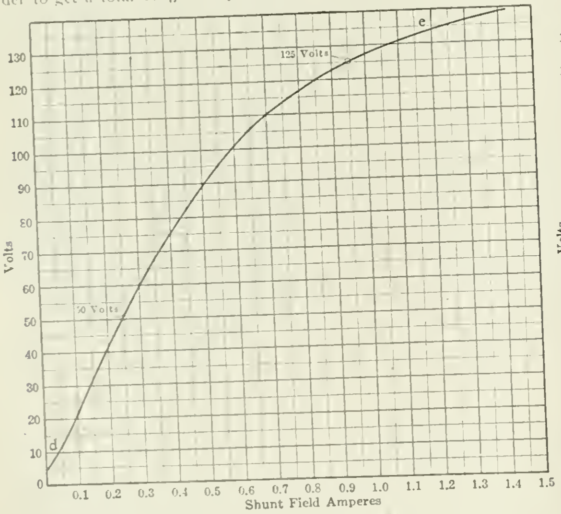


FIG. 1. NO-LOAD EXCITATION CURVE

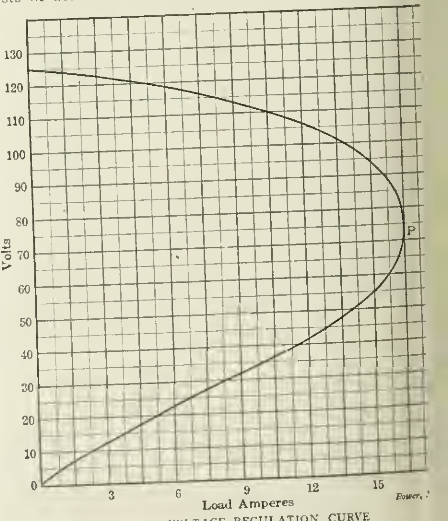


FIG. 2. VOLTAGE REGULATION CURVE

volts along the vertical scale. Then by drawing a smooth curve through the meeting points of vertical lines drawn from the measured values of field current to meet horizontal lines drawn from corresponding values of the voltage, the curve *de* was obtained. Suppose a compound-wound dynamo of the same voltage and current rating had been used in place of the shunt generator experimented on, and suppose further that during the experiment a rheostat connected in the ad circuit of this compound machine d been continually adjusted so as to keep 24 amperes flowing in this circuit. A curve would have been obtained, by lotting terminal volts against shunt-field urrent as in Fig. 1, differing from the ne shown only in that the voltage for y particular value of shunt-field amperes would have been higher and the curve would have begun to approach a rizontal direction earlier. The case of the compound generator is mentioned cause this type of dynamo is employed xtensively to excite alternators.

Now, referring to Fig. 1, consider what would happen if it were attempted to operate this 24-ampere generator, running s an exciter, at a voltage much lower an that for which it was designed, say 50 volts. The curve shows that any ight drop in the shunt-field current, ch as might be caused by a variation the contact resistance between the rushes and the commutator, would be ccompanied by a much greater drop in lts than if the same variation of field rrent occurred with the exciter running t 125 volts. On the other hand, if the hunt-field current should be given a sudden slight increase, as it might during a momentary rise in the exciter speed, for xample, the resulting rise in terminal lts would be relatively very rapid. Obviously, then, unless some automatic aphance like the Tirrell regulator were mployed, it would be practically impossible to hold the voltage of the alternator ady with the exciter running at so low voltage; for of course the voltage of e alternator would tend to vary with ery variation of that of the exciter. nce it appears that for satisfactory eration sufficient resistance would have be placed in the alternator-field circuit to make it possible to run the exciter about 125 volts without causing the ld current of the alternator to become essive. This resistance is supplied ie alternator-field rheostat. Running more of this rheostat cut in than necessary to keep the exciter voltage ady does put more load on the exter than need be, and therefore results a waste of energy.

When a Tirrell voltage regulator is ed it is generally best to work the exer voltage on the steeper part of the rve of Fig. 1. The regulator acts conmously, and gives the best results when e exciter is thus operated.

A condition introducing an additional necessity for the use of alternator-field rheostats may be mentioned here. In many electric plants two or more alternators are supplied with field current from the same exciter or from busbars on which exciters are run in parallel. In such cases it would be impossible to change the voltage of one alternator without changing that of all of them if each of these machines did not have a rheostat in its field circuit.

Speaking of exciters reminds me of a former experience with one of these that may be of interest in this connection. Being called into a plant once to "doctor" an exciter reported to be behaving badly, I found the engineer at the switchboard in a state of considerable perturbation because he could not hold the desired voltage on an alternator he was running. He had cut all the resistance out of the exciter-field rheostat and most of it out of the one in the alternator field as well. Every attempt to cut out more of the latter resistance resulted in a drop in the alternator voltage. He was advised to turn more resistance in the alternator-field rheostat, and when he did this the voltage rose to nearly the desired value and remained quite steady. Examination disclosed the fact that the exciter was an interpole machine having two series-field windings, one of these being the usual series winding of a compounded generator and the other the winding on the auxiliary poles for the purpose of improving commutation. The machine had been connected up in such a way that the shunt-field and the main series-field windings were in opposition; that is, they were "bucking" each other. This would probably have caused the exciter voltage to fail entirely if the interpoles had not been aiding the shunt field. As it was the machine had somewhat the characteristics of a shunt dynamo.

The curve of Fig. 2 was drawn by plotting the terminal volts of a shunt-wound dynamo against the load amperes. It is clear from an inspection of this curve that not more than 16.5 amperes could be taken from the machine for which it was drawn. The reason for this is that in order to get a larger current in the load circuit than 16.5 amperes the load resistance would have to be reduced so much that practically all the current generated in the armature would flow through the load, leaving the current in the field, which is in parallel with the load, so small as to allow the voltage to drop rapidly to zero in the manner shown. In the case of the exciter just referred to, resistance had been cut out of the alternator field until the exciter was operating in the neighborhood of the point marked *P* on the curve. No larger current could be obtained from it, of course. As soon as the alternator could be laid off for awhile the exciter-field windings were adjusted, and there was no further trouble.

## Comparative Coal Consumption of Naval Boilers

The recent cruise of the battleship fleet around the globe gave some interesting figures relative to the coal consumption of the different types of naval boilers in commission. Figures for the home run are not at hand, but the total consumption of the vessels while running in company from San Francisco to Manila are given in the accompanying table. By observing the figures on coal consumption reduced to a common basis, it will be noted that the vessels equipped with Babcock & Wilcox boilers burned the least coal. The saving in coal over vessels using Niclausse boilers was 552 tons, over those using Thornycroft boilers, 878 tons and 400 tons over the vessels equipped with Scotch boilers. These figures are the results of only three months' service, and the same proportionate saving over a period of several years would reduce considerably the naval expenditure for coal. Burning less coal would also increase the steaming radius of the vessels.

COMPARATIVE COAL CONSUMPTION OF NAVAL BOILERS.

| Vessel. | Average Trial Displacement. Tons. | Type of Boiler. | Working Pressure Pound Gage | Average Coal Consumption. Tons. | *Coal Consumption Reduced to Common Basis. Tons. |
|---|---|---|---|---|---|
| Connecticut<br>Kansas<br>Louisiana<br>Minnesota<br>Nebraska<br>New Jersey<br>Rhode Island<br>Vermont | 15,625 | Babcock & Wilcox | 265 | 5,481 | 5,481 |
| Georgia<br>Virginia | 15,000 | Niclausse | 265 | 5,873 | 6,033 |
| Missouri<br>Ohio | 12,500 | Thornycroft | 230 | 5,600 | 6,359 |
| Kearsarge<br>Kentucky<br>Illinois<br>Wisconsin | 11,536 | Double-ended Scotch<br>Single-ended Scotch | 180<br>180 | 4,878 | 5,971 |

*Reduced to common basis in proportion to two-thirds power of displacement.

# Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think,
Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

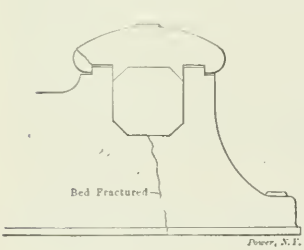
## A Broken Bedplate

An accident occurred to an engine, which suggests a very interesting subject for discussion.

As a subscriber, I am much interested in the correspondence department, and would be pleased to have some expert opinion as to whether or not some other part ought to have given out first.

It was a Corliss engine, 16x36, direct-connected to a generator running 150 revolutions per minute, and for six months had been carrying about half load without showing any signs of weakness. It was decided to put on metallic packing, and it was bought from a concern whose representative took the measurements.

The engineer bolted on the packing, leaving the old gland in position, solid against the cylinder. The old gland was not removed, as the man who measured for the packing provided for it remaining tight against the cylinder. After the metallic packing was in place, the engineer neglected to turn the engine over by hand to learn if the clearance was sufficient. He turned on the steam, with the result that on the first half stroke, the crosshead brought up against the packing solid, and broke the bed clear through as per sketch.



BROKEN BED AND CAP

The fracture showed that the casting was very poor at that point, and the thickness of the iron was $1\frac{1}{8}$ inches.

If the engine had been properly designed, should not the crank pin have been cut off or at least sprung (it proved to be dead square after accident)? Or else the connecting rod sprung? As near as we could measure, the clearance was short by about 1/16 inch to $\frac{1}{8}$ inch.

I would like to hear from some experts or designers on this point. I believe the frame should have been sufficiently heavy to withstand this shock, particularly as there was only the momentum of a half turn.

D. A. Jamison.

Providence, R. I.

## Experimemt on Refrigerating System

The permanent gases, which form in a refrigerating system, can be removed in two ways, by burning and by permitting them to escape under water. The former method is only applicable when combustible gases have accumulated to quite an extent, and when they are burned down to a point where it is difficult to maintain the flame, further purging must be done under water.

This is done by attaching a flexible tube to the purge pipe and allowing the gas to escape into water, where the ammonia will be absorbed and any foreign gases will bubble up and break at the surface. With either method some ammonia will escape into the room, and its pungent and far reaching odor might lead to the belief that a considerable loss was taking place. Experiments conducted by the writer prove, however, that such is not the case.

In preparing to purge the system the liquor in the generator was allowed to boil out until it tested about 19 degrees Baumé and in this weakened condition was circulated through the absorber, the expansion valve being closed. Under these conditions the ammonia gas above the liquor in the absorber was more readily absorbed, and to further assist in absorption the liquor was allowed to rise considerably above its normal level in the absorber, which compressed the gas above it.

The purge valve was then opened and the gas ignited; as the flame died down until it was with difficulty kept lighted, a rubber tube being attached and led to the bottom of a three-gallon jar containing cold water. A two-quart wide-mouthed bottle was filled with water and inverted in the jar in such a way that the bubbles of air and foreign gas passed up into the bottle, displacing the water.

After purging in this manner for several hours, the odor in the room was very slight and the density of the water was only raised 3 degrees Baumé. This would indicate the loss of ammonia by heavy purging is very little while the large amount of foreign gas removed greatly increases the capacity of the machine, permitting a lower absorber pressure and consequently lower brine temperatures.

Lewis C. Reynolds.

Willard, N. Y.

## A Motor Trouble

I was sitting at my desk the other morning awaiting traveling orders, when the boss came in with the morning's mail. He handed me a letter saying, "I think you had better go over and see these people." I read the letter which was a complaint against one of our motors; the trouble being that the shaft in the pulley end bearing was repeatedly running hot. They had tried different lubricating oils, but with no success.

I looked up the motor order and found that it was a 40-horsepower shunt-wound 220-volt constant-speed machine for driving a line shaft, and had been supplied only a few weeks previously. The report from the shop test said everything had been O. K. on a six-hour full-load test.

I went down to the customer's works and was shown the motor. First of all I inspected the belt drive. This was at a reasonable angle and tension, so I cancelled that idea. The electrician reported to me that every time it had run hot, they had inspected the oil well and found practically all the oil used up; in fact, they had regularly been filling it up on an average of more than once a day This sounded as if someone were playing a prank on the motor, so I sat down to await developments.

The motor was in the corner of the shop, with its commutator end against the end wall. Next to the pulley end was a fan. The inlet of the fan was practically opposite the motor bearing, and what with the suction of the fan and the moto pulley and belt, there was quite a draft I tore up a piece of thin paper into smal pieces and dropped them down betwee the pulley and the fan inlet, the resul being that they were drawn into the fan

I called up the electrician and aske him if he had noticed at any of the time when the fan had been stopped, that th motor worked satisfactorily. He said

Well, now you mention it, I believe it s as you say." This statement was conrmed by one of the men

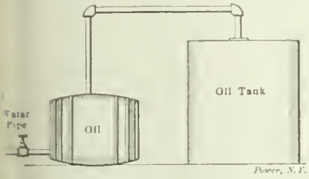
I then suggested to him that the trouble as being caused by the current of air upplying the fan passing through the ulley bearing and drawing out the oil om the oil well. The air inlet was ered by using a branch elbow, and no rther trouble has been experienced.

William Hargreaves.

Sheffield, Eng.

## Emptying an Oil Barrel

Here is a good scheme for emptying oil barrel where there is no pump and e barrel cannot be lifted up to a level h the tank Connect a pipe into one ad of the barrel near the lower edge



SCHEME FOR EMPTYING OIL BARREL

l another one up from the bung and n down into the oil tank. Then put city pressure on the pipe in the head, ich will force the oil into the tank. e oil, being lighter than water, will at on top and the last drop be forced t The connections must, of course, be ht.

Eugene L. Griggs.

Allston, Mass.

## What Made the Difference?

At one time it became necessary to re e an 11x24-inch slide-valve engine with x36-inch Corliss, the flywheel of the rliss weighing about 15,000 pounds ile the flywheel of the slide-valve enne weighed only 1500 pounds. The old ne was used for turning a portion of mill and the indicator showed it was g about 65 horsepower, although the d was not as steady as was desired.

After setting up the Corliss it was ght best to shift enough additional to make a total of 100 horsepower on Corliss.

he changes were made in the belting a pulleys, taking the additional mac es from another engine and belting th n to the shafting driven by the Corli the power required to drive these maches being 35 horsepower.

he engine was started and diagrams ta n which figured but 65 horsepower; the same load which the old 11x24-inch sl e-valve engine indicated before it was taken out, and more machines added to the load How could this be?

F. F. Russell.

Worcester, Mass.

## Home Fire Protection

Whether it is due to the fact that severe insurance competition has resulted in the allowance in policies of amounts perilously near actual values, or to pure haphazardness, that the plant owner or manufacturer does not, as a rule, systematically safeguard his property from fire, I am not prepared to state Few will deny, however, that the most of these plants are equipped with rediculously inefficient fire-fighting apparatus. In cities it is, of course, customary to depend upon the regular fire department. That this is a short-sighted policy will usually be admitted by the owners as well as everyone else and yet nothing definite is done toward preparation for the unexpected.

The power-plant engineer is perhaps the one who can do the most toward improving home fire protection, as the giving of alarms, supplying of pressure, etc., belong to his department. More often than not it is through thoughtlessness that the management has not taken steps to protect the plant, and when this is the case the engineer can easily convince his superiors by means of figures and concrete data on the cost of a fire pump, proper piping, hydrants, hose and other equipment. Often the power plant is already the possessor of a pump of the capacity required, in which case it is only necessary to arrange piping for quickly diverting to delivery to the hydrants about the plant. The only trouble with this course is the fact that a pump of far too small a capacity is apt to be chosen. No boiler-feed pump already in the plant, no matter how large, should be used for this purpose, because it is a part of the boiler equipment which is itself used to furnish steam, and although there may be other methods of boiler feeding this pump is subject to be called upon in emergency or it would not be there.

One of our large railroads has saved itself considerable loss in recent years by systematically protecting it's shops and terminals at different points by the means suggested. Each workman about the place is a volunteer fireman and is assigned to a company. Hose carts and hose with its adjuncts are furnished each company Fire chiefs are elected by the men themselves one for each shift; night and day. Each company has its captain reporting to the chief. To keep up the interest of the men, a drill is called at unexpected intervals during working hours by the engineer of the power plant or the master mechanic Each company is carefully timed and mistakes are checked up. The distances run are measured up and the results are posted on the bulletin boards about the shops. These notices are left until the time of the next drill, to the humiliation of the losers in the contest and the pride of the winners

Blueprints of the pipe and hydrant layouts are also kept before the men that they may never forget their locations; the code of whistle signals is also carefully posted. By the time the engineer has finished blowing the first whistle the men are well on their way to the hosecart station, the other whistles are counted as they run. The power-plant engineer is always ready with the pressure as he has a pump which is used for no other purpose.

It will perhaps appear that some time would be lost to the company by calling so many men from work to the drills, but on second consideration it will be seen that the loss is negligible. The average drill lasts less than five minutes, and once a month for each shift is frequent enough to keep up interest. The men go back to their machines refreshed by the run and work with renewed vigor. The results obtained by so efficient a force in time of emergency are only to be conjectured; they may be of enormous value.

L. F. Wilson.

Chicago, Ill.

## Uneven Wear of Gas Engine Piston Rods

During an observation of the operation of gas engines extending over several years and of several makes of gas engines, I have noticed many cases of abnormal wear of the piston rods. It is frequently difficult to ascribe the correct cause, and since the actual cause is what I am particularly interested in, I am writing this letter in the hope that some other readers, having had similar experiences, may write of them in these columns.

The wear mentioned occurs on both single-acting and double-acting engines, but is perhaps more rapid on double-acting engines, which always have water-cooled rods. Most of this type have metallic packing in the stuffing boxes, and the wear seems to take place up to the limit of ring travel on the rod and to cease at that point. In all the cases I have noticed, the greatest amount of wear has been on the coolest part of the rod.

For instance, in a double-acting tandem engine in which the cooling water was introduced into the rod through the crosshead or just back of it and flowed in series through both pistons and out of the tail rod, the maximum wear was on that portion of the rod next to the crosshead and it gradually diminished toward the tail end, where there was scarcely any wear. The wear, of course, occurred only on that part of the rod [illegible] by the packing rings, but it seemed to be roughly in inverse ratio to the temperature of the rod, being greatest near the point where cold cooling water was introduced and least where the hot water left the rod.

In looking for the cause of such an action, one naturally discovers certain conditions which seem to accompany this wear and if these conditions give a clue to the real cause. I confess that I have been unable to read the meaning to my satisfaction.

While I am convinced that the wear bears a certain inverse relation to the temperature of the rod, I am also quite sure that the temperature alone has nothing to do with it. I believe, however, that a cold rod does condense moisture from the gas in the cylinder (or from the air when the engine is idle), and that the presence of this moisture on the rod is one of the prime causes of wear. Whether the wet rod destroys lubrication and thus induces excessive wear or not, is an open question in my mind, but I am inclined to think that lubrication is not seriously impaired.

I have noticed many engines running on natural gas and they seem to be almost entirely free from this trouble, which would naturally lead one to think that some constituent of producer gas is responsible for the distribution of wear described. I am, in fact, quite convinced that this is so, and am also convinced that the element of sulphur in the gas is the basis of most of the trouble. In every case which has come under my notice, more or less (usually more), sulphur has been present in the gas. This sulphur seems to combine with the moisture on the rod to form an acid which is the immediate cause of the abnormal rod wear.

While this reduction in diameter is going on, the surface of the rod seems to remain as near perfection as could be asked for—as smooth as glass.

I have been running almost hot water into the rods of many engines and endeavoring to put it in at such a point and in such a quantity as will keep the rod uniformly hot throughout its entire length, and this has improved matters greatly. I believe it has, in fact, nearly eliminated the wear.

Now, what I want to know is, is the combination of a low rod temperature and sulphur in the gas the cause of this phenomenon? If not, what is the cause and how can it be prevented? What is the proper material of which to make piston rods in order to prevent this wear, if there is any such satisfactory metal, answering, of course, all other requirements?

If buying coal without sulphur for the producer is the remedy, what is to be done when a supply of coal containing sulphur comes to the plant, send back the coal, remove the sulphur from the gas or endure the result on the rods?

If it is necessary to remove the sulphur from the gas, what is the best, cheapest and least troublesome method?

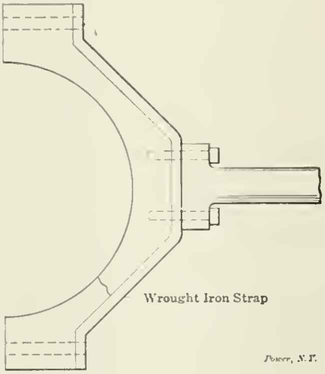
The experiences of others and answers to the above questions will be greatly appreciated.

L. B. LENT.

Brewster, N. Y.

## Temporary Repair of Eccentric Strap

This method will occasionally come in handy for fixing temporarily a broken eccentric strap, if the outside edge is flat. Bend a piece of wrought iron to



TEMPORARY REPAIR ON ECCENTRIC

the same shape as the strap and bolt it on as shown in the figure. If the break is in the strap which is attached to the eccentric rod, the strap will have to be bored for the bolts to come through. Don't forget afterward to shorten the valve stem by an amount equal to the thickness of the wrought iron.

EUGENE L. GRIGGS.

Allston, Mass.

## Peening a Hot Pin

A few years ago while running a 125-horsepower engine in a small woolen mill, I had a crank pin that could not be kept cool. It was as smooth as glass and apparently true; the oil holes and channels were ample, but I could not hold oil between the pin and brasses.

The bearing had brass linings, and thinking I could help matters, I made a set and filled them with babbitt metal, but got no better results. Being young in the business, I asked the advice of one or two older and more experienced men, and although I tried several kinds of oils, greases and patent lubricating compounds, it still ran hot.

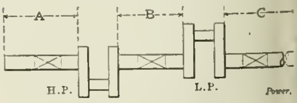
One day a man, who had the appr ance of being a "knight of the road," c along and stopped at the door and w talking he remarked about smelling a bearing. So I told him that I had bothered for some time with it. waited until shutting down time, wh took the rod off and started to scrape brasses. As he was looking around said he had run a locomotive at one and thought he could remedy the tro All that he did was to peen the pin li ly all around, and, to tell the trut thought he had ruined it. He then a fine file and smoothed the pin up put the rod on. From that time on pin ran as "cool as a cucumber" on quarter pint of oil every five hours would add that I have tried that s trick on three different occasions success.

F. RANDOLP

Norwich, Conn.

## Shaft out of Line

A 1200-horsepower engine broke high-pressure crank pin. The cr shaft was taken to the shop to have new pin shrunk in. The shaft was in a lathe, and after the pin had turned down to size, was taken back the engine to be coupled up. Whil was out the bearings had been teste to alinement with a piano wire and fo all right. When the engineer came bed the shaft into the bearings with b lead, it was found that they would spot fine with the shaft in one posit but would not show good markings w the shaft was rolled half a turn fart Although this did not look well, it decided to couple it up in the hopes the shaft would come to its bearings fore long. After a day's trial un steam the bearings continued to warm. The shaft was taken out again sent to the shop and set up i lathe. It was found that while the pins proved up all right with the secti *A* and *B*, section *C* had been sprung



SHAFT OUT OF LINE

of line about 0.004 inch. After *C* been put back in place there was further trouble in getting the bearings spot or to run cool.

T. H. HEAT

Seattle, Wash.

Never lose an opportunity to comp the steam gage with the safety v when the latter blows off. If they do agree, ascertain which is incorrect.

# Subjects Under Discussion

Comment, Criticism and Debate upon Various Articles, Letters and Editorials Which Have Appeared in Previous Issues

BRING OUT YOUR IDEAS

## Exciter Trouble

The letter of James A. Walker in the ·ovember 2 number, is indeed very in- resting in that he seems to have baffled ie company manufacturing the machine he general case of a commutator running hot can be attributed to many things. the brushes are allowed to spark, a rtain amount of heat is generated which be quickly transmitted to the commutator and brushes. But Mr. Walker ys his brushes do not spark, a state- nt so often inaccurately made. By s I mean that a brush may be spark- g and yet such sparking not be visible. t occurring toward the center of the sh and not as a fringe at the edge. ch sparking results in the pitting of brushes. An easy way to make sure is not the case is to determine the extreme positions of the brushes ere sparking is just visible, and then them in a position midway between e two positions thus determined.

Again, there may be too much friction tween the surface of the brush and the mutator due either to the lack of a per lubricant, or too much pressure ng put on the brushes, or both. The st of these can easily be overcome by lying a small amount of vaseline to surface of the commutator while the chine is in motion, using a soft, lint- ls cloth for the purpose. Of course the e of too much pressure is very easily died by relieving some of the ten- in the spring holding the brushes in Mr. Walker, however, states that pressure is relieved, sparking takes , but if he will look in other direc- s for the cause of sparking, as above lained, this latter trouble will be inated and the heating reduced.

As I take it, the whole commutator g hot and not merely a portion con- ing of a dozen or so adjacent bars. I ie latter was the case the heating c l easily be attributed to the fact that tl mica insulation placed between the secutive bars had broken down, caus- a short-circuit and the consequent of a heavy local current in the coils a ched to these bars.

nother quite unlikely source of heat g eration is in the faulty soldering on o he armature coils to their correspond- commutator bars.

should advise Mr. Walker to examine th machine along these lines, with the possible substituting of carbon and graphite brushes for the softer and more troublesome graphite brush. The end play spoken of would have no tendency to heat the machine, but merely allow the commutator to wear down evenly throughout its length and not in little hills and hollows as is so often the case.

John G. Moxey.

Philadelphia, Penn.

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If we knew just what wires were disconnected, and the type of machine, we would be able to give a better reason as to the possible causes of the trouble. If the exciter is a compound-wound machine, and the series connections are carried inside the field frame to their connections, we might disconnect all other wires, and yet the fields would get strong exciting current through the series windings, and the machine would generate with the armature short-circuited on itself, and the wonder would be that the machine is not destroyed. However, if the field connections are all broken, it would hardly seem possible that there could be sufficient residual magnetism in the field magnets to cause any considerable current to be generated in the armature, and the heating could hardly be due to that cause.

I should suggest that the most likely explanation is that through oversight the field connections have not been broken, and hence, the machine has been generating with other connections broken.

It might be possible that the trouble is due to the brushes bearing too hard on the commutator, or it might be that the commutator is allowed to run too dry, although I understand that graphite brushes do not give trouble due to this cause as do carbon brushes. In any event I would occasionally try the application of a clean cotton cloth, lightly saturated with clean oil, to the commutator.

I will suggest another remedy, namely, to try cutting out all resistance in the generator-field rheostat, and leave in as much resistance as possible in the exciter-field rheostat. This will lighten the load on the exciter, and should help the trouble, if it does not overcome it. I have often done this, especially in cases where the exciter was too small for the duty required of it.

William Westerfield.

Lincoln, Neb.

## How Would You Do It?

Under this title, Mr Heath calls attention to the fact that if nitrogen were removed from the air, the efficiency of combustion would be raised considerably. This is true, but, even if it were possible to remove the nitrogen, the combustion with oxygen alone would be so violent as to be almost explosive. Combustion proceeds just as rapidly as the oxygen is supplied. For example, ordinary gunpowder is merely a mixture of carbon, in the form of charcoal, with saltpeter which contains a large amount of available oxygen. When the powder is ignited, the oxygen in the saltpeter is liberated and the result is that the combustion is nearly instantaneous; or in other words, an explosion.

Another feature to consider would be the extremely high temperature which would result. If carbon were burned in oxygen, a temperature of about 15,000 degrees Fahrenheit would be obtained. This temperature would greatly exceed the temperature of the oxyhydrogen flame and even the oxyacetylene flame which is used for welding iron. Furnaces and grates would fuse quickly to one mass of clinker. There is no doubt that a great economy could be obtained if the gases could be cooled down to about 500 degrees Fahrenheit as they are ordinarily in boiler practice. Such being the case, the flue gases would carry off only about 600 B.t.u. per pound of coal or about 5 per cent., while there would be no such a thing as smoke or unconsumed combustible gases. This would raise boiler efficiencies up to about 90 to 95 per cent.

The main thing to be kept in mind is the title of this article; viz., How would you do it? There is no practical way of absorbing nitrogen or taking it out of a mixture of nitrogen and oxygen. The only way it is possible to get rid of the nitrogen is to absorb the oxygen by some compound, such as barium oxide and then heating in closed vessels when the oxygen is given off. Such a process is not practicable for supplying oxygen as would be needed for engineering uses. Also, if liquid air is allowed to stand, the nitrogen evaporates more rapidly, and the liquid remaining is very much richer in oxygen. However, the cost of making liquid air is enormous and such a thing is out of the question. I think most engi-are content to put up with the losses which the nitrogen causes and put their energies into more reasonable fields than that of getting rid of the nitrogen of the air.

JAMES E. STEELY.

Covington, Va.

## Kerosene in Boilers

John H. Hieber asks in the October 26 issue, "Why did the kerosene knock the scale and yet when used again later not prevent its forming?" It is safe to say that the kerosene had nothing to do with throwing down the scale, which was caused by the sudden change of temperature due to Mr. Hieber's treatment of the boiler in question.

It is a common practice with many engineers to use the "expansion and contraction" method of removing scale from boilers and, while no one can dispute the fact that it is very effective, still I consider it very harsh treatment.

L. C. TUCKER.

Newburyport, Mass.

## To Determine the Value of a Water Power

In the October 12 issue there is an article by W. T. Ryan with the above title. In this the second formula, for obtaining the horsepower available, is incorrect and is not used in the same form in the example given on the following page. This formula is given as

$$H.P. = \frac{(Q)\,(h)\,(62.5)}{33{,}000}$$

and in the paragraph above $Q$ is stated to be the discharge in cubic feet per second. If this were the case, the denominator should be 550 instead of 33,000; the latter figure would be used if $Q$ equaled the number of cubic feet *per minute* but should be divided by 60 when the second is the unit of time. The result of using this formula would be to estimate the horsepower available at only one-sixtieth of what it really was.

The difference in volume of the stream, although mentioned, is not given the importance that it deserves and unless this is understood costly mistakes are liable to be made. Unless storage capacity is provided only the minimum flow can be promised to anyone using the power or else auxiliary power must be supplied.

In the last example the total energy is given as 5500 horsepower but this could only be obtained by generating machinery with an efficiency of 100 per cent. In the case of electric power as mentioned here, the power finally paid for by the consumer would probably amount to only 50 per cent. or even less of that in the river, the rest being lost in the wheels, generators, transformers, distribution system and meters, so that there will be little more than is required by the town instead of two and a half times as much.

G. H. MCKELWAY.

Brooklyn, N. Y.

## Some Erroneous Ideas

In the September 14 issue, Mr. Hartley points out some erroneous ideas, and in subsequent issues his critics try to prove him wrong and have a little fun at his expense, but I think the laugh is on them, as will perhaps be seen when we get through.

In the October 19 issue, Mr. Clapper compares an imperfectly fitting sliding valve, weighing 100 pounds, to a perfectly fitted surface plate and a 10,000-pound weight on top, and wants to know if the one having the greater weight can be moved as easily as the one having the least. Well, hardly, but who said it could? Not Mr. Hartley, did he?

But even at that, if his two surface plates, "ground to a perfect bearing on their seats" had a film of water, oil or air between them he could put ten times 10,000 pounds on top (if they were strong enough) and move it, after the inertia of the mass has been overcome, a good deal easier than he could move the valve under discussion.

Just to prove the case for some of the boys here, we took an old 2-horsepower slide-valve engine and blocked up the steam and exhaust ports, set the valve in place, put on the cover, turned on 60 pounds of steam, and then turned the cylinder upside down, when we heard a thump in the steam chest. We then concluded that the valve had not been "ground to a perfect bearing on its seat," and let it go at that.

Let us look at the cylinder-head bolt question and before we prove ourselves right, let us prove the other fellow wrong. Mr. Hutchins says (November 9) to stretch a spring between the ends of a hickory stick and we will see that any additional pull on the spring puts an additional stress on the spring; true enough, but will he, or someone else, tell the audience how he can put any more stress on the spring without increasing its length; and when the spring stretches what becomes of the stress that was on the stick? In trying to prove Mr. Hartley wrong, he has proved him right, in that he said "no extra stress comes on the bolts until the steam pressure exceeds the initial tension in the bolts." In the case of the stick alone, the stress on it balanced the stress on the spring when the spring was, say, 20 inches long, and in the case of the hand and stick, with the spring at the same length, the stress on the spring balanced the combined stresses of the hand and stick, proving Mr. Hartley right.

Let us put the stick back in the wood pile, forget about gaskets, and the metal under the nut that compresses 0.02 inch, and take a look at the pop va on the boiler, or the piston-relief va on the Westinghouse engine, or the fl ing head in an ice machine, there have the problem before us in practice

According to Mr. Benton (October the increase of stress on the bolts is p portional to the increase of steam pr sure, which is logical to the argum Within working limits, the compress of the springs in these appliances is portional to the force applied. Hence the initial compression of the spring equal to 1 inch and the stress equal 2000 pounds, an additional stress of 1 pounds due to steam pressure n shorten the spring another ½ inch; must be evident to all who care to se

If the disk and spring must be ½ i away from the seat in order to resist extra 1000 pounds, it must have left seat a long while before the pressure to 1000 pounds. To be logical it n have started to leave the seat at the indication of any pressure in the inder. But the fact of the matter that it did not, and it's a good thing the fireman that the theory is wrong

If the pressure increases the stress the spring (or bolts if you wish), doesn't the spring shorten and show

In practice we find that safety-v disks, and relief valves and such, ren on their seats until the pressure under disks exceeds the stress on the spr or bolts holding them to their seats, when the steam pressure exceeds holding-down force, the material hol them down will alter in length and indicator of any kind will show it.

If the steam pressure were less, yet the spring altered in length to s an increase of stress, we would have spectacle of a lesser force overcon a greater force and that sounds to erroneous.

ALBERT HILENFIEL

Cleveland, O.

On page 716, L. F. Wilson states he agrees with Mr. Hartly, regarding strain on a cylinder-head bolt, but of his discussion shows that he is of the same opinion, having ideas gether at variance with the condition they actually exist.

Mr. Hartly says, in substance, tha additional strain is set up in the b due to the steam pressure in the cyli until the force of the steam acting ag the head equals the force with whic head is pressed against the cylinder. force tending to press the head from the cylinder will then balance force tending to hold the head on, any addition to the pressure tendin force the head off, increases the s on the bolts.

Mr. Wilson says he agrees with Hartly in this idea, but states that r of 1000 pounds were holding the against the cylinder, and a force of ounds, or 1/10 of the strain in the were exerted against the head by pressure in the cylinder, that this force pressing against the head l relieve the joint of a correspond- unt of pressure. According to e force now tending to hold the gainst the cylinder is 900 pounds, e says that this 900 pounds plus o pounds of steam force equals the strain of 1000 pounds.

of the steam engines I have seen had cast-iron cylinders, cast-iron and steel studs, and I would ask Wilson to explain how a force of nds, in this case, or any ordinary in an actual engine in operation, ngate these steel studs, or com- the iron cylinder head so that the ay be relieved of part of the initial He says the joint between the r head and the end of the cyl is relieved of an amount of pres- rresponding to the force of the tending to force the head off.

his example, the steam force were nds, the joint would be relieved i the initial force, but the force n on the bolts would still be 1000 This is Mr. Wilson's idea.

rding to Mr. Hartly, the strain bolts would be 1000 pounds, be- e steam force just balances but t exceed the initial strain in the t

r Mr Wilson's example the bolts actually be subjected to a strain pounds, because the bolts do not r give according to the variations am pressure exerted against the t remain firm, maintaining their strain, forcing the head tightly the cylinder and any force exerted the head, tending to force the d way from the cylinder, increases n on the bolts, and the two forces gether give the total strain on ts

rding to Mr. Wilson's idea, if, f a steam pressure being exerted the head, a vacuum existed in nder, as in the case of a con- engine, I suppose he would claim atmospheric pressure exerted e outside of the cylinder head increase the force with which the pressed against the cylinder and strain on the bolts would be a corresponding amount.

ch changes in the force with which ler head is pressed against the do actually exist, as Mr. Wilson think, I would like to know how he ever been able to keep a gasket the joints and keep them steam ght.

HARRY W. BENTON.

Cleveland, O.

## Seaweed and Condensers

Mr Meller's suggestion for a strainer inside the boiler room page 700 of the November 2 issue while it will doubtless help engineers in small plants does not solve the seaweed problem on this coast, nor anywhere where they are dealing with great intake conduits for the condensing water of a large station, and not with a little pipe that one man can lift out of the water and put back

When the strainer has to be cleaned so often as five times in a shift it would be well to use two of them in parallel. As only one-half the quantity of water would pass through each they would go longer between cleanings, and while one was out for cleaning the other could serve for both. If the cleanings were alternate, the greater amount of water would pass through the cleaner screen when it was returned, and this amount would increase as the other approached its time for coming out. When the latter screen was returned clean it would take the heavier flow relieving that through the partially clogged one. It is possible that this could be worked with parallel screen boxes on conduits of considerable size, but we must have the intake screened or the conduits will pack with seaweed and grass, and if we do, the growth will pack around the screen and keep the water out.

R. P. ADAMS.

Los Angeles, Cal.

## Corliss Engine Valve Setting

I am running my 18x36-inch Corliss engine 100 revolutions per minute with the valves set as follows: Wristplate on the center; steam valves 1/4 inch lap; exhaust valves line and line, and with the engine on the center the steam valves have 1/32-inch lead. With the governor blocked up 3/16 inch the head-end valve trips with the wristplate at full throw and the crank-end valve knockoff touches the hook, but does not trip. With a heavy load I block the governor so the trips are operative all the time and and I can carry the steam pressure higher, and though during our overload period the speed falls off from three to five revolutions per minute, results on the whole are very good. I get a more even speed and do not have to shut down for steam.

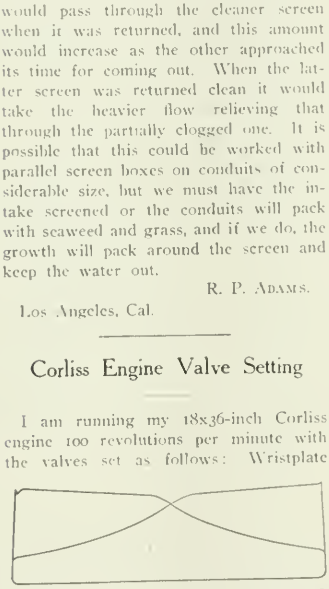
Power, N.Y.

FIG. 1. DIAGRAMS WITH GOVERNOR OPERATING

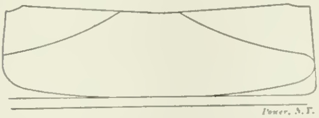
Power, N.Y.

FIG. 2. DIAGRAMS WITH GOVERNOR DOWN ON THE BLOCK

I am inclosing some indicator diagrams and would like any suggestions for bettering them. I am going to lower the back pressure soon so that will help us some. This valve setting has helped me very much and I hope someone else will try it out. I think a little more lead would better the steam line on the diagrams.

JAMES H. ROSE.

Milwaukee, Wis.

## Twelve Hour Shifts

I expected to see more comment on the editorial, "Twelve Hour Shifts," in a recent issue of POWER, but I suppose the "boys" are so tired when through that they do not feel like doing much writing. The temperature of some of the engine rooms in summer is enough to take the ambition out of anyone who has to stay in them twelve hours.

Many good engineers, who work long hours at night have got into trouble and lost their positions by trying to give what their employers asked for—twelve hours' honest labor per day, seven days per week, 52 weeks per year.

I knew an engineer who was discharged for sleeping on duty. His turn consisted of thirteen hours at night; the chief engineer who discharged him worked about eight hours per day, and I have often seen him sleep several hours at a stretch during the middle of the day. This is not a "knock" at chief engineers in general, but one example of "man's inhumanity to man."

I find that the engineers are very, very rare who will acknowledge that they might accidentally doze off while on a long watch at night. I know that the engineer is very rare who works long hours at night and is not liable to doze off when conditions happen to be just right.

The present-day engineer who expects to hold his own and meet the demands made upon him, must read several of the leading engineering publications, and keep up with new mechanical appliances and methods. In many places he is expected to be handy with the tools of all trades, in the way of making repairs about a factory, shop or building.

He must work long hours, work at night, work Sundays and holidays, be responsible for valuable machinery, property and lives, and all this for comparatively small pay.

About 5 per cent of the engineers working long hours get from one to two weeks' vacation each year, in which they [illegible] whether they still live or just exist, the other 95 per cent keep up the continuous grind.

Aside from all this, there are some engineers who work reasonable hours for fair pay, and some chief engineers who treat their men as men

The running engineer and the chief engineer know positively that a man cannot give twelve hours' good service daily, and keep it up day after day and week after week. Then why not, "herald the news to the man higher up," and call for closer consideration of the engineer's duties, and something may be done to shorten his day, and lengthen his years of usefulness.

N. L. Odeon.

Mt. Oliver Station, Penn.

## Cylinder Lubrication

We have a 16x32 Nordberg Corliss engine in our plant running at 85 revolutions per minute on 110 pounds of steam pressure. During the past summer we have run 13 hours a day and have used about 1½ pints of a dark, heavy cylinder oil per day, which costs 45 cents per gallon. I find that the valves and piston have kept in as good condition as could be desired.

My practice is to take the cylinder head off about once a month and give the cylinder walls a coating of flake graphite mixed with cylinder oil, and if I find that the piston-packing rings have a sharp edge, I round them off a little with a smooth file.

H. Jahnke.

Milwaukee, Wis.

My experience with cylinder oil is as follows: For five years we used on a 12x36 Bates Corliss engine, 88 revolutions, 100 pounds of steam pressure, 160 average horsepower, running 10 hours a day, one quart of Capitol cylinder oil. On a 12x12 Ideal engine, 300 revolutions, 100 pounds of steam pressure, running 24 hours a day, we used one quart of the same oil, and one quart also on a 10 and 6 by 10-inch Worthington duplex pump, 100 pounds of steam pressure, running 24 hours a day.

One year's record for a 14x20 Atlas engine, 130 revolutions, 80 pounds steam pressure, average 80 horsepower, running 10 hours a day, was one quart of Capitol cylinder oil per day. On a 10x14 engine the make unknown 260 revolutions, 80 pounds of steam pressure, we used one quart of this oil each 36 hours. On two Marsh pumps, 5 and 3 by 6 inches we used one quart of oil each ten hours.

We are about to raise the pressure on the two engines mentioned last to 125 pounds and will probably be obliged to change to a higher grade of oil.

With a less quantity of oil the Corliss engine would groan badly, while on the Ideal and 10x14 engines the valves rattled and the eccentric straps heated.

H. W. Rowley.

Adrian, Mich.

Since writing my last letter on this subject to Power and The Engineer I have visited the White Star steamer "Oceanic," and was not surprised to learn that in this vessel, with main engines capable of developing 28,000 indicated horsepower, no oil is used for internal lubrication in the cylinders or valve casings; the piston rods, however, are swabbed every half hour or so with cylinder oil. The stroke of the engines is 6 feet, revolutions per minute about 78.

If statistics were available it would be found that in marine practice the use of cylinder oil is cut to a minimum or entirely avoided.

Within the writer's experience there have been instances of some marine engines that would not run without a given quantity of oil, and all attempts to cut down this consumption had to be abandoned. There were valid reasons for this; but in the opinion of some engineers it is held that if oil is given to a new engine and the practice kept up for a little time an appetite for oil is created which will last as long as the engine. Engines may have these human tendencies but the writer and a few others would rather believe that a more palpable reason would be found through an investigation which would account for the varied oil-consuming tendencies of engines of similar types. In one case where oil could not be cut down, very muddy water was used for feeding the boilers and it was found that the lubricating properties of mud had to be increased at the expense of oil.

Frank H. Williams.

New Haven, Conn.

My account of cylinder lubrication may be out of place in this discussion as it seems to be a discussion on oil. We have an 18x36 Corliss engine driving a railway generator. When I came here as assistant engineer the chief told me to give the engine 7 to 10 drops of oil per minute, as the engine seemed to require that amount. Then at times one of the valves would groan and we would stop the noise by an injection of oil via the hand pump route. We also had a jet-condenser pump requiring 4 to 5 drops per minute, and a boiler-feed pump about 6 drops per minute.

Shortly after becoming chief engineer myself, I noticed an article in Power referring to a cylinder grease manufactured by the Ohio Grease Lubricant Company. I opened communication with this company with the result that I shortly had one of their lubricators on my engine and a supply of grease for trial. After about 10 days I found that I could run the engine very satisfactorily with two drops of grease per minute. With the oi ubr cator it was necessary to fill twic day, but with the grease we fill other day, or one-quarter as oft has also become a rare thing to he valve groan.

Finding that the grease did so soon had a lubricator for each pumps, and started giving each drops per minute, which was sc duced to two per minute.

The operation of all the lubr with grease is entirely satisfact both the management and mysel had been using a 30-cent lubricatin

W. A. Wa

Radnor, Ohio.

In answer to your request for i tion in regard to cylinder lubric submit the following data:

In my present plant I have one Corliss engine, 24x48 inches, run 65 revolutions per minute. I quart of cylinder oil, fed thr Rochester lubricator, in a 10½-ho and about two tablespoonfuls of each day, fed through the hand oi I have tried to cut down this am oil, but the condition of the valv not allow it, as a very small dec the feed will cause the valves a peculiar grinding noise.

In another plant I had charge sisting of a 10½ and 20½ by American Ball duplex compound making 285 revolutions per minute three pints of cylinder oil in an hour run. This was for both cy When I first took charge the b oil used was a compounded o gave considerable trouble in the an open heater being used. After ing to a straight mineral oil, so-ca got rid of most of the boiler tro

In another plant where I had under a chief who did not believe ing the oil men rich, we had an inch Greene engine making 85 rev per minute. We fed two drops o cylinder oil per minute, and afte years' service the surfaces of the and valves were in first-class con

Some four years ago it was n fortune to see the inside of inders of a compound yacht eng never had a drop of cylinder oil or graphite, and I must say they good—as smooth as glass, with finish and not a scratch or any that sort on their surfaces. The had been in use about four yea made two trips to Europe, one to and had traveled up and down t five or six months every year. I see the valves or seats, but the informed me that they were in good condition. He was a firm in not using oil in his main engi did use it in all the auxiliaries, ing his small vertical electric-li d him why it was he used oil in . electric-light engine, and not in his engine, but he could give no satis- y reason, and if one vertical engine steam from the same boilers can thout oil in its cylinders, I cannot hy another has to have it.

W. E. SARGENT.

nklin, Mass.

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plying with your editorial request rmation on cylinder lubrication, the following as practised in the i which I have charge:

Two high speed, automatic, par lnced slide-valve engines, 16x16, rsepower, 250 revolutions per min- drop in 40 seconds.

One high-speed, automatic, bal- slide-valve engine, 14x16, 125 wer, 250 revolutions per minute, p per minute.

One cross-compound, Meyer (high-pressure valve balanced), 18 by 14 inches, 90 horsepower, lutions per minute, one drop per tes.

Two tandem-compound, piston 10 and 18 by 18 inches, 90 horse- 115 revolutions per minute, one 25 seconds.

l used is the best obtainable in lity and is a high-grade mineral rt-size "hydraulic" lubricators d.

Al gines run noncondensing on 115 steam pressure. Steam conditions t as bad as they possibly could e boilers, horizontal tubulars, have d es; the water is muddy and alka- ile the steam main is low and t ward the boilers.

ne separator is used and this is t on the main between the boilers first engine. At times the trap g the water from this separator arge water for several minutes sly; and occasionally the high the extreme end of the main t water enough to make us think ler heads are about to leave us. cylinder in the plant is in fine n, but the valves and seats of the balanced" high speeds (a) siderable cutting, although the r cards show them to be steam .

s (a) and (b) are belt con- generators. Engines (c) and connected to two two-stage air rs; (c) being of the "cross- d" type with receiver beneath r—no trap or drain—and (d) the "straight-line" type with re- ipe over the cylinder. The valves nes (d) drag heavily, no matter ch oil is used, and are badly cut, s showing, with one-fourth cut- ing, steam admission for prac- ull stroke; while with (c) the r has run at one drop in two minutes for several hours with no signs of insufficient lubrication.

With all three compressors and two high speeds running approximately 20 or 22 hours per day and every day, the two high speeds being used alternately, a barrel of cylinder oil lasts a month.

A. F. ANDERSON.

Lujane, Colo.

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In the light and power station where I am now employed we have three engines using oil as follows:

New Brown, 10x30, 125 revolutions per minute, force feed lubricator, single feed piped into the steam pipe 20 inches above the throttle. This engine is using Harris high-pressure valve oil, 19 drops to the minute, 1⅛ quarts on a 19-hour run.

Harrisburg Standard, cross-compound, 16 and 28 by 18, 200 revolutions per minute, force feed lubricators on each cylinder, the oil entering just above each steam chest. On the high-pressure side we use Harris high-pressure valve oil, 20 drops per minute, 1¾ quarts per 19-hour run; on the low-pressure side (vacuum) Rarus oil, feeding 20 drops per minute, 1¼ quarts per 19-hour run.

Ball, 9x12, 300 revolutions per minute, hydraulic lubricator, the oil entering the steam pipe 15 inches above the throttle, using (vacuum) Pomo oil, 8 drops per minute, 1 pint per 6-hour run.

The boiler pressure on all is from 100 to 110 pounds.

I have had two interesting experiences with cylinder oil on New Brown engines and will relate them here.

On a 12x34, 90 revolutions per minute, there was a double-feed hydraulic lubricator, the oil entering the top of each steam-valve chest. Two drops per minute were used on each feed, using 1¼ pints per 10-hour run, of Franklin oil, made by W. A. Wood, Boston. A force-feed lubricator was put on, single feed, entering the steam pipe 16 inches above the throttle, and the oil was cut down to a pint per day and better lubrication secured. The steam valves of the New Brown are very sensitive to a change in lubrication and I had to give the dashpots more compression at once. The cylinder also showed up better. The steam pressure was 80 pounds.

The other experience was with a New Brown tandem-compound 17 and 33 by 48, 97 revolutions per minute, running 23¼ hours every day. From 7 a.m to 6 p.m. the boiler pressure was 175 pounds (gage), and from 6 p.m. to 7 a.m., from 110 to 120. The receiver pressure was about 10 pounds during the day and two during the night; vacuum, 26 inches. There was a double-feed oil pump for each cylinder, the oil entering the top of the steam-valve chests. Franklin cylinder oil (W. A. Wood, Boston), was used in both cylinders. The low-pressure cylinder was in fine shape and we used about 2 quarts per day (23¼ hours). The high-pressure cylinder had recently been scratched somewhat by the breaking of the piston. The man who rebored the cylinder must have followed W. E. Crane's advice to leave it rough, only he beat Mr Crane to a "frazzle." It was rough and no mistake; we called it the "washboard." Partly on account of this, but more, I think, because of using the same oil for a temperature of 377 (in the high-) and 240 (in the low-), we had hard work to keep it from showing signs of distress. We used a little over 12 quarts every 23¼ hours in this cylinder. Probably a heavier oil in the high would have saved a dollar to a dollar and a half a day, and surely a cheaper oil would have done just as well for the low-pressure cylinder.

WILLIAM E. DIXON.

Hudson, Mass.

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For a considerable period the high-pressure engines of three 20 and 36 by 44-inch cross-compound units, of the Hamilton-Corliss type, coupled directly to electric generators and running at a speed of 100 revolutions per minute with an initial steam pressure of 140 pounds per square inch, gave an entirely satisfactory performance with an average rate of cylinder lubrication of about seven drops of "600 W" cylinder oil per minute. The tranquil aspect of this engine equipment was, however, destined eventually to be sorely disturbed, when, in anticipation of a prospective enlargement of the plant by the addition of a turbine-driven generating unit, in connection with which it was designed to use superheated steam, a superheater was installed and connected to the steam main; the quantity of superheat being 100 degrees Fahrenheit. Immediately that the engines were put to work with this high-temperature steam, they began to manifest those unmistakable symptoms of distress which the experienced engineer always recognizes as indicative of insufficient cylinder lubrication, and an increase of the oil feed to double and even treble the quantity used when the engines were supplied with saturated steam, seemed to have scarcely any mitigating effect whatever.

It was plainly to be seen that the "600 W" would no longer suffice; and this being the case, it naturally devolved upon the oil company's representative to furnish something that would meet the altered requirements. The oil man confidently averred that he had the needed article, and brought around a sample of it in a gallon can. The sample was tried according to directions, but it failed utterly to produce the desired result. The next day the oil man brought in four more gallon samples, all tagged and labeled with specific names, and requested that they be tested successively. The general result, however, was much the same as that attending the trial of the first samples. These samples, according to the agent, had been compounded with a view to producing a lubricant that would withstand the 100 degrees of superheat, and yet would be no more expensive to the purchasing company than the oil that had formerly been supplied; but as they all fell a long way short of attaining the object aimed at, he felt constrained to recommend, as the only avenue of escape from the difficulty, the grade of higher priced oil which his company compounded especially for use with superheated steam, and in accordance, he brought around a sample gallon of "——" oil. The result of the test, however, was no more satisfactory than in the case of the cheaper grades, for the valves continued to grind, and the pistons to grunt and groan, in the same old way.

The situation had by this time assumed a distinctly perplexing character for the oil man, who was, apparently, at his wits' end to furnish a lubricant that would do the work on that particular job. Nevertheless, he lugged in a can of oil the next day which he avowed had been compounded under his personal supervision from a formula of his own invention, and requested the engineer to give it a fair trial. The engineer did so and found that the oil worked splendidly, for the engines ran along as smoothly as they ever did, on a feed of one drop for every 12 revolutions.

When the new brand of oil had thoroughly demonstrated its superior lubricating properties under the changed conditions of service, the oil man dropped in one day, and in a confidential mood, imparted the information that its excellence as a cylinder lubricant under high temperature, was altogether due to compounding the ingredients in the proportion of 10 pounds of oil of beeswax to 45 gallons of cylinder stock of 600 degrees fire test, and 5 gallons of acidless tallow oil.

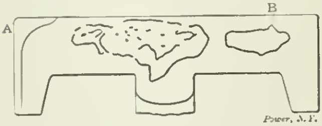
A. J. DIXON.

Chicago, Ill.

## Flywheel Explosion at Scranton

I had an opportunity to inspect the plant and the fragments of the wheel mentioned in POWER by Mr. Mason and I heard the account from one of the engineers after the first excitement had passed. It seems that it was the custom to let this set carry the night load until the increasing morning load began to make it "trail," when a larger unit was started and the small set shut down for the day. It now appears that the flywheel let go almost immediately after the load was taken off, with the result substantially as described by Mr. Mason.

The portion of the wheel that was thrown some 200 feet and almost completely buried I had the pleasure to dig out with the assistance of two other men and the information thus gained was very interesting indeed. The piece weighed, I should guess, not far from 300 pounds and included a little more than the part of the rim covering two spokes, both of which were broken off near the web. Between these two spokes there was a heavy rib to which some part of the governor had been fastened. The break at one end of the rim section and the spoke adjacent to it showed no sign of structural weakness where it was possible to clear it of the dirt and fragments of wood. The break at the other end was, however, of a very different character, as is shown in the sketch, which is not to scale. At *A* there was an old crack into which oil had worked to a depth varying from $\frac{1}{4}$ inch to an inch or more. A knife blade was stuck into the blowhole *B* to a depth of at least $2\frac{1}{2}$ inches. The inside of this hole had the appearance of having "frozen" before the pouring had been completed and the middle portion of the rim section was of a coarsely crystalline structure. I should like to have seen the portion of the rim from which this piece parted, but the men did not know what had become of it, though it was likely among some pieces found later on the roof of the power house. The portion of the spoke adjacent to the rim break just described showed unmistakable signs of shrinkage strains. There was an oil-marked crack extending nearly all the way around, only small portions of metal scattered here and there over the surface of the spoke showing fresh breaks. This, therefore, from the information that I was able to collect, seems to have been the weak section of the wheel.



PORTION OF WHEEL THROWN 200 FEET

Returning now to the engine. When the wheel let go, the front end of the engine was jerked upward with such force that the foundation bolts, four of which were located at the crank end of the bed, were broken off at the surface of the foundation, and the front end of the engine was raised to a considerable angle. The steam pipe, which was a long-radius wrought-iron bend, was bolted (without any separator) to the throttle valve. When the front end of the engine was moved so violently the throttle valve was ripped loose from its fastenings on the cylinder, and the reaction of the steam blowing from the end of the pipe turned it in such a way that the throttle end of the pipe was found up among the roof trusses, but the other end
was not disconnected from the
header. My conclusions are briefly
as follows:

1. The wheel casting was de
though in a manner that would hav
detected only by accident when the
was new. There was enough
around the blowhole to make the
ring true and it would have be
reasonable to expect to find it by d

2. The speed variation in the
operation of the engine caused a
springing of the wheel which gr
weakened the metal in the rim a
ready overstrained spoke by the
of the metal until the normal r
speed strained it almost to the br
point.

3. The speed of the engine ros
denly upon the removal of the load
ing a portion of the wheel to be
away, thus throwing the wheel
balance.

4. The engine continued to rot
a time with the unbalanced wheel
caused the jerk that broke the four
bolts and the steam connection.

5. The blame, so far as there
blame, seems to be with the pour
the casting.

Apparently Mr. Mason's informa
mine do not agree as to which
the engine was raised from the f
tion. It seems to me that both r
correct; that first one end was
and thrown down violently, the r
raising the other end of the engi

CARL H. BE

Scranton, Penn.

## Lead in Vertical Engine

In the issue of October 12 H. E.
says that vertical engines should h
lead; that the shaft should run fre
the cap on the top part of the box
not touch the shaft, and that the
should be so set as to admit stea
the crank pin had passed the center
the lead would lift the shaft in the

I have set up a good many eng
the last 30 years and have built so
but the molding and forging on
and I think that Mr. Mansur is m
in his ideas. If you don't keep
down on the shaft it will certainly
matter what the weight is. Th
will lift no matter what size the en
If the shaft is in proper shape the
be fitted so that it will not heat
25 years it has been my experi
setting valves to adjust them un
get the coolest running and yet be
on the boiler as possible. If the c
left with some lost motion and you
get some water in lower end of c
where would your cap and bol
Broken I think.

C. T. PRY.

Oil City, Penn.

# Real Relation of $CO_2$ to Chimney Losses

## The Test for Percentage of Carbonic Acid in Flue Gases Shown to Be Reliable as a Practical Measure of Boiler Furnace Efficiency

### BY JOSEPH W. HAYS

Although some time has elapsed since contribution on "Real Relation of $CO_2$ Chimney Losses," by James E. Steely, eared in POWER (June 8), comment surely be in order, for I have found t the author was not fully understood by y engineers and that conclusions have n drawn from his article which I do not ve were anticipated or desired I be- e, furthermore, that Mr. Steely was error in several particulars and ac- ingly venture to oppose some of his lusions.

would go on record at the outset with statement that the determination of percentage of $CO_2$ (carbon dioxide, rbonic-acid gas) in the gases of com- tion is the most reliable all-around that we have of furnace efficiency, for many reasons the only practical If the percentages of the unem- ed, or free oxygen, and of the escap- combustibles, carbon monoxide, hydro- and methane (marsh gas), could be y determined, that of $CO_2$ might relegated to a very unimportant place. y cannot, however, be readily deter- ned and we cannot analyze for any of without first removing the $CO_2$ the gas sample. With proper ap- s, a $CO_2$ determination can be made ery two minutes on flue gases and if is in a hurry the thing can be done pidly as once a minute.

determine the percentage of oxygen require from five to ten minutes. n monoxide, hydrogen and methane each require more time than oxygen, one must be something of an expert ndle hydrogen and methane. Methane is slippery individual and we have good s for suspecting its presence in ce gases at high temperatures. The lty consists in capturing the elusive ne and measuring it.

we go beyond $CO_2$, we can scarcely short of a full analysis, for we have ight to assume the absence of either hydrogen or methane. We can almost w safety assume that if CO occurs, f the other gases are to some ex- te present.

pound of the gas CO (not a pound carbon in combination with oxygen forming CO) has a heat value of around 460 B.t.u., while a pound of methane has a heat value of 25,260 B.t.u. and a pound of hydrogen a heat value of 62,000 B.t.u.

t standard temperatures and pressures a cubic foot of CO contains 341 B.t.u., a cubic foot of hydrogen 345 and a cubic foot of methane 1065. It will accordingly be seen that a very little methane goes a very long way as compared with CO.

When we are undertaking to account for heat losses we cannot therefore stop with CO and we would accordingly be unable to take Mr Steely's tables and comparisons as official, even if his figures were correct. I will undertake to show that they are wrong and that the conclusions which he draws from these figures are wrong also.

#### FLUE-GAS ANALYSIS NEEDS INTERPRETATION

We are not justified in assuming anything of a definite nature from the reported analysis of a sample of flue gases unless we know something of the circumstances under which the sample analyzed was taken. Flue-gas analysis is something that requires interpretation. As a general proposition the higher the percentage of $CO_2$ the greater the economy, but this is a rule to which there are a great many exceptions. We must know what these exceptions are, we must understand how to interpret the analysis, and when we both "know" and "understand," we have a practical and reliable guide for furnace operation in the $CO_2$ analysis. Judgment is necessary in all cases. Let me cite some instances:

We may increase the percentage of $CO_2$ in the case of a chain-grate stoker by running the fires over and wasting carbon in the ash. It usually pays to sacrifice a little carbon in this way, if necessary to shut out the air leakage at the rear of the grate, but we can go to the extreme in this matter as in all others. We may dump so much combustible into the ashpit that the loss from this cause will exceed the gain indicated by the increase of $CO_2$.

Suppose the case of an excess draft and air leakage into the breeching or last pass near the point where the gases leave the heating surfaces. The gases flowing through the breeching will be diluted by the excess air and the percentage of $CO_2$ will be low, owing to such dilution. If we stop these leaks we increase the draft pressure at the furnace beyond the requirements of economy. The percentage of $CO_2$ will be lowered at the furnace and throughout the passes of the boiler but it will be increased in the breeching. Efficiency will be lowered, as a leakage of this kind in the face of an excess draft is a good thing and reduces coal consumption.

We run our boiler furnaces for the purpose of generating steam to operate the plant, not for the purpose of seeing how much $CO_2$ we can manufacture. The load must be carried, gas or no gas, and it might be a losing financial proposition to increase $CO_2$ at the expense of capacity.

Other instances might be cited to prove my contention that the practice of flue gas analysis must be mixed with common sense, or gumption. We will now follow Mr. Steely's article through to its conclusion, taking up the various matters in the order that he raised them:

Mr. Steely says: "Under a very few conditions, a high $CO_2$ and a low flue-gas temperature will indicate a high economy or at least a low chimney loss, but it is not to be supposed that these factors always indicate such condition." I would amend this sentence by striking out the words "a very few" and substituting the word "most." I have pointed out several circumstances that are exceptions to the rule that "the more $CO_2$ the gas contains the higher will be the efficiency."

#### COAL ANALYSIS

Mr. Steely next takes up the subject of coal analysis, explaining what is meant by the terms "proximate analysis" and "ultimate analysis." He applies the term "volatile combustible" to all of the "volatile matter," which is a common mistake. "Volatile combustible" cannot properly be reported in a proximate analysis, for the reason that the volatile matter is not all combustible, a large percentage of it being inert and just as noncombustible as the ash.

All of the oxygen contained in the coal is in combination with hydrogen as "water of composition" and this water of composition constitutes the greater part of the inert volatile matter. It is held in some sort of peculiar bond with the combustible volatile matter and cannot be driven off in the laboratory by heating in an oven. It arises as water vapor when the volatile matter is distilled off or burned. Mr. Steely, in the several tables from which he draws his conclusions, treats all of the hydrogen of the coal as combustible and all of the oxygen as capable of performing the oxygen function in combustion His tables are ac-

[illegible] by itself. The "true volatile matter" may be readily computed from an ultimate analysis and the "volatile matter" corrected to "volatile combustible" by subtracting all of the oxygen and nitrogen and deducting from the hydrogen an amount equal to one-eighth of the weight of the oxygen. This gives the true "volatile combustible" and its heat value may be computed from DuLong's formula. We must distinguish between the total hydrogen of the coal and the burnable or "disposable" hydrogen.

Mr Steely points out that errors arise in flue gas analysis due to the condensation of water vapor carried by the gases and also to the absorption of $SO_2$ by the potash solution employed to absorb $CO_2$. The condensation of water vapor decreases the volume of the chimney gases and makes the apparent percentage of $CO_2$ too high, while the $SO_2$ coming down with the $CO_2$ is credited as carbon dioxide and this increases the error. No one can dispute these facts, but anyone may take the position that they do not amount to anything and be correct in the contention. Let the water vapor condense if it wants to and let the $SO_2$ be absorbed. Taking Mr. Steely's own figures, with 5 per cent. of hydrogen, the error in the $CO_2$ reading due to the water vapor is only 0.13 per cent. In other tables Mr. Steely makes the error due to $SO_2$ from 0.13 to 0.16 per cent. The two errors added together make a result that is negligible for all practical considerations. It might be remarked in passing that the air contains $CO_2$ to the extent of from 3 to 6 parts in 10,000 or 0.03 to 0.06 per cent. This adds further to the error and the addition may amount to one half as much as Mr. Steely adduces to the hydrogen.

No one claims that the determination of the $CO_2$ in flue gases can be more than relatively correct. Relative accuracy is amply sufficient and if we must have absolute accuracy, the whole thing is at once placed beyond the reach of the average operating engineer. We are satisfied with relative accuracy in other matters. We accept the coal record in terms of tons and pounds. No one thinks of demanding it in grams and milligrams. There is no occasion to split hairs in flue-gas analysis.

Mr. Steely refers to two analyses of flue-gas samples, made during the run of an evaporation test at the exposition experiment station of the United States Geological Survey at St. Louis. He draws some conclusions from a comparison of these analyses that I consider entirely unwarranted.

### The St. Louis Tests

Before commenting upon these analyses I must first call attention to certain facts in connection with these St. Louis tests:

The bulletins of the Geological Survey report 78 tests, made "to determine the economy of coal as a fuel." These tests were conducted upon a great variety of coals, hailing from Alabama, Arkansas, Colorado, Illinois, Indiana, Iowa, Kansas, Kentucky, Missouri, North Dakota, Pennsylvania, Texas, West Virginia, Wyoming, New Mexico and Indian Territory. There was everything from lignite to anthracite, and no favorites were played, all of the coals being burned in the same furnace, on the same grate and under whatever method of furnace management seemed good to the fireman. No attempt was made to alter furnace conditions or methods of burning the fuel to meet the varying requirements of the coal, and I judge that no special attempt was made to develop efficiency in any case. It was low in every instance.

The average temperature of the escaping gases was over 628 degrees Fahrenheit. The average efficiency of the boiler, including the grate, was about 62 per cent. The average air supply, computed on the $CO_2$ percentages, was about 270 per cent., or nearly double what it should have been, if we agree that a supply equal to 140 per cent. of the theoretical amount represents good practice. The smallest quantity of air employed during any test was 200.5 per cent., and the greatest 570.2 per cent.

The smallest loss due to heating the unnecessary air (the air above 140 per cent.) was 4.11 per cent., in terms of the total carbon of the coal, and the highest loss 24.56 per cent. The highest loss due to CO, expressed in terms of the total carbon, was 5.95 per cent., the average percentage of CO in this case being 1.11 per cent. by volume. The preventable loss due to heating excess air in the same instance was 5.44 per cent. By a strange coincidence, this horrible CO example, the worst in the entire 78 tests, was the one picked upon by Mr. Steely for his illustration. The test was No. 27 and the coal was described as New Mexico No. 1. The next highest CO occurred in test No. 22 and was 0.44 per cent. by volume. The average CO for the entire series of tests was 0.108 per cent. by volume and the average loss due to CO, expressed in terms of total carbon, was 0.721, or a little less than three-quarters of one per cent. The average loss due to heating air in excess of 140 per cent. for the entire series of tests was 9.97 per cent. in the same terms of total carbon.

I give the foregoing figures for several reasons: First, "it takes more than one swallow to make a summer" and more than one boiler test to establish the "law and the prophets" in steam engineering.

Second, we have had these tests quoted at us ever since the St. Louis Exposition and all kinds of conclusions have been drawn from them, the quoter and drawer invariably picking out some isolated single test that seemed best suited to his purpose. It is pertinent to inquire, what special authority, if any, attaches to these tests, either singly or collectively? They do not show us how to secure good economic results with any of the coals teste There was apparently no effort made conduct the tests for the purpose of veloping possible efficiency, for no ciency worth talking about was shown any of the tests, rather the contrary. Th was no attempt made to conduct the t with a uniformity as to conditions. draft at the furnace ranged between extremes of 0.120 and 0.340. While furnace and general conditions may h been adapted to some of the coals, t were certainly not adapted to all of th The smallest percentage of total carl dropped through the grates with the was 1.68 and the highest was 18.88, percentage of carbon in the ash in latter case being 59.38. Of what v are the data from a test on high-vola coal if the fuel is burned in a furnace on a grate adapted for anthracite? test under such circumstances is un to the coal and it is unfair to assert the data point to any dependable en neering conclusion.

### Investigation of Test No. 27

Let us now investigate test No. 27, one from which Mr. Steely took his ures and drew his conclusions:

The coal, as already stated, was N Mexico No. 1. The boiler was of Heine type, hand-fired, the furnace be of the ordinary kind and equipped wit patented, automatic, air-feeding, "smo consuming" apparatus. We will me note in passing, and without comm that there was 64 per cent. of smoke.

The main things that we must disc in connection with this test are the an ses of the gases, as it is upon a comp son of two of these analyses that Steely bases his figures.

I will first quote from a letter rece received from the chief engineer of of the largest power plants in New Y City:

"In a hand-fired plant, a 'snap' sample is to my mind of no value w ever. I can go to any boiler in this p and get a sample that will show anyt you ask for, from 6 to 16 per cent., pending on what point in the cycle firing the sample is taken from."

We will bear in mind that this St. L furnace was hand-fired and that the samples analyzed were essentially 's ones. Lack of space precludes a disc sion of the sampling apparatus emplo but I believe I am prepared to show the samples could not have been a age ones for the periods they purpo to cover. One analysis an hour me nothing, unless we can secure a san that represents the correct average that hour.

I have already said that Mr. St picked upon the most extreme case of to be found in the entire series of tests. He next selected the sample sh ing the highest CO encountered du the test and compared it with another, ly one of the ten samples taken in hich no CO was found. He admits that e case is an extreme one.

Let us assume that the samples under scussion really represented the averages r the periods they were supposed to ver. The first thing that strikes us is closed by Table 1.

Table 1.

| | $CO_2$ | O | CO | O Unaccounted For |
|---|---|---|---|---|
| ple No. 1 | 8.7 | 10.4 | 0.0 | 1.60 |
| ple No. 2 | 10.1 | 8.6 | 2.1 | 0.95 |

If the analyses were correct, we may arge the unaccounted for oxygen to hydrogen of the coal. I hold it more y that an error occurred in the work nalysis than that there should have n nearly twice as much disposable rogen in the first case as in the second. s is no reflection upon the man who de the analyses, for such errors will r. Chemists are well acquainted with fact that the cuprous chloride solu- , employed for the absorption of CO, s the gas in a very unstable way, and under some circumstances return it r absorption has occurred. We are acngly justified in entertaining two ts with reference to these analyses. analyst might have been in error and t cuprous chloride might not have been e right frame of mind. In either case r might have been CO in the first ple and less than 2.1 per cent. in the d. Also, in either case the figures a useless for Mr. Steely's line of comparison.

Table 2.

| | Temperatures. | | Draft in Inches | | | | |
|---|---|---|---|---|---|---|---|
| e, A.M. | Boiler Room, °F. | Stack, °F. | Hood | Furnace. | $CO_2$ | O | CO |
| 7.34 | | 467 | | | | | |
| 8.00 | 60 | 561 | 0.42 | 0.09 | | | |
| 8.20 | 61 | 538 | 0.37 | 0.07 | | | |
| 8.40 | 63 | 517 | 0.24 | 0.09 | 8.7 | 10.4 | 0.0 |
| 9.00 | 61 | 487 | 0.21 | 0.08 | | | |
| 9.20 | 65 | 476 | 0.22 | 0.08 | | | |
| 9.40 | 66 | 466 | 0.20 | 0.09 | 10.7 | 8.1 | 1.1 |
| 10.00 | 66 | 458 | 0.23 | 0.13 | | | |
| 10.20 | 67 | 582 | 0.52 | 0.29 | | | |
| 10.40 | 68 | 552 | 0.27 | 0.13 | 10.1 | 8.6 | 2.1 |

7.34 Test started, fire 2 inches thick.
9.15 Fire raked, 6 inches thick.
9.54 Fire raked, 7 inches thick.
10.15 Fire raked, 7 inches thick.
10.21 Fire sliced.

will now assume that the samples aken for analysis represented correct verages and that the analyses as reported were correct; can we accept Mr. Steely's figures and conclusions? Hardly. Let us look into the matter further.

y main objection to Mr. Steely's figures is that they too largely rest upon hypothesis and assumption. They are based upon an assumed flue-gas temperature of 600 degrees Fahrenheit and an l air temperature of 72 degrees Fahrenheit. The real figures as to temperature were available, and if we are making a critical study of anything, we should take the facts exactly as they are, assuming nothing. Note Table 2 taken from the log of the test in this connection.

These were the conditions under which the test was actually run for three hours. The first of the gas samples analyzed was taken at 8.40 and from the manner in which it was collected, no one can tell what portion of the hour it was presumed to cover, or in actual fact represented. Mr. Steely took this analysis and the one made at 10.40 for the purpose of his comparison and applied a stack temperature of 600 degrees and a boiler-room temperature of 72 degrees to both of them. One set of conditions governed the gases for the first hour and entirely different conditions governed them during the third. We can get flue gases of almost any composition we desire, if we tease the fire with a hoe and a slice bar. The fuel may be made to belch combustible spasmodically.

The percentage of free oxygen measures the percentage of unemployed air passing through the furnace. Does the net available heat carried away by the combustible gases exceed that which would be appropriated by the extra air required to burn them? It often costs more to burn CO than we save by consuming it. We can't run the boiler furnace with the theoretical supply of air and the time has come to apply gas analysis in a practical way, mixing with it just as little as possible of theory and figures. I concede that a low $CO_2$ under certain conditions will express more efficiency than a higher percentage under certain others. What we want is a guide for furnace operation that will enable us to save the most coal under all of the conditions that obtain during the day's run. A difference of a hundredth of an inch in the draft pressure at the furnace will affect the rate of coal consumption, but we cannot control drafts to the nicety of hundredths. We can only approximate things in furnace practice, and I therefore say that the best approximate guide is the most practical. When it comes to specific heats and slide rules, what may we expect of the average fireman?

### PERCENTAGE OF $CO_2$ A MEASURE OF PERCENTAGE OF EXCESS AIR

The percentage of $CO_2$ is a closely approximate measure of the percentage of unemployed air passing through the furnace. The wastes due to excess air will in almost every instance many times exceed any accompanying waste due to incomplete combustion. About 780 tests of flue gases were made at St. Louis, the 78 tests covering about that number of hours. I doubt if Mr. Steely can pick another pair of gas samples from the entire list and duplicate his figures, let him work upon assumed stack temperatures or take the actual figures as he chooses. The fireman can rely upon $CO_2$ about 779 times out of 780. It is of course necessary to consider air leaks in the setting and various other matters in connection with gas analysis.

Every effort should be made to popularize gas analysis in the boiler room. The subject is one that has been covered with too much mystery by the theorist. There is no mystery about it. Theories and formulas are all right in their places and when we are writing for technical men we may pepper and salt our subject as much as we please with them. We do not find technical men in our boiler rooms and if flue gas analysis is to make headway with the operating men, we must simplify the proposition as much as possible. A man must be something of an expert to determine oxygen and CO, he must be still more of an expert to determine hydrogen and methane. Anybody can determine $CO_2$ and analysis for this gas is sufficient for all practical purposes. If we are making a critical study of the furnace, it is another matter altogether.

I fear that Mr. Steely left the impression that the $CO_2$ analysis was in no case to be depended upon as a guide in furnace operation. The facts are that it can be relied upon in almost every instance. There are exceptions, but they are relatively few and widely scattered.

The best argument in favor of $CO_2$ as against CO, is found in the averages on these St. Louis tests. I will repeat the figures. The average loss, in terms of carbon, for the entire series of 78 tests, occasioned by the presence of CO, was 0.721 per cent., while the average loss due to air in excess of 140 per cent. was 9.97 per cent. The percentage of $CO_2$ being a closely approximate measure of the percentage of excess air, it would seem wise for the purposes of ordinary practice to confine ourselves to an investigation of this gas.

# Estimated Horsepower of a Gas Engine

The accompanying tables were published in our issue for March 23, this year, and we have had so many requests for extra copies of that number, which is out of print, that the tables are reprinted here again. Some errors in the original article, due to accidental transpositions of the data from which the calculations were made, are corrected in the present tables, which will, therefore, be found more useful than the originals.

TABLE 1

*Constant × Diam × Stroke × Rev per Min. = Probable Brake Horsepower*

| Kind of Gas. | Type of Cylinder. | |
|---|---|---|
| | Single-acting. | Double-acting. |
| Producer | 0.000056 | 0.000112 |
| Illuminating | 0.000065 | 0.00013 |
| Natural | 0.00007 | 0.00014 |

The constants in Table 1 are the approximate brake horsepower obtainable per inch length of stroke, per revolution per minute, and per inch² of piston diameter. That is, if the piston diameter be represented by *D* and the length of stroke by *S*, the approximate brake horsepower will be given by the formula:

$$D^2 \times S \times r.p.m. \times constant = B.H.P.$$

TABLE 2. APPROXIMATE HORSEPOWER CONSTANTS.

*Constant × Stroke × Rev per Min. = Probable Brake Horsepower per Cylinder.*

| Single-acting Engines. | | | | Double-acting Engines. | | | |
|---|---|---|---|---|---|---|---|
| Cylinder Diameter. | Producer Gas. | Illuminating Gas. | Natural Gas. | Cylinder Diameter. | Producer Gas. | Illuminat-Gas. | Natural Gas. |
| 5 | 0.00140 | 0.00162 | 0.00175 | 10 | 0.0105 | 0.0122 | 0.0132 |
| 5¼ | 0.00154 | 0.00179 | 0.00193 | 10½ | 0.0116 | 0.0135 | 0.0145 |
| 5½ | 0.00169 | 0.00197 | 0.00212 | 11 | 0.0128 | 0.0148 | 0.0159 |
| 5¾ | 0.00185 | 0.00215 | 0.00232 | 11½ | 0.0139 | 0.0161 | 0.0173 |
| 6 | 0.00202 | 0.00234 | 0.00252 | 12 | 0.0151 | 0.0175 | 0.0189 |
| 6¼ | 0.00219 | 0.00254 | 0.00274 | 12½ | 0.0164 | 0.0191 | 0.0206 |
| 6½ | 0.00237 | 0.00275 | 0.00296 | 13 | 0.0178 | 0.0207 | 0.0222 |
| 6¾ | 0.00255 | 0.00297 | 0.00319 | 13½ | 0.0191 | 0.0222 | 0.0239 |
| 7 | 0.00274 | 0.00319 | 0.00343 | 14 | 0.0206 | 0.0239 | 0.0257 |
| 7¼ | 0.00294 | 0.00342 | 0.00368 | 14½ | 0.0222 | 0.0257 | 0.0277 |
| 7½ | 0.00315 | 0.00366 | 0.00394 | 15 | 0.0236 | 0.0274 | 0.0295 |
| 7¾ | 0.00336 | 0.00390 | 0.00421 | 16 | 0.0270 | 0.0313 | 0.0337 |
| 8 | 0.00358 | 0.00416 | 0.00448 | 17 | 0.0305 | 0.0354 | 0.0381 |
| 8¼ | 0.00381 | 0.00443 | 0.00476 | 18 | 0.0340 | 0.0395 | 0.0425 |
| 8½ | 0.00405 | 0.00470 | 0.00506 | 19 | 0.0380 | 0.0441 | 0.0474 |
| 8¾ | 0.00429 | 0.00498 | 0.00536 | 20 | 0.0421 | 0.0489 | 0.0526 |
| 9 | 0.00454 | 0.00526 | 0.00567 | 21 | 0.0464 | 0.0538 | 0.0579 |
| 9½ | 0.00505 | 0.00587 | 0.00632 | 22 | 0.0510 | 0.0597 | 0.0637 |
| 10 | 0.00560 | 0.00650 | 0.00700 | 23 | 0.0557 | 0.0646 | 0.0696 |
| 10½ | 0.00617 | 0.00717 | 0.00772 | 24 | 0.0606 | 0.0703 | 0.0759 |
| 11 | 0.00678 | 0.00786 | 0.00817 | 25 | 0.0657 | 0.0763 | 0.0827 |
| 11½ | 0.00741 | 0.00860 | 0.00926 | 26 | 0.0711 | 0.0825 | 0.0889 |
| 12 | 0.00806 | 0.00936 | 0.0101 | 27 | 0.0767 | 0.0890 | 0.0959 |
| 12½ | 0.00875 | 0.0101 | 0.0109 | 28 | 0.0825 | 0.0958 | 0.103 |
| 13 | 0.00946 | 0.0110 | 0.0118 | 29 | 0.0885 | 0.103 | 0.111 |
| 13½ | 0.0102 | 0.0118 | 0.0127 | 30 | 0.0947 | 0.110 | 0.118 |
| 14 | 0.0110 | 0.0127 | 0.0137 | 31 | 0.101 | 0.117 | 0.126 |
| 14½ | 0.0118 | 0.0137 | 0.0147 | 32 | 0.108 | 0.125 | 0.135 |
| 15 | 0.0126 | 0.0146 | 0.0157 | 33 | 0.115 | 0.133 | 0.143 |
| 16 | 0.0143 | 0.0166 | 0.0179 | 34 | 0.122 | 0.142 | 0.152 |
| 17 | 0.0162 | 0.0188 | 0.0202 | 35 | 0.129 | 0.149 | 0.161 |
| 18 | 0.0181 | 0.0210 | 0.0227 | 36 | 0.137 | 0.158 | 0.171 |
| 19 | 0.0202 | 0.0234 | 0.0252 | 37 | 0.144 | 0.168 | 0.180 |
| 20 | 0.0224 | 0.0260 | 0.0280 | 38 | 0.152 | 0.177 | 0.190 |
| 21 | 0.0247 | 0.0287 | 0.0309 | 39 | 0.160 | 0.186 | 0.200 |
| 22 | 0.0271 | 0.0315 | 0.0339 | 40 | 0.168 | 0.195 | 0.210 |
| 23 | 0.0296 | 0.0344 | 0.0370 | 41 | 0.177 | 0.205 | 0.221 |
| 24 | 0.0323 | 0.0374 | 0.0403 | 42 | 0.186 | 0.216 | 0.232 |
| 25 | 0.0350 | 0.0406 | 0.0437 | 43 | 0.195 | 0.226 | 0.243 |
| 26 | 0.0379 | 0.0439 | 0.0473 | 44 | 0.204 | 0.236 | 0.255 |
| 27 | 0.0408 | 0.0474 | 0.0510 | 45 | 0.213 | 0.247 | 0.266 |
| 28 | 0.0439 | 0.0510 | 0.0549 | 46 | 0.223 | 0.258 | 0.278 |
| 29 | 0.0471 | 0.0547 | 0.0589 | 47 | 0.233 | 0.270 | 0.291 |
| 30 | 0.0504 | 0.0585 | 0.0630 | 48 | 0.243 | 0.282 | 0.304 |

Table 2 gives the products of the constants in Table 1 and the square of the piston diameter for single-acting engines, and similar products for double-acting engines, modified by an allowance of 6 per cent for the space occupied by the piston rods. This, of course, is a rough-and ready allowance, since the space occupied by the rods ranges from about 5 per cent. of the piston area in engines of relatively small output up to about 10 per cent. in very large engines. Since the proper deduction for the large majority of engines in use ranges from 5 to 7½ per cent., however, the allowance will give more nearly accurate results than would be obtained by ignoring the piston-rod area.

These tables apply only to engines operating on the four-stroke cycle.

The stroke and diameter are to be taken in inches.

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In winter, if the boiler is exposed to cold, close the valves between the boiler and the water-gage glass when the boiler is shut down for the night, and let the water run out of the glass. Also leave all drain cocks on pipes, etc., open.

Always bear in mind to clean out a boiler thoroughly after doing any hammering on it, as scale may have been dislodged and have dropped down on the fire sheet. Bags and serious ruptures have resulted from neglect of this precaution.

# Gasolene and Alcohol as Engin Fuel

The United States Geological Survey h recently issued a bulletin on "Commerci Deductions from Comparisons of Gas lene and Alcohol Tests on Internal-Cor bustion Engines," by Robert M. Stron The tests, which were under the tec nical direction of R. H. Fernald, eng neer in charge of the producer-gas se tion of the Technologic branch, were co ducted at the fuel-testing plant in S Louis, Mo., and at Norfolk, Va. T tests dealt primarily with gasolene, for ing part of an investigation of mine fuels. To determine the relative econo and efficiency of gasolene it was co pared with denatured alcohol.

When the series of tests was start it was found that it took from 50 to 1 per cent. more alcohol than gasolene produce a given power. With spec alcohol engines, however, suited to t use of alcohol, the latter fuel has be made to do as much work, gallon f gallon, as the gasolene. On this point, t bulletin states that by using alcohol an alcohol engine with a high degree compression (about 180 pounds per squ inch above atmospheric pressure) t fuel-consumption rate in gallons p horsepower per hour can be reduced practically the same as the rate of co sumption of gasolene for a gasolene gine of the same size and speed. T indications are that this fuel-consumpti ratio for gasolene and alcohol engi will hold true for any size or speed, the cylinder dimensions and revoluti per minute of the two engines are same.

Some of the more important res and conclusions stated in this bulletin as follows:

The "low" heat value of completely natured alcohol will average 10,500 h units per pound, or 71,900 heat units gallon.

The low-heat value of 0.71 to specific gravity gasolene will average 200 heat units per pound, or 115,800 h units per gallon.

A pound of gasolene requires appr mately twice as many pounds of air complete combustion as a pound of cohol.

A gasolene engine having a comp sion pressure of 70 pounds but other as well suited to the economical use denatured alcohol as gasolene, will, w using alcohol, deliver about 10 per c greater maximum power than when us gasolene.

When the fuels for which they are signed are used to an equal advant the maximum brake horsepower of alcohol engine having a compression p sure of 180 pounds is about 30 per c greater than that of a gasolene en having a compression pressure of pounds, but of the same cylinder diameter, stroke and speed.

Alcohol diluted with water in any proportion, from denatured alcohol, which contains about 10 per cent. of water, to mixtures containing about as much water as denatured alcohol, can be used in gasolene and alcohol engines if the engines are properly equipped and adjusted.

When used in an engine having constant compression, the amount of pure alcohol required for any given load in-reases and the maximum available rsepower of the engine decreases with a diminution in the percentage of pure lcohol in the diluted alcohol supplied. he rate of increase and decrease, respectively, however, is such that the use f 80 per cent. alcohol instead of 90 per nt., or denatured alcohol, has but little ffect upon the performance of the en-ine; so that if 80 per cent. alcohol can e had for 15 per cent. less cost than 90 r cent. alcohol and could be sold with-t tax when denatured, it would be nore economical to use the 80 per cent. lcohol.

The relative hazard involved in the rage and handling of gasolene and lenatured alcohol is of particular im-rtance in considering their use as fuels r marine and factory engines and en-ines to be placed in the basements of ffice buildings or in other places where general fire would be likely to result rom the accidental burning of the fuel tored or carried for immediate supply, r where the forming of explosive or in-ammable mixtures of the fuel vapors nd air in the immediate vicinity would hazardous.

Very few alcohol engines are being sed in the United States at the present me, and but little has been done toward aking them as adaptable as gasolene gines to the requirements of the vari classes of service. Engines for sta-nary, marine and traction service, au-mobiles, motor trucks and motor rail-ay cars designed especially to use de-tured alcohol have, however, been tried th considerable success.

The price of denatured alcohol is eater than the price of gasolene, and quantity of denatured alcohol con-med by an alcohol engine as ordinarily nstructed and operated is in general latively greater than the quantity of solene consumed by a gasolene engine the same type. Considerable attention being given to the development of ocesses for the manufacture of alcohol m cheap, raw materials which are gen-lly available, and it seems reasonable expect that the price of denatured al-hol will eventually become as low or wer than the price of gasolene, es-rially if the price of gasolene advances. also seems reasonable to expect a eater general improvement in alcohol gines than in gasolene engines.

## Lubrication of Engine Cylinders

By William Westerfield

I note the request, in the editorial department, for information as to quantity of cylinder oil used.

It depends on the quality of the steam, the quality or character of the oil used, and also on the condition of the engine cylinder itself. I make it a rule to be sure and use enough and watch results, that is, the running of the engine. If the valves are not getting sufficient lubrication, they have a way of telling you about it. You will note a trembling sensation if you lay the hand on the valve rod or stem, and by putting the ear to the cylinder it will be easy to tell whether the piston and cylinder walls are getting what is "coming to them." If they are not it will be easy to distinguish a grating, scraping or scratching sound. The best way to listen for symptoms of this kind is to take a lead pencil, place the point against the engine cylinder at the proper point and place the other end in the ear, snugly. Then every sound that occurs in the cylinder will come to you very distinctly. In this way one avoids the necessity of being at sea as to what he is doing.

It has been some time since I have been directly in charge of a power plant, but I will say that I have operated slide-valve engines of 150 horsepower capacity on one quart of cylinder oil per twenty-four hours. As I have said, the quantity of oil used will depend on conditions.

While I am at it, I will say something about the use of cylinder oils that was not incorporated in the editorial suggestion. I have found in many instances that engineers were using high flash-test oils where the pressure was low and a cheaper oil would have done the work much better than the more expensive. I have known engineers to have a pure mineral oil of high flash test at a high price, where the steam pressure was only 80 pounds by gage, and very wet. In one case of this kind they were paying 80 cents per gallon, and on my recommendation they tried a lower-grade compounded oil at 35 cents per gallon, and they got better results than with the higher grade. Later I advised the use of a still cheaper oil at 29 cents, also a compounded article, and the results in this plant were just as satisfactory as with the high flash-test oil formerly used at about three times the price.

I now have supervision of one plant where they were using an oil that is purely mineral, and a crack brand of one of the largest companies. I took the matter up with the manager of the oil company, and selected a grade that sold for one-third the price of the other, and the results are perfect. The pressure in this case is 90 pounds.

In this connection, I want to say that a pure mineral oil is about the most worthless thing you can get for wet steam, no matter what the grade may be. I have for years made it a practice to select an oil suited to the conditions that exist in any particular plant. For dry steam at high pressure, use a higher grade of oil, and if it is a pure mineral oil so much the better. But if you want something that will stick to the metallic surfaces and not wash off when your steam is wet, a compounded oil is the thing.

It is also a mistake to purchase a high flash-test oil for low pressures and temperatures under any condition. So long as the oil is not decomposed by the heat it is subjected to in the cylinder, or its lubricating qualities destroyed, it is good for the work, so far as this quality is concerned. Hence money spent for a high-test oil, where it is not required, is money thrown away.

In many cases, when operating plants of larger capacity, and where the main units operated under high pressures, say 150 to 160 pounds, gage, I have used a high-grade oil in the main engines, and in the auxiliary apparatus, such as pumps, etc., a cheaper and lower grade. This can be done to advantage, because the steam to the pumps is almost always wire-drawn, hence its pressure and temperature are low when it enters the steam chest and cylinders of the pump and comes in contact with the oil.

While I will not assert that these little economics make multimillionaires, I will say that they help to do so; and even if they did not, the practice of them will raise the engineer in the estimation of the watchful employer, which means better conditions and more money.

## Condenser Repair Kink

The condenser was a cast-iron affair surface-cooled by a centrifugal pump operated by an independent engine. For some reason—probably left running too slow—this pump lost its prime. The engineer did not notice it until the main engine began to labor, due to the drop in vacuum. He immediately speeded the circulator up to full speed and forced a lot of cold water through the condenser. Not long after an attendant noticed steam seeping out through the side of the condenser and on examination found a crack had developed from the head for about 2 feet along the side. A pin hole was drilled at the end of the crack to stop it from extending, and a closely fitting bronze patch was cast to completely cover the crack. Half-inch cap screws were put in at 3-inch intervals all the way around, and a mixture of red and white lead, worked up to the consistency of dough, was placed over the crack. The patch was then drawn up snugly on this joint and stopped all further trouble

# Some Useful Lessons of Limewate

## A Further Discussion of the Subject of Coal Analysis; the Simple Apparatus Required; the Method of Analysis Simply Explained

### BY CHARLES S. PALMER

In the last lesson we began the discussion of coal analysis, noting that the four chief ingredients to be determined are first the moisture; second the volatile matter; third the fixed carbon and fourth the ash. Now to make a good analysis of coal means "quantitative" work. But this means a fair chemical balance, some good crucibles, and also some desiccators; not to mention half a dozen other little things, such as forceps to handle the crucibles with, pipe-stem triangles to heat the crucibles on and also a good bunsen burner. Now it is quite possible that some of you may be interested enough in this to try to have your superintendent get you an outfit.

One can make a very fair balance for himself by using knife edges made from the sharp angle of a specially broken piece of glass. Every good balance has three knife edges, one at the central part of the beam and one at each end of the beam to carry the scale pans. But these knife edges should have some hard surfaces to work on, and pieces of common glass will serve, in one case set into the top of the post on which the beam rests, and in the other cases set on the top of the ends of the beam to support the knife edges which carry the scale pans. The relative positions of these knife edges and these flat glass surfaces are shown in Fig. 1. Very few chemists will bother to make themselves a balance which is accurate and sensitive, but I can testify from my own experience that if one is willing to take the pains he can have a very good homemade balance There is another thing to be considered and that is a set of weights. These weights will have to be bought or borrowed, but I have seen an interested student make a very good set of weights by filing down pieces of a brass rod for the coarser weights, cutting up thin aluminum foil for the finer weights and comparing these with a good standard set.

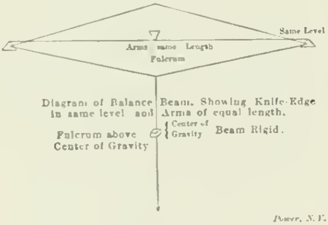
Same Level
Arms same Length
Fulcrum
Diagram of Balance Beam. Showing Knife-Edge in same level and Arms of equal length.
Fulcrum above Center of Gravity
Center of Gravity
Beam Rigid.
Power, N.Y.

FIG. 1

Also, a piece of fine aluminum wire will make a very good rider to be adjusted on the right arm of the balance beam. There is nothing at all impossible in getting a homemade balance, but perhaps we had better reserve that for a special lesson which may come later, and we will assume for the present that you have some kind of a balance which is sensitive at least to centigrams, that is, hundredths of a gram.

METHOD OF ANALYSIS

In determining the moisture, all that is necessary is to get a couple of watch glasses which balance each other, and this can be done by filing away a little of one or pasting little strips of paper on the lighter watch glass. Then put into one of the watch glasses a certain amount of the coal-dust sample, say 5 or 10 grams. Weigh this carefully, using the other watch glass for a counterbalance, and then put it in a tin box over a moderate source of heat You can make a round hole in the top of the can, in which you will pı cork, and through which you will in a thermometer, as shown in Fig. 2. can should have a small hole near the at the side and another at the bottom air circulation.

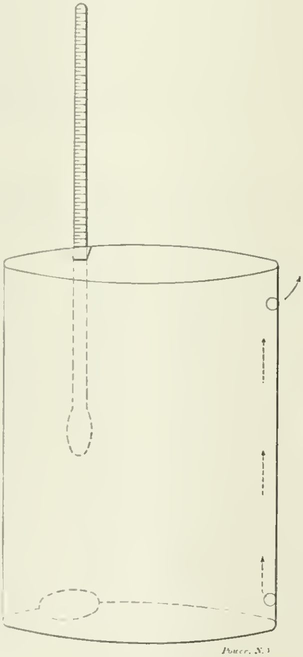

FIG. 2

If you are using a Fahrenheit therm eter let the temperature rise so that thermometer will show about 225 deg or if you are using a Centigrade therm eter, about 110 degrees. About two h heating of the sample at this tempera will dry it. It should then be coole setting it on a clean glass plate and ering it with a big tin can, undern which (and at the side of your coal sa in the watch glass) stands a little cu strong sulphuric acid or calcium chlo not chloride of lime or bleaching pow but real calcium chloride, $CaCl_2$. See Fi This is to keep the air dry in the cove that the coal sample will not absorb n ture on cooling. In 10 or 15 mi remove from the tin-cover desiccato watch glass carrying the coal sample weigh it. The difference from the ori weight (5 or 10 grams, or whatev was) represents the loss in mecha moisture.

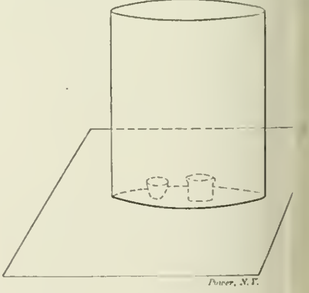

FIG. 3

*The Volatile Matter*—The volatile ter is determined by weighing out o two grams of the coal sample in a porcelain crucible, setting this on a stem triangle on an iron support, pu on the cover, and igniting strongl six or seven minutes over a good bu en flame. This operation distils from he coal all the volatile matter, leaving ly the coke-like carbon and the ash. Re ve the flame after six or seven minutes' i- tion, leaving on the cover until the c ci- ble is almost cool, so that the hot ca on will not be burned off by the air. en ere is no danger of burning up the fixed rbon inside the crucible, the cover can removed, and with the forceps the cible can quickly be placed on glass in homemade desiccator. Let this cool t l it is at the temperature of the room, 15 or 20 minutes, and then weigh kly The loss in weight will be the atile matter plus the moisture which have already determined, and which y be subtracted from the apparent loss volatile matter by calculating in per ges.

*he Fixed Carbon*—To determine this, the same crucible, with the same coal le (minus its volatile matter) and ite it strongly over the flame without ver until all the carbon has burned and there remains only a clean grayish or reddish ash. As before, l while still hot, remove this crucible the desiccator; do not place the cruci- rectly on glass, but on a little dry, n sand, or a strip of thin asbestos l, to avoid cracking the glass. When is cool, weigh it; the difference be- n the weight of the crucible after the tile matter had been burned off and weight of the crucible with the ash esents the fixed carbon, or the most able part of the coal.

*e Ash*—Before you began this experi- t you had to weigh the empty crucible. T ng this weight from your notes and racting it from the weight of the le plus the weight of the ash, of se, will give you the weight of the As has been said before, this ash ly consists of silicate of alumina or

*ulation*—You have now the weights rst, the volatile matter, represented e loss on heating the crucible and with the cover on for six or seven tes; second, you have the loss be- n this weight and the weight of the ble and the ash; and, third, you have the weight of the ash by subtracting the wht of the original crucible.

### FINAL CALCULATIONS

se three differences, the weight of latile matter, the weight of the x carbon and the weight of the ash, h added together should equal exactly ight of the original coal; thus, sup- that you took a gram of the coal at the crucible weighed 12 grams. h your first weight of the crucible plus l would be 13 grams. Assume that ght of the crucible plus the coal the volatile matter is driven off is grams. That indicates a loss of matter of 0.1 gram, which is 10 ent. volatile matter. Assume that eight of the crucible plus the ash burning off the fixed carbon is 12.10. represents a loss for the fixed carbon gram, or 80 per cent. of the orig- al oal. Now, your crucible, weighing 12 ms, when subtracted from 12.10, the weit of the crucible plus the ash, shows 0.1 gram, or 10 per cent ash. Of course, in actual work your crucible will not weigh exactly 12 grams, but you can put in exactly 1 gram of coal and the differences might be relatively the same, although the volatile matter, the fixed carbon and the ash vary in all coals. Hence your analysis stands as follows: Amount of coal taken, 1 gram; volatile matter, 10 (including moisture); fixed carbon, 80; ash, 10; total, 100.

### PECULIARITY OF THE FIGURES

There is something peculiar about the figures of such an analysis to which reference must be made. In the case of a coal analysis the sum of the volatile, the fixed carbon and the ash ought to come to a total of exactly 100 per cent.; and yet there is hardly any other analysis commonly performed by chemists where an actual 100 per cent. total of ingredients is allowable. At first sight this may seem surprising, but incidental human errors and the incidental chemical and mechanical errors due to slight impurities, or to slight losses (as the impurities in the reagents, or the losses incidental to precipitating, filtering and washing 5, 10 or 15 ingredients) are so great that there is not one chance in a hundred thousand that the results of a good analysis will add up exactly 100 per cent. As a rule, the total comes between 99 per cent. on the one hand and 101 per cent. on the other, and in very good analyses between 99.5 per cent. and 100.5 per cent. Indeed, this close approximation to 100 per cent. without exactly hitting it is commonly regarded among chemists as an incidental proof of the genuineness and honesty of the work, while an analysis of the ordinary substance (excepting coal analyses) showing a total of 100 per cent. always carries the impression that the figures have been "cooked." Of course this does not imply anything against a very common practice of calculating percentage into 100 per cent., which is an entirely different thing, but when this is done it should be always so stated. Now you can see why it is not good form to have the ordinary chemical analysis foot up a total of exactly 100 per cent., while the ordinary coal analysis, with the volatile, the fixed carbon and the ash, should foot up exactly 100 per cent. The reason for this is, that you start with a weighed crucible plus a weighed amount of coal. You do not do any dissolving, precipitating, filtering or washing, but simply subject the same crucible with its contents to varying degrees of heat. The volatile, the fixed carbon and the ash are represented by differences between certain weights, and as one difference begins where the other leaves off, obviously the sum of these differences ought to equal the original weight of the coal added to the weighed crucible. It is much as though you should try to divide the length of a foot rule into three parts. These three parts may vary in different cases. One may be 1/3 foot, one 1/2 foot, and one 1/6 foot, or one may be 1/6 foot, one 3/4 foot, and the other 1/12 foot, but in each case the sum of the three fractions must equal exactly 1 foot. So that is why, in a coal analysis, a total of 100 per cent. is not only allowable, but actually demanded.

### TRY IT YOURSELF

I do not suppose that all of the readers of POWER will be able at once to step up to do this quantitative work implied in coal analysis, but it will not hurt anyone at least to try it, and if he cannot assemble or make all the apparatus required, it will not hurt one to know how it is done. The best rule in education is this: "If you would learn a thing, use it," so the best way to understand a coal analysis is to try to do it. If there were any simple method of performing the coal analysis it would be described here, and, although quantitative analysis and the use of the balance are usually considered advanced subjects, yet I know of no reason why the beginner should not attempt them. Civil engineering and the use of trigonometry in measuring tracts of land are usually considered rather advanced subjects, but that should not prevent us from carrying a pocket 2-foot rule, or from knowing something about the compass and the north star.

In addition to the short analysis of coal into the conventional ingredients called the volatile, the fixed carbon and the ash, there is another method of measurement called the thermochemical or calorimetric, which consists in actually measuring the heat given out by burning a weighed amount of coal in pure oxygen. Of course this is still more accurate for commercial purposes than the analysis as given above; for what one buys, when he buys coal, is really so much heat power and not merely so much fixed carbon or volatile matter; and even this volatile matter, particularly in bituminous coals and western lignites, may represent a very large part of the heating power of the coal.

Just here I can imagine some of our husky readers as querying whether there is any use in all this bother to find out the chemical composition of the coal, when anyone can tell how it behaves practically under a boiler. An experienced fireman who knows his boiler can probably easily tell the difference between a good coal and a poor coal, but I doubt very much whether even the best fireman could always tell the difference between a good steam coal, carrying, say, 78 or 79 per cent. fixed carbon, and another good steam coal of precisely the same external appearance and quality, but carrying, say, from 80 to 82 per cent. fixed carbon; yet the difference between these two coals might easily amount to hundreds of dollars a year. That is the reason why these lessons of limewater may represent your opportunity

POWER
AND THE ENGINEER

DEVOTED TO THE GENERATION AND
TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.
355 Dearborn Street, Chicago.
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of POWER solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "POWPUB," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During* 1908 *we printed and circulated* 1,836,000 *copies of* POWER.

*Our circulation for November,* 1909, *was (weekly and monthly)* 162,000.

*December* 7............ 40,000

*This paper reaches* 40,000 *separate readers each month and* 30,000 *each week.*

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*

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## Sulphur in Gas Engines

The question of sulphur in producer gas now occupies somewhat the same position as did that of hydrogen a short time ago. All sorts of difficulties were attributed to the presence of this element in gas for power purposes. When anything occurred not easily understood, relating to the combustion of the fuel, it was easy to say that there was too much hydrogen in the gas. Producers were even designed with the object of making a gas containing no hydrogen in order to eliminate the disturbances attributed to this constituent. But it has been found that a reasonable amount of hydrogen is not disadvantageous, and back fires, preignitions and the like have been assigned to their rightful causes.

The possible effect of sulphur on their engines is now worrying more owners of plants than the older hydrogen question, and coals low in sulphur are in great demand in consequence. Careful tests by the United States Geological Survey, however, have failed to show any deleterious effects on the engines themselves due to the sulphur in producer gas. According to these tests, the places to look for trouble from sulphur are before the gas gets to the engine and after it leaves the engine. It should be noted, however, that the tests were made with single-acting engines. Double-acting engines are invariably equipped with water-cooled piston rods, and somewhat "scattered" and unsystematic observations of such engines seem to indicate that there is more wear at the cooler parts of the rods when producer and blast-furnace gases are the fuels than in engines operating on natural gas. The combination looks suspiciously like sulphurous acid in the cases of the producer and blast-furnace gases.

Sulphur in the producer has a tendency to cause clinkering and to this extent is undesirable, and a solution of sulphurous acid may be formed when the gas comes in contact with the scrubber water. It may well be possible that wet scrubbers will be lined with lead to guard against the corrosive action, when all grades of coal, both anthracite and bituminous, come to be gasified in producers.

In the exhaust pipe, when it is "dosed" with a jet or spray of cooling water from the jackets, conditions are more favorable for the oxidizing of sulphur dioxide into sulphurous acid and corrosive action may be expected there. However, the exhaust piping of the ordinary plant is generally the cheapest and easiest to replace of any of the equipment, and if the producer is gasifying a coal satisfactorily, it would seem that the fuel should not be hastily condemned, especially if such action is taken for fear of possible destructive effect on the engine and the engine is of the single-acting type.

A change of coal was advised i a recent installation because the ex ust smelled strongly of sulphur. Thi ele- ment in all its lower stages of oxi ion has a distinct smell, indicating th the formation of the molecule is only r- tially complete. Therefore, when tl haust smells strongly of sulphur t an indication that a large quantity, ably the greater portion, of the su h contained in the fuel is passing har es ly to the atmosphere as dioxide, the worst, sulphurous, not sulphuric

## Firemen's Licenses in Ohi

The attorney-general of Ohic rendered another decision bearing the engineers' license law. Fro newspaper account before us it wo pear as though it were directed the special permits to firemen to c boilers issued by William E. Ke until recently the chief examiner

The law provides that "It shall lawful for any person to operate tionary steam boiler or engine State of Ohio * * * without havin duly licensed, to do so as provided in." And that "It shall be unlaw any owner or user of any steam or engines other than those excep operate, or cause to be operated steam boiler or engine without licensed engineer in charge."

From the first part of the sec would appear to be necessary for to have a license; from the latt it might be inferred that the fact licensed engineer was in charge wo sufficient. The act provides for ex tions only for persons who desire as steam engineers, with no allus firemen. Mr. Kennedy appears t issued a special permit for firemen have accepted their fees therefor same way that fees were accepte engineers for the regular en license. These fees were turned i State treasury. W. E. Haswell, t chief examiner, has instructed examiners to notify all persons no ing firemen's licenses to report amination for engineers' license date to be affixed by the distr aminer. He intimates that consi delay will be involved and that be reluctant, so far as is consiste law and the general welfare of sons affected, to prosecute firemen the engineers' license law until af date fixed by the examiners for su ex- amination. It is further intimat t the chief examiner will not be li ly make a move toward arresting emen until the legislature has had a ch ce amend the law, and to give fir en a license law of their own with cer examinations than those for the e neer.

## Cicago Smoke and Electrification

igorous criticism has lately been directed against the Chicago smoke-inspecti department, the burden of which has b that in proceeding against department stores, hotels, laundries and small plts in general, the fact has been lost t of that the numerous railroads enteg the city are really the greatest onders in this regard and should be brght up with a round turn before any ble results can be achieved. In all th criticisms of Mr. Bird's régime, howev are contained allusions to the good his administration has already aco ished and doubtless had the activ of the department been directed y to the suppression of railroad the same criticisms that are now cu nt would have gained circulation on grounds that the stationary plants we being neglected.

is true that a large percentage of wntown area of Chicago is covered railroad tracks, which emphasizes importance of smoke from this sre; but it is also true that from the ver nature of the case the locomotive wil the last source of this nuisance eliminated. The installation of a r furnace in the ordinary stationary la where weight and space are not i h prime importance, is a comparative simple matter, but coal burned in a l motive fire box is burned in close t with the heating surface and the gs quickly enter the boiler tubes where te are rapidly cooled, and have little of mixing with the necessary am nt of oxygen. Small opportunity en of introducing refractory mari in amounts sufficient to affect a v ble result and the conditions are ntrary to the teachings of the new sc of combustion.

Se radical change will have to be in the motive power before smoke wl entirely suppressed and the citizens of Cicago believe that electrification will i y come. It will come, however, onlyby forcing it on the railroads as ws ne in New York City, and in the sam way that track elevation was forced. Te fficials of the Illinois Central recet decided against electrification in th ce of the strongest public opinion d l the influence that numerous civic orga ations could bring to bear, and declar that they would adopt the expelie f burning coke at an estimated adli nal cost to their fuel bill of $250,000 year, even though this amount acrdg to their own figures would pay m r han half the fixed charges on the eetication of their entire suburban syste. Also in the last few days various orgaizations of trainmen, meeting in Chicao, have condemned the proposition on th grounds that it would be dangerous to thr lives in the operation of trains and put many of them out of employment. These instances are cited to show that if, two years ago, when the present smoke administration came into power, the effort had been made blindly and literally to force the anti-smoke ordinance on the railroads such bitter opposition would have been aroused as to nullify to a great extent the usefulness of the department before any good had been accomplished.

On the other hand, the policy of education and coöperation which has been adopted has resulted in honest efforts on the part of the railroads to mitigate the evil, efforts the extent of which is not appreciated by the public, and has at the same time allowed the department to get the stationary plants well in hand and effect a marked betterment in the general situation.

In view of the rich field for improvement in Chicago before the present smoke ordinance went into effect and the backwardness in this direction of other representative cities using bituminous coal, it would seem that no little injustice is being manifested in blaming the smoke department because electrification has not already been accomplished.

## The Gas Engines at Point Breeze

An article relating to the new Bethlehem gas engines to be installed at the Standard Oil Company's Bayway refinery, and published on page 824 of the issue for November 24, contained some references to the gas engines at the Philadelphia (Point Breeze) refinery which appear to have been made under a grave misunderstanding of the facts. The most important of these was to the effect that preignitions had sheared off 11-inch crank pins and twisted main shafts in two. We are now informed by an engineer who is more closely in touch with the plant that one main shaft failed as a result of improper alinement of the main bearings and that there has never been a case of crank-pin shearing. The less serious statement in question was to the effect that the regulation troubles which developed at first were due to too sluggish a governor action. Subsequent information indicates that the regulation difficulties were due to the widely and rapidly varying quality of the gas, which, as the article states, is about the worst possible gas-engine fuel.

The article was written by a member of the Standard Oil engineering staff, and was therefore "passed" with less critical scrutiny than we customarily apply to contributions. It is only fair to the author and ourselves, however, to say that the tribulations at Point Breeze were mentioned to indicate the tremendous handicaps under which the engines had been brought to a state of highly satisfactory operation; not to disparage them. We happen to know that the builders of those engines have spent money like water and put forth unlimited effort in order to overcome the abnormal conditions which the character of the gas developed when it was attempted to use it for engine operation, and the result is a triumph for the builders, not discredit.

## Boiler Insurance

Boiler insurance is a good thing, but the name is unfortunate. It is a misnomer and misleads people as to where lies its chief merit. One talks about boiler insurance, and boiler-insurance rates, and the man who gets the largest policy for the least amount thinks he has the best proposition, and, if it were fire insurance or life insurance, this would be true. What we want is boiler inspection—not boiler insurance. We want the companies to prevent accidents, and not to pay the owner a sum of money after the accident has occurred and killed and injured a lot of citizens. Immunity and not indemnity is what the public desires, and the company which has the fewest number of losses in proportion to the boilers which it handles, is doing a better work for the public and for industry than is the company which pays out the largest amount of money in indemnities.

## Honesty in Expense Accounts

This is essentially an engineer's paper, and it aims to deal with problems confronting the engineer, hence we need no apology for discussing expense accounts, but only to explain that we feel the subject a legitimate one, because many engineers travel on the road and these are often in doubt in regard to some phase of the question of what constitutes legitimate items in the expense account.

Broadly speaking, the home company pays for the transportation, board and lodging of its employees when on the road engaged in company work. It pays for the actual expense incurred only, and the idea that a certain sum is allowed for each item, and that that sum may honestly be charged irrespective of actual expense, is most fallacious.

If, through circumstances or choice, a man eats a fifteen-cent lunch, he has no right to charge more than that amount in his expense account, nor has he a right to ride in a day coach and charge up a sleeping-car berth, nor to walk to a plant some distance away and charge up livery, nor to walk to a hotel and enter an item for bus. A man cannot, with honesty to himself, spend time which the company has paid for in doing work for which the company is to be again assessed.

# Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

## Westover Four-Record $CO_2$ Recorder

The new Westover four-record $CO_2$ recorder is designed to make four records from as many boilers, all records being shown in full view at one time on the recording drum.

Each record covers a period of 24 hours, the time between each analysis being 1.4 minutes, thus making the analysis from each boiler about 5½ minutes apart. The machine is furnished with an electric motor, the current from the incandescent lamp socket being sufficient to operate it.

The general appearance of the machine is shown in Fig. 1. At the top is located the electric motor, either direct or alternating currents being used, the motor running at a speed of 1800 revolutions per minute.

The motor shaft is coupled to a gear which meshes with a horizontal worm gear of such size that the speed of the motor is reduced to the required speed to operate the machine. By means of the train of gears shown, motion is imparted to the cam shown at the left and top of Fig. 1. These gears receive their motion from the vertical worm gear which meshes with a secondary worm gear on the lower part of the vertical shaft.

The worm wheel next to the motor carries a crank pin for operating the piston connecting rod, which connects directly to the plunger of the pump *A*, Fig. 2, and shown at the extreme bottom of Fig. 1.

The stroke is 2½ inches. No packing is required and the piston rings are made of cupped leather.

The pump on its downward stroke raises the water level in the gas-receiving chamber *B*, which is connected to the bottom of the pump by the pipe shown. The upward stroke raises the water level and floats in the float chamber *C*, and burette or measuring chamber *D*, the water level in *C* and *D* lowering when the piston lowers.

The cam shown at the extreme left of the top portion of Fig. 1 operates a horizontal moving lever having a roller at one end and a toothed segment at the other, which meshes with a small pinion and imparts an oscillating movement of about ⅓ of a circle to a three-way valve shown at *F*, Fig. 2, by means of the vertical shaft connected to the same, as shown in Fig. 1.

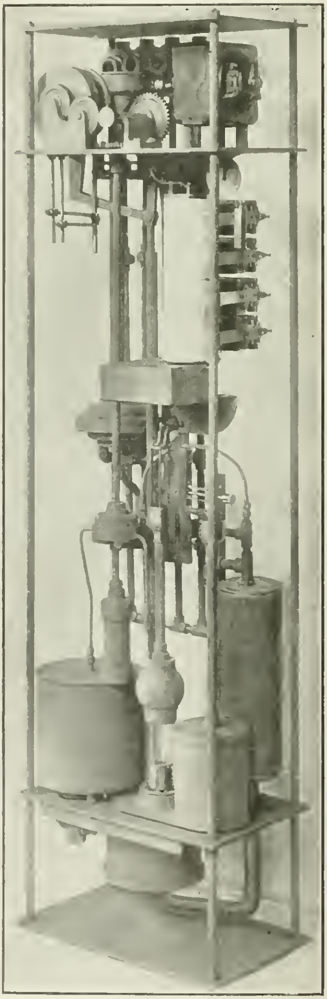


FIG. 1. WESTOVER FOUR-RECORD RECORDER

This valve opens a free passage from chamber *D* to chamber *F*, and when in its other position opens a free passage from chamber *D* to the water sea which is opened to the atmosphere.

A four-way valve is placed betwee four boiler connections on the one and burette or measuring chamber the other side. It is a revolving valve in design, containing eight in four pairs. By its continual cular motion it admits the gas fron four boilers in rotation, the gas say, No. 1 boiler being admitted t chamber *B* by the lowering of the level in it, and passing over into cha *D* by the raising of the water level from chamber *D* through the valve seal *G*, to the atmosphere, while next charge of the two or pair of ch follows the same course, with the d ence that the gas is passed over fr through the valve *E*, not to *G* and t atmosphere as before, but over int caustic-potash chamber *F* for an The first charge is called the cleanin charge, and removes all the old ga

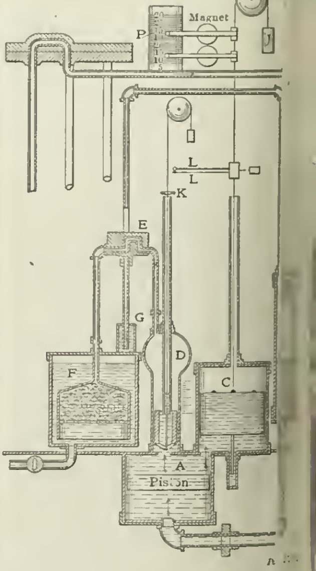


FIG. 2. SECTIONAL DIAGRAM OF RECO

maining over in the pipes from the vious analysis, while the second cha is for analyzing only.

The measuring vessel *D* is the same in ry respect as the principal feature of various hand analyzers, and, there- requires no special description. Its asuring capacity is 300 cubic centi- ters.

y the action of the pump piston the at rises and falls in the float cham- 2 inches, which corresponds to the tical hight of the charts shown in Fig. w ich vertical hight of 2 inches cor- ponds to the full theoretical 20.9 per t $CO_2$. The float is back balanced by and weight *J*, Fig. 2, the chain rying the four marking pencils.

e magnets are a part of the mark- pencils and are brought into play in n in unison with the movement of ur-way selective valve, which unison harmony is maintained by the mag- c quadruple selective switch which sts of the usual rotative circuit ker and breaker.

he caustic-potash chamber *F*, is made ne casting so there are no joints to k. The inverted chamber within the el is filled with powdered material s as to present a large caustic-potash ace for quick absorption. As the gas s over from measuring vessel *D*, the within the inner chamber is lowered derably, the level in the outer cham- b rising correspondingly. The de- n of the level in the inner vessel b w the level in the outer vessel pro- a pressure within chamber *D* which, he return stroke, insures the lower- f the float in the chamber and con- ntly button *K* ahead of the lowering e water level in chamber *G* and in- tally of the contact points *L L*.

e gas-receiving chamber *B* is prac- ly a liquid pump, the surface of the r within same acting as a piston. When the water level falls by means of the action of pump *A*, the gas is received through the four-way selective valve and also through the water seal shown within the chamber Contrawise, when the water level rises the charge of gas passes out, not through the tube through which it entered, but through a small $\frac{1}{8}$-inch tube over into and through the three-way valve to the measuring chamber *D*.

On account of the moisture in the gas it is not practicable to bring it in direct to the selective valve without drainage being allowed for. For this purpose a water seal is provided. This seal is for the purpose of receiving such accretions of moisture as are sure to be in some gases and taking care of it automatically, there being an overflow vent which allows the moisture to evaporate or drip away drop by drop.

As moisture gathers in the seal, there must be a place for it to go and a seal vent open on top provides an outlet. With coals containing very slight moisture enough evaporation takes place at the top of this pipe to correspond with such a small amount of moisture. Where the moisture is so considerable that it is not evaporated away, this tube is led to a receptacle.

As this is a four-record machine, it means four charts instead of the usual one chart. These four charts are printed on one sheet of coated paper and filed away as one chart containing four records. The recording pencil or marker consists of a projecting piece of thin sheet silver $\frac{1}{8}$ inch wide which leaves a clean, sharp, black line on the coated surface. The hight of each individual chart is 2 inches. This hight of 2 inches represents the theoretical amount of $CO_2$ contained in the gases of combustion. The diameter of the drum is 3 inches and the hight 10 inches, thus making the charts about $9\frac{1}{2}$x10 inches. The charts encircle the drum and are held at their edges by three small gummed seals about one-quarter the size of the ordinary postage stamp. When the charts have received their record, and have to be withdrawn, the seals are broken. The drum is driven by the friction occasioned by its resting on a revolving plate which is part of the clock movement, thus, when the chart has been affixed, the drum can be revolved to the point corresponding to the hour and minute of the day at which the change is made. By a simple change, the travel of the recording pen is increased three of four times its standard 2-inch travel, thus making the recorder easily adapted to the close measuring of low percentages. Furthermore, by the use of a phosphorus solution instead of the caustic potash solution the machine becomes an oxygen recorder. Again, by an additional mechanism it is adapted to record both oxygen and $CO_2$.

The drum-clock movement is simply the ordinary clock movement without the usual face and hands. What corresponds to the hour hand in the ordinary clock is fitted with a plate on which the chart drum rests. There is enough friction between this plate and the drum to cause the latter to revolve without slipping.

This machine is manufactured by The Caldwell Company, 220 Broadway, New York City.

## New Departure Packing

A new packing brought out by the Clement Restein Company, 133-9 North Second street, Philadelphia, Penn., con-

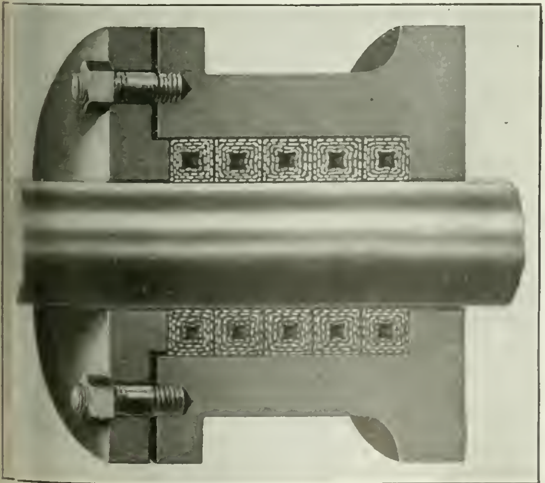


FIG. I., FORM WHICH NEW DEPARTURE PACKING ASSUMES IN BOX

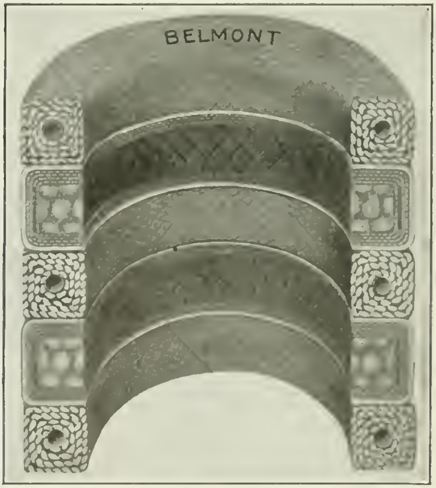
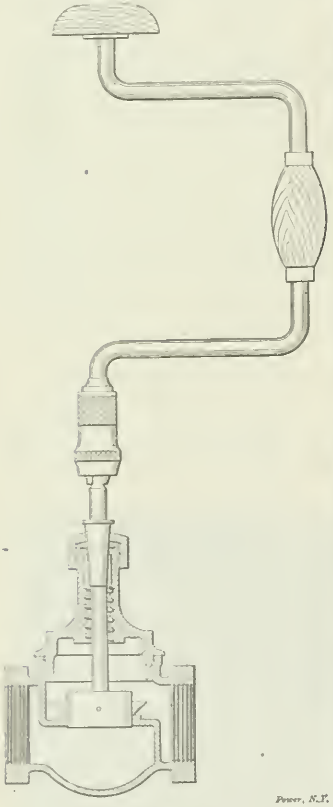


FIG. 2. IN COMBINATION WITH OTHER FORMS

[illegible] of friction made up in a square mold and with a round hole in the center. When pressure is applied the material is moved into the central space, as shown in Fig. [illegible], relieving excessive compression and allowing only the elasticity of the packing to force it against the rod. Used alone it is especially adapted to Corliss valve stems or it may be used with other packings of different material and design, as shown in Fig. 2, to produce a combination adaptable to any pressure or condition for which fibrous packing can be used.

## Skinner Valve Reseating Tool

A valve-reseating tool, which should find a welcome in any steam plant, is shown in the illustration. It will be seen that by using the bonnet of the valve, and a taper bushing which fits into it and acts as a guide at the top, and the guide in the opening of the valve at the bottom, the tool is so directed that perfect alinement is assured.



SKINNER VALVE RESEATING TOOL

The cutter works on the principle of a shear cut, with ample clearance, for both flat and taper seats, and will not chatter, it is claimed. The cutter does not grind, but cuts the seat, leaving it smooth and polished. It requires but very little pressure to operate, and the same valve seat may be recut several times. The operation of this device is so simple that any engineer is capable of using it without special instruction. It is manufactured by James McCrea & Co., 558 Washington boulevard, Chicago, Ill.

## Burke's Smokeless Furnace

The Burke furnace may be attached to water-tube or tubular boilers, by simply removing the lower half of the bler front and grate bars.

The construction of the furnac is simple and rigid, consisting of heavy st iron plates for the front and sides, fi h bolted to the foundation plates and e together in the rear by the cross be bars at the grate level, and an ang c heavy iron at the bottom bolted to h foundation plates, as shown in Fig. 1

To aid further in securing alineme the furnace construction two cast gusset plates extend from the top to tom at the rear. These are fasten the side plates, foundation plate and

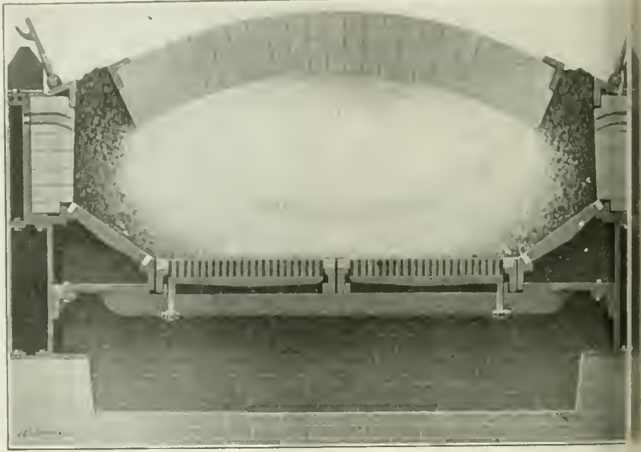


FIG. 1. BURKE'S SMOKELESS FURNACE

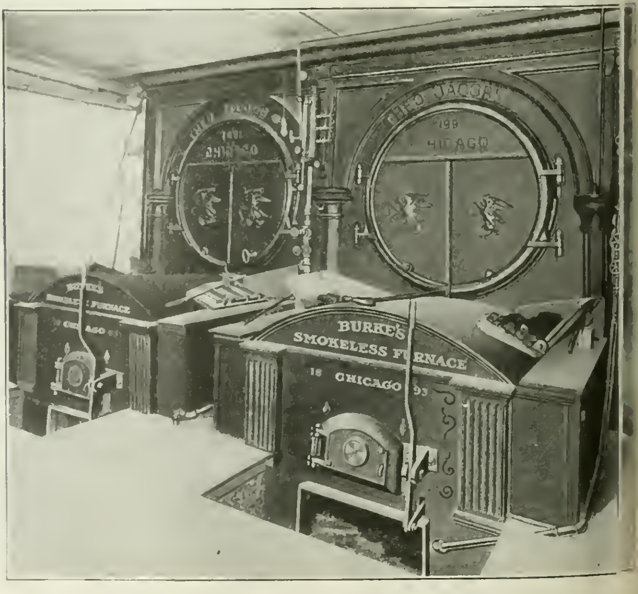


FIG. 2. BURKE FURNACE APPLIED TO A RETURN-TUBULAR BOILER

bar which crosses the entire rear end of the furnace. This angle bar is embedded in the bridgewall, which prevents it from becoming burned out from the heat generated. Fig. 3 is a cross-sectional view of the furnace.

The arch is built of firebrick placed on end, making it 9 inches in thickness. On top of this firebrick arch is a blue annealed steel cover, and between this brick and cover is an asbestos lagging which prevents the radiation of heat into the boiler room. A rise of 2 inches to the foot is given to the arch; the arch itself being so constructed by fitting the brick that there is no possibility of its collapse, by tying together the side plates. The inclined side grates are stationary and the center grates of the shaking-finger type.

It will be seen from Fig. 1 that the coal is placed in the pockets or hoppers located on top of the furnace by any standard ethod of coal conveyance, and feeds by s own weight from the hoppers into the rnace where it is consumed. The coal received from the hoppers upon the clined side grates, where it rests until oroughly coked, the gases or volatile mbustion matter being distilled from the een coal and completely consumed durg its passage over the incandescent mass coal upon the horizontal grates below d the white-hot arch above. This is intended to insure complete combustion of all gases, hence high efficiency and an absolutely smokeless stack

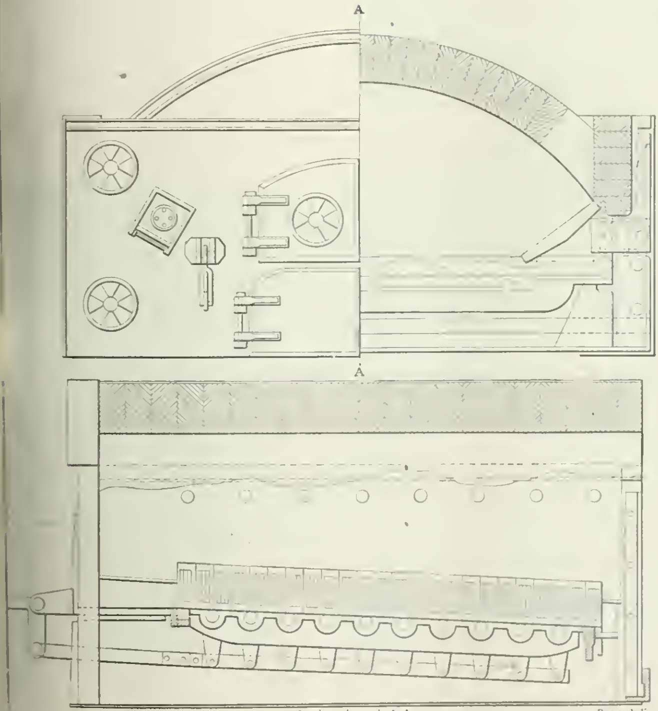


FIG. 3. CROSS-SECTION OF BURKE FURNACE

A draft of 0.25 inch over the fire is necessary in order to obtain the best results from this furnace, as with a lesser draft there is a tendency for the heat to be retained in the furnace instead of passing under the boiler and through the tubes. All air for combustion is taken through the grates which are so designed as to give the requisite amount for complete combustion.

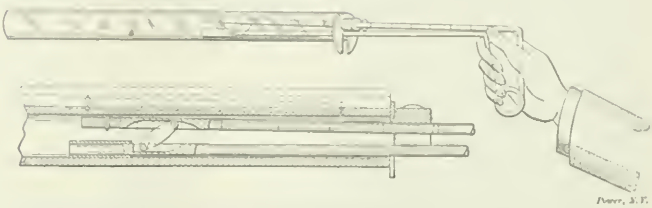
The doors in the furnace are never opened except for cleaning purposes; all stoking being done through the pockets on top of the furnace, thus preventing any variation in furnace temperature. Fig. 2 shows the application of this furnace to return-tubular boilers.

This furnace is manufactured by the Burke Furnace Company, 185 Dearborn street, Chicago, Ill.

## Skinner Gage Glass Cutter

A neat, simple and reliable water glass cutter is illustrated herewith.

It is made with two arms, which form a spring handle at one end which causes the upper arm, containing the cutter, to move away from the lower arm when pressure is brought to bear on the extension ends forming the handle. The cross connection acting between the two arms acts as a hinge and forces the cutter up against the inside of the glass when the handle is pressed with the hands.



SKINNER GAGE GLASS CUTTER

A gage on the rod can be set so as to bear against the outside end of the glass, the cutter coming at the point where the glass is to be cut; then by turning the cutter in the glass it is easily broken where desired.

This device is manufactured by Skinner & Connolly, Yonkers, N. Y.

## The Eddy Automatic Smoke Recorder

Increased attention is being paid to the economical burning of fuel as its importance becomes better realized, and as commercial methods of record keeping come more extensively into use devices for checking furnace operation will become necessary parts of the boiler-room equipment

The Eddy automatic smoke recorder, illustrated herewith, is a device of this character It is designed to be especially useful in cities having smoke ordinances, where cleanliness is an item, or where it is desired to check the performance of high-grade furnace equipment at all hours of the day or night, when carelessness on the part of the operatives might neutralize any gain in efficiency to be expected from the costly apparatus installed.

Mounted on a highly finished metal stand, the machine, as evident in Fig. 1, is entirely self contained It can be located in the engine room or any convenient place within reasonable distance of the stack and is connected to the uptake with a ⅛-inch pipe. Samples of the flue gases are drawn into the machine and the density of the smoke is recorded on a revolving chart operated by clockwork, cross ruled for both hours and minutes. In this way it not only shows exactly when the smoke occurs, but it also shows the duration of the period of smoke, the unconsumed carbon in the flue gases themselves making the record on the paper so that no mistake is possible.

A representative chart from the device is shown in Fig. 2. Smoke in all its gradations from the heavy black, prohibited by the smoke ordinance, to the light gray vapor, that never claims the attention of the smoke inspector, is reproduced in direct proportion to the amount of coloring matter contained in the gases as they pass to the stack.

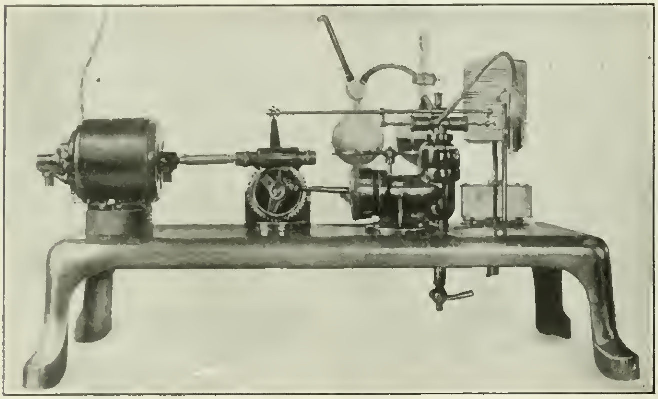


FIG. 1. GENERAL DESIGN OF THE AUTOMATIC SMOKE RECORDER

The gases are first made to pass through a condenser, and then impinge on the surface of sulphuric acid in a closed vessel, for the purpose of removing the water vapor carried over in the sample. In operation the suction is obtained by a 1¼x1½-inch outside-packed plunger pump, which causes a column of oil to pulsate within a vertical glass dome.

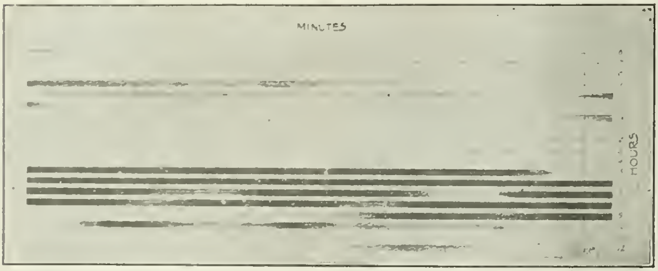


FIG. 2. REPRESENTATIVE CHART FROM SMOKE RECORDER

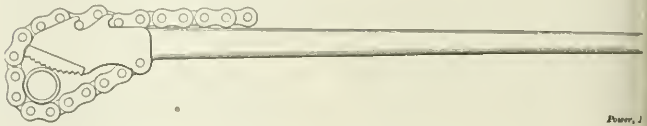
Mechanically operated suction and discharge valves are provided, properly timed to work in connection with the pump, the whole being driven by a 1/12-horsepower motor, through a universal coupling and worm-gear transmission as shown in the photograph.

All parts of the mechanism are self-oiling and designed to operate for long periods without attention. After passing through the purifying process the gases are forced through a small nozzle against the surface of the moving chart, when the coloring matter in the gases is driven into the pores of the paper, thus leaving its record.

The device is manufactured by the Hamler-Eddy Smoke Recorder Company, 3906 South Halsted street, Chicago, Ill.

## Brock Pipe Wrench

A new design of chain-pipe wrench illustrated herewith. It is made with strong chain, which is attached to body of the wrench by a pin. On back of the wrench are notches, in wh the projecting pin of the chain links r be held when the chain is in place aro a piece of work, as shown.

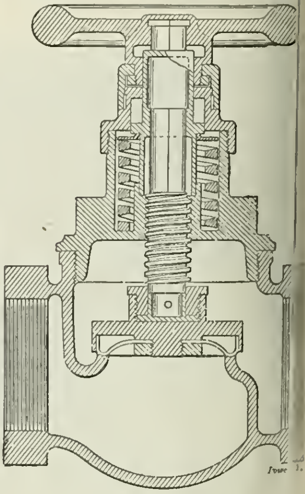

Power, J
THE BROCK PIPE WRENCH

The wrench can be used on any size style of fitting, and has a half-link justment, which allows of close adj ment of the chain. It can be used narrow places, and as the jaws are serted in the head they are easily moved if they become broken.

The wrench is made by the Br Wrench Manufacturing Company, 18 street, New York City.

## A Non-Packing Valve

The ordinary valve must occasion receive attention to keep the stem from l ing, as packing, of whatever nature, eventually become affected by the ste oil, gas, or other fluid handled in the tem. It was in the attempt to overc ne this disadvantage that the valve is- trated herewith was brought out.


Powe
NON-PACKING VALVE

It consists of a globe valve of he usual construction, having ground- int metal seats in the packing gland, he in position by a cast-iron coil spring. A spring made of steel must be tempered before it can be used as such, and when subjected to the action of steam this temper becomes impaired. A cast-iron spring has no temper to lose. This valve is claimed to be especially valuable on oil lines or in any other service where the s stance handled is destructive to ordinary soft packing.

Knudson-Von Kothen Manufacturing Company, Dolton, Ill., is manufacturing the valve.

## Society Notes

At the regular meeting of the "Modern Science Club," 125 South Elliot place, Brooklyn, N. Y., November 16, Russel l nell gave an interesting talk on the M n facture, Use and Abuse of Valves, te, Globe and Check. The lecture, w s well attended and was followed by l vely discussion in which many partici- d.

The annual entertainment and ball of New York Engineers Protective As- t on was held in Lyric hall, Friday ning, November 10, where, after the entation of a fine vaudeville program, t floor was cleared for dancing. The g nd march, which was led by W. M. I kham, was followed by a program o 20 numbers. Dinner was served from I to I in the banquet hall. Everyone w t home feeling that the oldest or- g ization of engineers in New York City w sure of a life much longer than it has al ady enjoyed.

MEMBERS OF THE "KNOCKERS' CLUB" ASSEMBLED AT "THE MORGUE"

he following is the list of officers cl ted at the first annual convention of T National District Heating Associa- ti held at Columbus, O., November 10 and 11, 1909. President, A. C. Rogers, Toledo, O.; secretary and treasurer, D. L. Gaskill, Greenville, O.; first vice president, J. H. Harding, La Porte, Ind.; second vice-president, H. W. Hellman, Grand Rapids, Mich.; third vice-president F. E. Reidhead, Paducah, Ky.; executive committee, Grant Miller, Toledo, O.; W. A. Wolls, Columbus, O. The convention selected Toledo, O., as the place for the second annual convention, the date to be in May of 1910. The exact dates will be determined later. The office of the association is now located at Greenville, O., and in the hands of D. L. Gaskill, secretary and treasurer of the Ohio Electric Light Association.

## Interesting Lectures at Stevens Institute

Stevens Engineering Society, one of the student branches affiliated with the American Society of Mechanical Engineers, has arranged a very interesting series of lectures for the season of 1909-10. The series was started October 11 and the schedule provides for weekly lectures up to May 10, 1910, with the exception of the Christmas vacation. Among the names of the lecturers a number of men of national reputation appear. On December 14, Rear Admiral George W. Melville is to talk on "Essentials of Naval Efficiency in an age of Engineering;" for January 4, Henry G. Stott has chosen the topic "Engineering Efficiency;" T. Commerford Martin on January 18 speaks on "Features of Electrical Development;" February 15 David S. Jacobus lectures on "Power Plant Economics," and on February 21 Henry L. Gantt is to give a talk on "The Engineer as a Manager." These lectures are held at Stevens Institute, Hoboken, N. J., and anyone interested is cordially invited to attend.

## Knockers Club Reception

On the evening of November 15, some eighty members and guests of the Knockers Club gathered at "The Morgue," 518 West Fifty-eighth street, to enjoy the semi-annual beefsteak dinner. During the social hour which preceded the dinner, cigars were liberally supplied and the nonsmoker was looked upon as being a little out of his element.

The dinner, which consisted of real broiled beefsteak, grilled bones, mutton chops, bread and celery, was washed down with sherry and beer with which the busy waiters kept filled to the brim all glasses that were not turned. Under the direction of Frank Martin the "Bunch" gave a vocal and instrumental musical entertainment which helped to make this dinner the perfect one.

## Personal

S. L. Nicholson has recently been appointed general sales manager of the Westinghouse Electric and Manufacturing Company, and has direct charge over the sales policies of the entire company. Mr. Nicholson has been with the company for eleven years in many different capacities, as salesman, as district department manager, and as industrial and power sales manager for the past five years, from which last position he resigned to take the present post. He is perhaps best known to motor manufacturers as the organizer and president of the American Association of Motor Manufacturers.

## Business Items

The Minneapolis Steel and Machinery Company is furnishing one of its Muenzel producer-gas engines and gas producer plants for the county light plant at Milbank, S. Dak., which is owned by Oscar Claussen, consulting engineer, St. Paul, Minn.

The "first family dinner" of the Parker Boiler Company was held at the Engineers' Club, Philadelphia, on November 19. The heads of all departments of the business were present and together with several guests, kept the party entertained with responses and anecdotes. H. F. Snyder was master of ceremonies. Following the dinner, a meeting of the employees was held with J. C. Parker as chairman. The subject was "Co-operation" and many valuable suggestions were offered by the various men.

The Western Electric Company completed with September five-sixths of its fiscal year and unless unexpected developments take place before the end of November the twelve months will show a gross business very close to $47,000,000, or 42.5 per cent. greater than the gross business for 1908. Indications for the next year are all favorable and the officers of the company expect 1909-10 will show an increase of at least 20 per cent. over the year which is now drawing to a close. On this basis next year's gross sales will be in the neighborhood of $57,000,000, far outstripping 1907's gross of $52,700,000, which was the second largest year in the history of the company. September sales ran very close to those of August and showed an increase of 50 per cent. over September, 1908, the improvement being noted in all lines of the company's business. Growth in the business of the Western Electric Company at the present time is taking place most rapidly in the region west of the Mississippi river. The company recently increased its facilities in Omaha so that that branch now handles electric light and electric supplies in addition to telephone supplies. At present there are 17,000 employees on the company's payrolls, as compared with 13,000 a year ago, or a gain of about 30 per cent. The greatest number which the company employed at any one time was 29,000 in 1906.

Following the completion of the main machine shop addition at the plant of the Dodge Manufacturing Company, Mishawaka, Ind., ground has been broken for an additional warehouse for finished products. For a long time the present warehouse has been inadequate to take care of the volume of business and this condition, together with a firm resolve to better the service, is responsible for the new building. The plans call for a structure of reinforced concrete, 256 feet long by 112 feet wide, four stories high and a basement, and will cost in the neighborhood of $160,000. The first floor, raised to a level with the floor of a freight car, will be used for shipping and inspection purposes, with offices for the general traffic manager and his force. A loading platform will extend the entire length of the warehouse with ample trackage for loading and moving cars with promptness and speed. The Lake Shore & Michigan Southern already has extensive yards at the Mishawaka factory, but connection with the warehouse will be made direct. Suitably placed doors will give access to and from the shipping floor. The basement and the second, third and fourth stories will be confined to the storage of products. Each will have elevator facilities and the whole equipped with the most modern appliances of the day in warehouse construction. In the new warehouse arrangement it will be possible to fill orders for standard goods, such as pulleys, hangers, pillow blocks, collars, couplings, clutches and other transmission machinery in special or carload lots as fast as the railroad company can furnish cars and pull them away.

## New Equipment

The Island Creamery Company, Hibbing, Minn., will erect a $15,000 plant.

The Oelwein (Iowa) Light, Heat and Power Company will build a new power plant.

Ferris Brothers, Watertown, S. D., are having plans drawn for a $100,000 electric-light plant.

The Balbach Refining and Smelting Company, Newark, N. J., will increase its power plant.

The Brewster Cocoa Manufacturing Company, Jersey City, N. J., will enlarge its power plant.

Edward Donlon will erect a $1,000,000 electric power plant at Thompson Falls, Mont., near Missoula.

Luick Ice Cream Company, 687 Jackson street, Milwaukee, Wis., will erect an addition to its power plant. Gas producers will be installed.

The Aberdeen (S. D.) Electric Light and Power Company has been purchased by the Union Company of Omaha, Neb.; $100,000 is to be spent on new equipment.

Sealed proposals will be received until 3 p.m., December 18, 1909, at the Treasury Department, office of supervising architect, Washington, D. C., for power plant, including boilers, engines, generators, heating and ventilating apparatus, etc., for United States custom-house and appraiser's store buildings at San Francisco, Cal. Specifications can be obtained at the above office.

## New Catalogs

H. W. Johns-Manville Company, 100 William street, New York. Pamphlet. Morris metallic packing. Illustrated, 8 pages, 4½x7 inches.

Woven Steel Hose and Rubber Company, Trenton, N. J. Catalog. Mechanical rubber goods and packings. Illustrated, 30 pages, 5x8 inches.

Covington Machine Company, Covington, Va. Catalog. Punching and shearing machines, boilermakers' tools, etc. Illustrated, 28 pages, 6x9 inches.

Harrison Safety Boiler Works, Philadelphia, Pa. Catalog. Cochrane steam stack and cut out valve heater and receiver. Illustrated, 48 pages, 6x9 inches.

New York Leather Belting Company, 51 Beekman street, New York. Pamphlet. "From Forest to Factory." Victoria-Balata belting. Illustrated, 64 pages, 6x9 inches.

## Help Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," Power.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

AGENTS AND ENGINEERS wanted in every city to sell a high-class steam specialty. Address Linton Machine Company, 26 Cortlandt St., New York.

WANTED—Erecting men to erect and start high-grade automatic engines; furnish references and state ability, etc. Address Erie City Iron Works, Erie, Penn.

ESTABLISHED New York manufacturing agent handling well known steam specialties, wants active partner with capital to develop business; unquestionable honor required. Box 84, Power.

WANTED—In New Jersey, a mechanic draftsman, familiar with general constru tion work, who has had some experience photography; state experience and sala Box 78, Power.

WANTED—A young ambitious draftsm for paper mill office; permanent position t the right man; send application giving ref ences, previous experience and age. Hamm mill Paper Company, Erie, Penn.

## Situations Wanted

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CHIEF ELECTRICIAN for a growing dustrial plant; 14 years' experience with namos, motors and electrical equipmen Pennsylvania, New York or New Jersey p ferred; reference given. Box 86, Power.

WANTED—Position by mechanical er neer; technical graduate; large experience designing, erecting and operating power pla and mills; as assistant or designing engine or chief draftsman; highest references. I 85, Power.

ENGINEER wishing to make a change time after this year in January, 1910; han with tools; can handle engines, pumps, b ers; will start doing anything until a pl is open; married; age 35; sober and hon working man; country preferred, but will any place. Box 87, Power.

ELECTRICIAN, experienced in power lighting plant construction is open for gagement; last three years in direct cha of complete electrical equipment installatio expert on repairs of transformers, motors generators; steam and water prime move speaks English and Spanish; American; 27; sober, ambitious and industrious; A-1 erences. Address Box 52, Power, 355 D born St., Chicago, Ill.

ELECTRICAL ENGINEER with highest erences, wishes to form connection with g concern, preferably in or near New Yo three years' experience in Mexico, five ye in Chili; speaks Spanish and German fluent has had wide experience both in selling constructing electrical, steam and hydra machinery; open for immediate engagem Address "H. K. W.," Box 71, Power.

## Miscellaneous

*Advertisements under this head are serted for 25 cents per line. About six wo make a line.*

PATENTS secured. C. L. Parker, Solic of Patents, 4 McGill Bldg., Washington, D

IF YOU DESIRE to learn the latest provements in steam boilers, correspond w the Detroit Water Tube Boiler Co., Detr

ENGINES AND BOILERS, ⅛ to 2 engine castings in sets. Models and gea machine work. Sipp Electric and Mach Co., Paterson, N. J. Catalog 4c.

PATENTS—H. W. T. Jenner, patent torney and mechanical expert, 608 F. Washington, D. C. I make an investiga and report if patent can be had and exact

WANTED—A hardware or mill supply cialty to sell on royalty, or manufacture sell on royalty, or purchase outright. dress with particulars, "Specialty," Box Power.

ENGINEERS AND FIREMEN—Send cents in stamps for a 40-page pamphlet taining a list of questions asked by an ex ining board of engineers. Stromberg lishing Co., 2703 Cass Avenue, St. Louis,

ANY FIRM or engineer in charge c steam plant that is troubled with scale in boilers can get absolutely free, the best cator and reducing wheel made, with ve lined mahogany case. For particulars, dress Great Lakes Chemical Works, Ma woc, Wis.

JOBBING MACHINERY Supply Comp in Middle West, operating large and equipped machine shop, desires to manu ture some article of merit in the line of chinery or mill supplies; have excellent cilities for pushing sales. Anyone wit good article but without facilities to m facture, write to Box 82, Power.

## For Sale

*Advertisements under this head are serted for 25 cents per line. About six w make a line.*

FOR SALE—20x48 Wheelock engine two 72"x18' high pressure tubular boiler good condition cheap. Address "Engin Box 2, Station A, Cincinnati, Ohio.

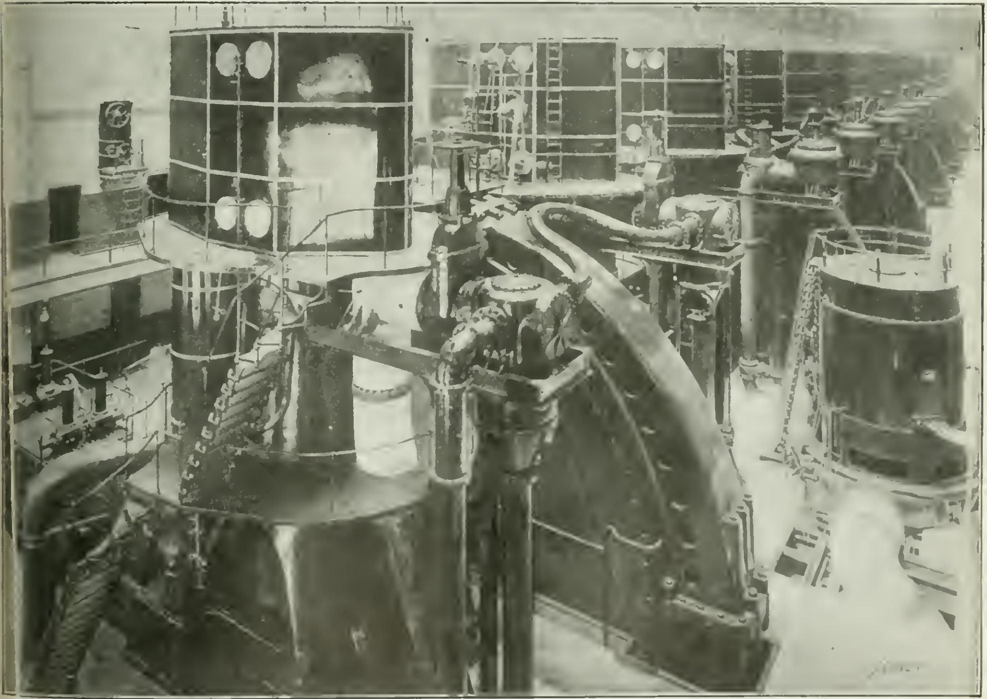
FOR SALE—Cheap six 66"x18' 0" sec hand tubular boiler shells with sixty-si tubes, good for 125 pounds steam pres also four 42" steel stacks 90' 0" long one 72" stack 90' 0" long heavy plate. dress Box 76, Power.

# The Interborough Low-Pressure Turbine

## 5000-Kilowatt Three-stage Curtis Turbine and Manhattan Engine of Same Capacity Develop Kilowatt-hour on 13 Pounds of Water

### BY FRED L. JOHNSON

As one of the important advantages of the steam turbine over the reciprocating engine is, that it can be made to efficiently utilize nearly all of the available energy of expanding steam incident to the use of vacuum, this feature has led to the development of the low-pressure turbine designed to operate economically in connection with reciprocating engines, as was suggested by Professor Rateau several years ago. Low-pressure turbines without valves or governing mechanism can be arranged to take steam directly from the exhaust pipes of engines. These turbines being designed to give high efficiency with highly expanded steam should operate with a high vacuum. There are cases where the saving effected by such an arrangement is so great that it would be difficult to believe if the facts were not thoroughly established by repeated tests.



1. MANHATTAN ENGINES, IN FIFTY-NINTH STREET STATION, AND LOW-PRESSURE TURBINE OF EQUAL CAPACITY AT THE RIGHT

Engineering experiments which will probably aid in effecting great gains in both capacity and economy in existing power plants, involving the abandonment of but a negligible part of the present equipment, and accomplishing this result with a minimum additional investment, have for some time been under test at the Fifty ninth street power station of the Interborough Rapid Transit Company, of New York City.

As it is well known that the energy generated by the expansion of a given weight of steam depends not upon the particular pressures between which the steam is expanded but upon the number of times it is expanded, engineers have turned their attention toward some method of utilizing the energy in the steam rejected to the condenser by the reciprocating engine. The apparatus which has been designed to realize this energy is the low-pressure turbine for which a very large field exists in connection with engines which are now running condensing. Such engines make poor use of the available energy in steam at low pressure as the improvement in engine economy secured by condensing is seldom more than 25 or 30 per cent., while a low-pressure turbine and condenser will improve upon the steam consumption of a noncondensing engine more than 50 per cent.

If an engine be operated with a back pressure only slightly less than the release steam pressure corresponding to its expansion ratio and the exhaust steam be taken through a properly designed tur-

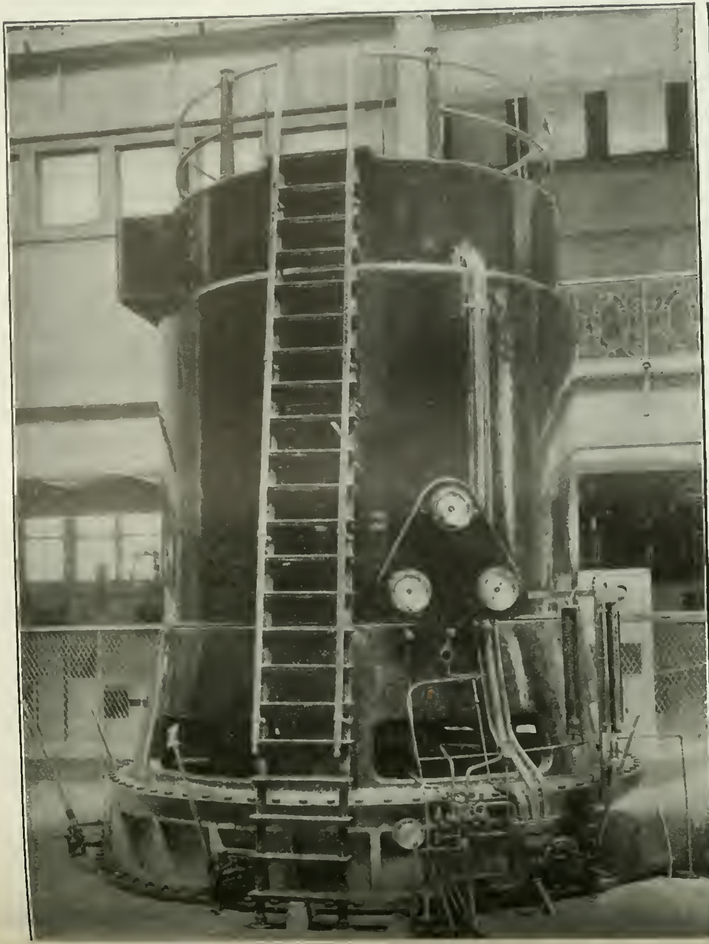
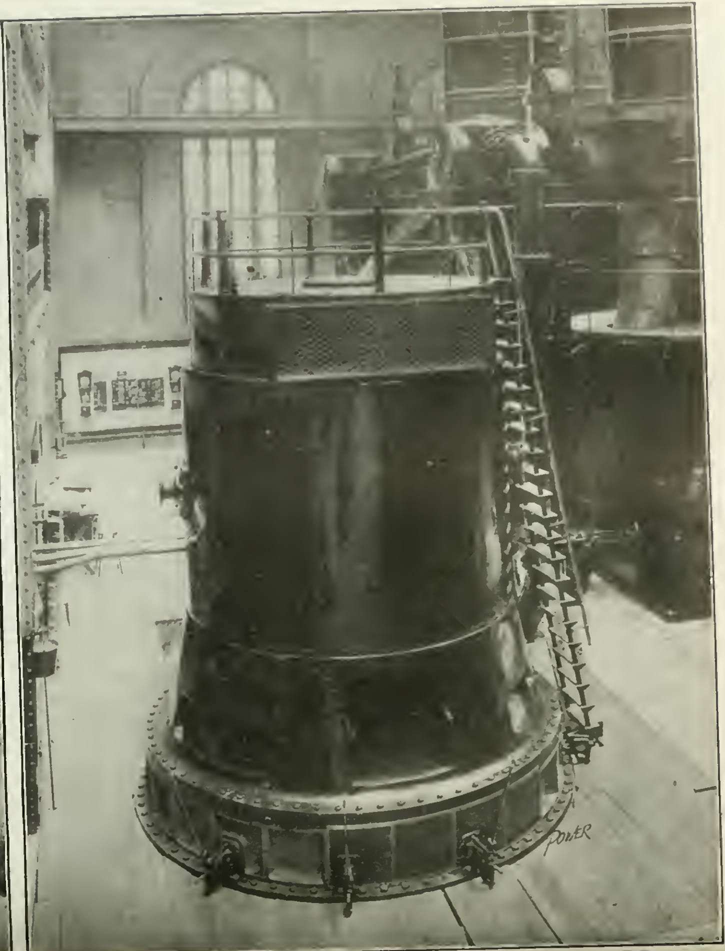


FIG. 2. [illegible]



[illegible]

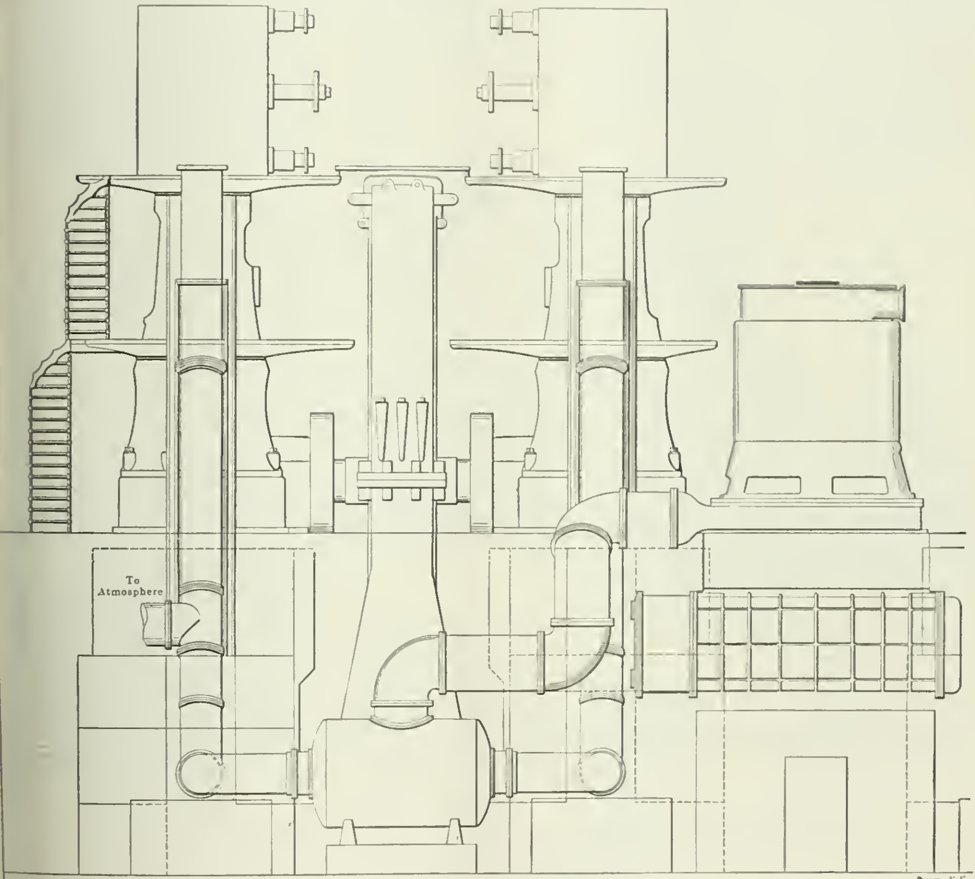
bine to a condenser, a great gain will result. The low-pressure turbine makes vailable in the form of mechanical or lectrical power the energy of steam at pressure which is either used with poor conomy in the condensing engine or sted in the noncondensing engine. It ay be considered to be an improved thod of compounding an engine, ac-mplishing successfully the aim which s partially realized by dividing engines in two or more cylinders and discharging to a condenser.

In practice the low-pressure turbine is installed between the exhaust of an existing engine and the condenser, and takes the steam exhausted by the engine after it has done its work expanding from boiler pressure to the pressure of the engine exhaust. The energy of steam discharged at a pressure of about six pounds absolute in the steam engine is entirely wasted. This would be a matter of little importance if the amount of energy wasted was small, but as a matter of fact it is very large.

It has been frequently demonstrated that while the reciprocating engine is efficient in utilizing the energy of steam when expanded from ordinary boiler pressures to that of the atmosphere, it is inefficient in its use of the energy which still remains after expansion to the atmospheric pressure has been accomplished. It has also been often shown that the steam turbine is particularly efficient in the realization of the energy in the lower pressure ranges, and as there is approximately the same available energy in steam as ordinarily used, below the atmospheric line as above it, designers have been led to investigate and consider the results that might be obtained from the adoption of a combination unit consisting of a reciprocating engine expanding the steam from ordinary boiler pressure to atmosphere, and a turbine expanding from the engine exhaust to a vacuum of 29 inches. Under such conditions each member of the unit would operate within the limits of its own most economical pressure range and a highly efficient combination might be expected.

A compound engine working between 180 pounds gage pressure and atmosphere will deliver to the switchboard a kilowatt-hour for each 30 pounds of steam exhausted; a low-pressure turbine will take this steam and between the exhaust pressure of the engine and 29 inches of vacuum will extract power sufficient to deliver to the switchboard another kilowatt, making two kilowatts for 30 pounds of steam rejected to the condenser, or a joint performance of the combined machines of 15 pounds of water per kilowatt hour, a performance much better than could be reasonably expected from either turbine or engine alone operated under ordinary commercial or industrial conditions of load variations.

Recent tests on a combined engine and



Power, N.Y.

FIG. 4. FRONT ELEVATION OF ENGINE AND TURBINE

turbine unit operating over a range of load varying from one-half rating to 50 per cent. overload, have shown that the water rate per kilowatt-hour varied less than one-half pound.

One salient feature of the possibilities of the combination is the ease with which the capacity of an existing engine plant may be increased by the installation of low-pressure turbines between the engines and condensers, increasing the efficiency as well as the capacity for a comparatively small expenditure for new apparatus. Operation in connection with the reciprocating engine seems to be an ideal field for the low-pressure turbine and a combined unit may have a thermal efficiency closely approximating, if not exceeding, that of the gas engine.

At the Fifty-ninth street plant there are installed several engines, known as the Manhattan type, with cylinders 42 and 86 inches in diameter, running at 75 revolutions per minute, which were designed to carry a load of 5000 kilowatts, though the best economy is reached at a point slightly below this. As the generators were designed for a constant load of 5000 kilowatts but guaranteed to carry an overload of 50 per cent. with a temperature rise not exceeding 35 degrees centigrade, they are run much of the time with a load of 7500 kilowatts. Running with the engine the low-pressure turbine generator recently installed carries a load ranging from 4000 to 6000 kilowatts, and does this without governor regulation. The generator takes care of the speed by automatically taking such a load as will keep the frequency in unison with that of the engine-driven generator. There is, of course, the usual speed-limit attachment which in the case of an emergency stops the machine by shutting off the steam valve in the supply pipe.

This combined machine has been operated under test conditions for several months with loads varying from 9000 to 15,000 kilowatts at a water rate of less than 15 pounds per kilowatt-hour, the regular load being from 11,000 to 12,000 kilowatts. These results are obtained from dry saturated steam at 200 pounds pressure at the boiler. There is a drop of about five pounds between the boiler and the engine, and when the two machines are operating together, the load is usually distributed between the engine and the turbine in a ratio of 6 to 5.

Approximately 23½ pounds of water per kilowatt-hour should represent the average performance of the engine when operating alone with its rated load. Te low-pressure turbine will develop nea y the same power on less than 24 pou s of water per hour, so that a water rate f 12 pounds per kilowatt-hour might e expected from the combined unit w n operating under the best conditions.

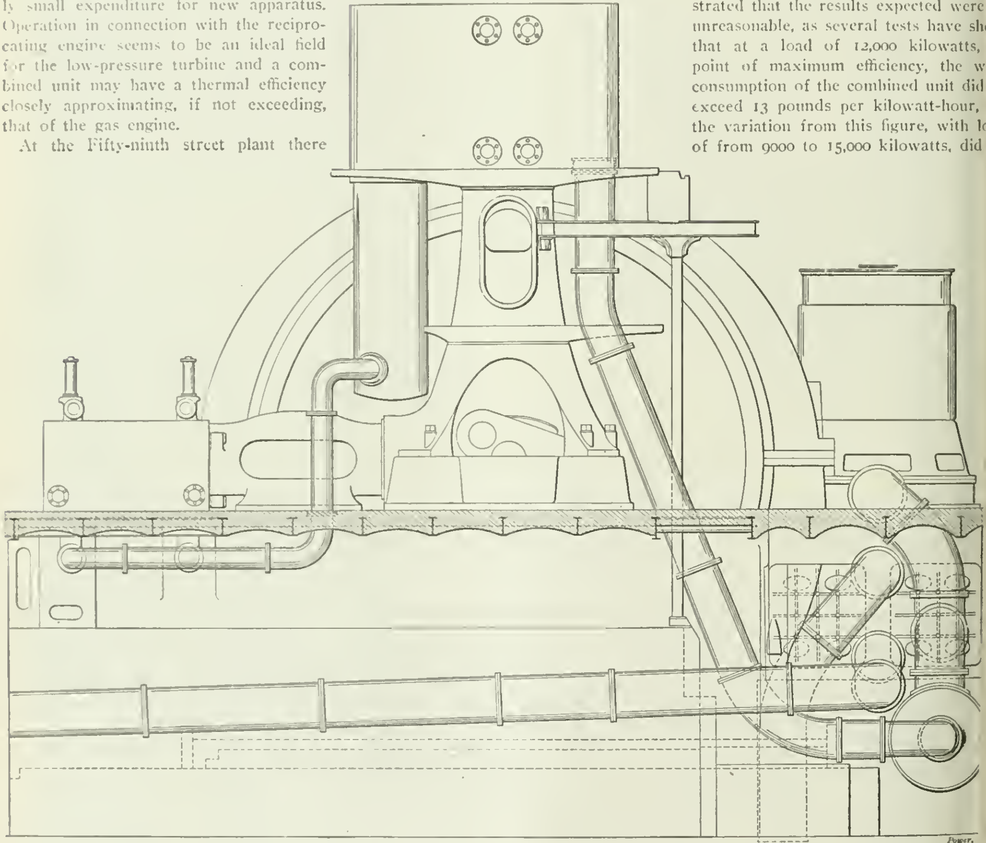


FIG. 5. SIDE ELEVATION OF COMBINED UNIT

The machine installed at Fifty-ni street is a three-stage vertical turbine, f which a very clear conception may e obtained from the sectional elevat n, Fig. 6. This machine has fully dem strated that the results expected were unreasonable, as several tests have sho that at a load of 12,000 kilowatts, point of maximum efficiency, the wa consumption of the combined unit did exceed 13 pounds per kilowatt-hour, the variation from this figure, with lo of from 9000 to 15,000 kilowatts, did exceed 0.4 of one pound of water kilowatt-hour. With coal havin thermal value of 14,500 B.t.u. per p a kilowatt-hour is produced at the sw board for 1½ pounds of coal b under the boilers.

In appearance the turbine, Figs. 2 3 is not unlike the usual high-pre r machine. Each of the three b wheels carries two rows of buckets be- tween each pair of which are the al rows of curved vanes for redirectin he steam at the proper angle to the xt row of moving buckets. These bu et and directing vanes are, however, ich larger than are used in the high-pressure urbine of the same power, thus providing for the passage of the much greater volume of steam necessary for the development of the required power. As the mechanical clearance between large staonary and moving parts is not necesrily greater than with smaller ones, the ercentage of energy lost in eddies and y steam leakage past the buckets is much maller than in the high-pressure turbine.

It will be seen by referring to Figs. 4 d 5 that the steam from both low-presre cylinders of the engine, on its way the turbine, passes to a large horizontal arator from which the condensation is pped at the bottom and the steam alwed to pass to the steam chest of the rbine through a 40-inch steam pipe m the top of the separator. As it is esired to keep the steam-chest pressure t or near one pound above the atmosre, the nozzle diaphragm of the turne is provided with several slide valves, g. 6, by which sections of the nozzle ws may be covered when the pressure s below that desired, thus reducing the ntity of steam admitted to the first w of moving blades and increasing the ck pressure on the low-pressure cyllers of the engine.

The nozzle-covering valves are operated means of the levers which are plainly wn in Figs. 2, 3 and 6. If on account the load the engine exhausts steam ter than the turbine uses it, the presre in the turbine steam chest will rise, if too little steam is coming from the ne, the pressure will fall. One of the s on the front of the generator frame g connected with the steam chest, rise or fall of pressure is noted by operator and corrected by opening or sing one or more sets of nozzle valves. With no governor on the turbine, the nerator acts in parallel with the engine erator, "floating" on the system, and speed is controlled by the capacity the generator to take its share of the d. If, for instance, the turbine tends increase its speed, this increase will se the generator to take more of the d, thus relieving the engine, which will nce cut off shorter and consequently ver less steam to the turbine. This cause the turbine to run slower and w a part of its load back to the ene from which it was taken. In prac this surging of the load is so slight it is not perceptible and no governor eeded.

he speed limit previously mentioned consists of a flat ring placed slightly eccentric to the shaft and kept in this position by a helical spring, which at ordinary speeds will resist the centrifugal force tending to increase its eccentric position, b which will yield to the slight increase force caused by too high speed and allow it to strike a detent which will release a weight attached to the "butterfly" throttle in the supply pipe and instantly close the valve

Air for cooling the generator is drawn from outside the building through a duct, which has been attached since the photographs were taken, by two screw or propeller fans keyed to the shaft. One revolves in an air-tight casing over the top and the other immediately below the generator, discharging the air into the engine room through the openings in the generator-supporting frame. By means of circular partitions and deflecting skirts the upper fan drives a current of air through and around the armature, while the lower one cools the revolving field by drawing air downward through it.

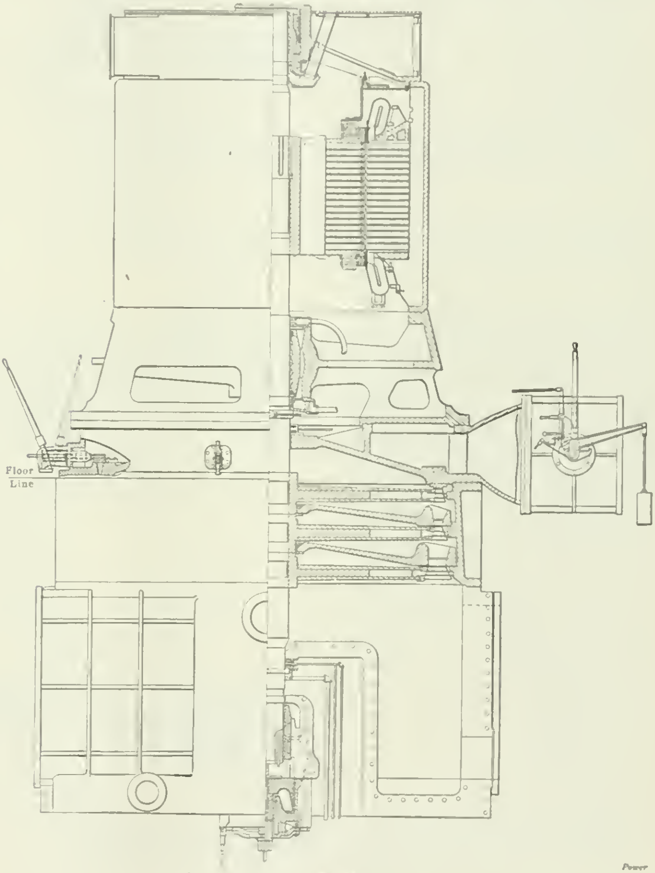


FIG. 6. ELEVATION OF TURBINE IN PART SECTION

Directly under the turbine is a Worthington turbine base condenser containing 25,000 square feet of cooling surface, which, with the water-shed plates between the horizontal rows of tubes, is sufficient to maintain a 20-inch vacuum at any rate of steam consumption that has yet obtained. The condensation is returned to the boilers by a Worthington two-stage centrifugal pump driven by a Kerr turbine, and the air is taken care of by a steam driven 24-inch Laidlaw Dunn Gordon single stage dry vacuum pump.

Circulating water is furnished by a 36-inch Worthington volute centrifugal pump of 90,000 gallons per minute capacity, which is driven by an American ball angle compound condensing engine rated at 500 horsepower.

Since the installation of the turbine a great deal of interest has been manifested both in its operation and its performance, and additional data in this regard will be available when H. G. Stott, superintendent of motive power for the Interborough Rapid Transit Company, presents his paper on the low-pressure turbine at the February meeting of the American Society of Mechanical Engineers.

During the time that has passed since its installation, the turbine has been subjected to tests under all conditions that obtain in central station practice, with such results that as rapidly as possible two similar units are being installed.

# An Indicator Genius

By William Westerfield

We are told that at one time in the distant past there lived a man whose name was Ananias. Little is known about him, his biography, as I remember it, being very brief. The thing brought especially into the limelight in his biography was his ability as a liar, so that "unto this day" he is held up as a pattern for those who would excel in this line. There is also a society, I am told, named for this man, and the requisite for membership in this society is to have a certain strenuous individual call you a liar, or some such endearing name; then you are a member.

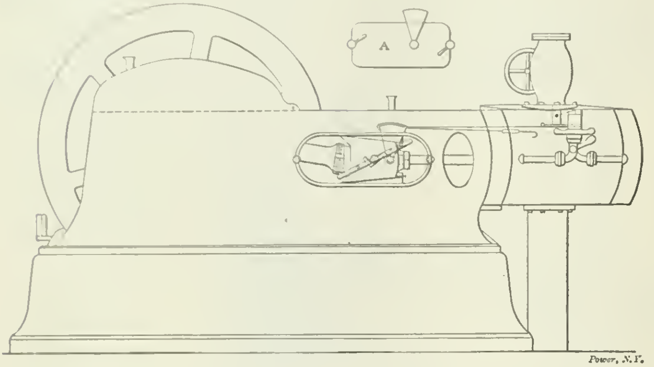


FIG. 1.

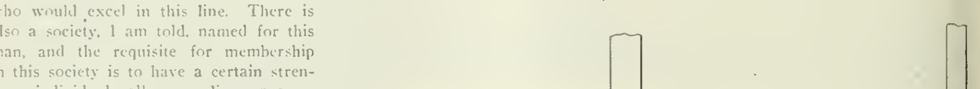


FIG. 2.

I desire to let it be known in the beginning of this article that I am neither a descendant of Ananias nor a member of the society named for him, and that the statements made herein, both descriptively and pictorially, are entirely true. But while all that may be told herein is true, it is doubtful if the "whole truth" will ever be known. However, I trust that I have brought to light enough to edify in some degree those who may chance to read this.

Somewhere between the Great Lakes and the Gulf, and the Atlantic and Pacific, there is a power plant consisting mainly of two Atlas high-speed engines, 17x15 inches, direct-connected to alternators of 150 kilowatts capacity. The engineer who at one time had charge of this equipment finally became the possessor of a steam-engine indicator which had a reducing wheel attached. To this latter fact he owed much grief, and to this same fact this story owes its existence.

In Fig. 1 I show the engine with tl indicator properly attached; *A* is the guard or cover plate for the opening the guide barrel, as shown in the ma cut. It will be noted that the splash syste of oiling is used. There is a small sect shown on the face of this plate, and r ferring to the cut of the engine, a the indicator attachment, it will be se that this sector is attached to a shaft e tending through a bearing in the cov plate, and that there is an arm attach to the inside end of this shaft, having offset at the end which rides upon an i clined bar attached to the crosshead. the crosshead reciprocates, this arm ris and falls, following the inclined bar, a this, of course, causes the shaft to osc late, and this motion is communicated the sector. The amount of this oscil tion will depend on the difference in t hight of the two ends of the inclined b. The cord is attached to the sector and carried in a groove in the rim of it. must be apparent that this is a reduci motion, and is not intended to be used connection with a reducing wheel.

In this sketch, it will be noticed tl two cords are carried out from the sect I will explain that the speed being hig I used the extra cord shown by the low line, in which was connected a rubl band to keep the inner arm of the moti securely in contact with the inclined b already described, so that any distort might be guarded against and at the sa time less tension could be put on indicator-drum spring.

Our engineer, of whom I first star to write, undertook to get diagrams fr this rig, with the reducing wheel tached to the indicator, and I am told that he did succeed in obtaining some diagrams about a quarter of an inch in length. This was succeeding some, but they were not as good as he desired, and he began to cudgel his brain for something better adapted to the requirements of the situation. The result, or rather one of the results of his cogitations is shown in Fig. 2. A stick *B* about two feet in length was tied to one arm of the sector with cord, and the indicator cord was attached to this. This seemed to be a step in the right direction, for the diagram obtained was somewhat longer than the first, but yet it was not what would be called standard. Then a longer stick was procured. As part of the power generated in this plant was used to drive the machinery of a broom factory, broomsticks were very plentiful and one was brought into service. In order to steady the broomstick and overcome its momentum a cord was stretched from the roomstick and fastened to a post about teen feet away. Near the middle of is cord a 3-inch nut was suspended to ke up the slack. The results with this rrangement were not as good as desired, for the broomstick in swinging over ne in collision with a party who had lected to vacate the right of way, was ken off, the sector smashed, and the broken off short inside the guide rrel.

he method above described having ven a sad failure, the engineer did not e up but with laudable persistence set ut to find other ways to conquer. His xt venture is illustrated in Fig. 3. In e crosshead pin there is a ¾-inch tapped le, into which may be screwed a puller r removing the pin. Into this hole the gineer inserted an eyebolt, into the eye which a long stick, in fact, another oomstick was inserted and secured as own. It will be noticed that the end the stick is inclined downward at an gle of about 45 degrees, and that the indicator cord is led upward from the end of the stick at about the same angle. The reducing wheel was removed, and it was thought that the manner of connecting the cord to the stick at such an angle would give the desired reduction of motion. That some diagrams, if such productions could be so called, were secured, I am reliably informed, but I have never been able to secure one for inspection. They were not considered desirable for keeping, I suppose.

As a result of these experiments the successor of the engineer who carried out these experiments found the indicator motion for one of the engines entirely wrecked, and failure leading to discouragement, the one for the other engine that had not been experimented with had been allowed to lose itself.

In looking over this matter and the line drawings which accompany it, I cannot deny that it appears unreasonable that any man of mature years could be so dense as to employ the methods described, but I assure the reader that the facts related in the foregoing are true.

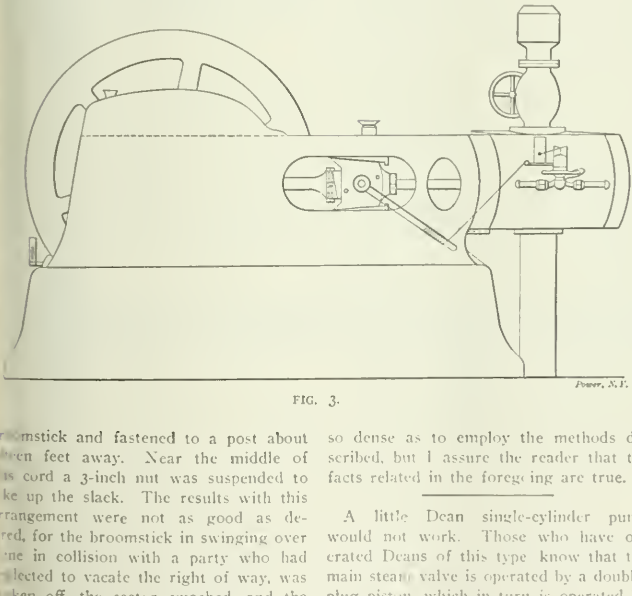


FIG. 3.

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A little Dean single-cylinder pump would not work. Those who have operated Deans of this type know that the main steam valve is operated by a double-plug piston, which in turn is operated by a little gridiron valve. Now this last valve, aside from a little groove that is cut in the face, looks as if it made no difference which end went fore or aft. The pump had been taken apart and put together a couple of times, still when steam was turned on it would not budge. In taking the machine apart for the third time and studying the workings, it was found that it did make a difference which way the valve was put in. That if it was put in upside down the groove failed to connect with the exhaust port, and hence the reason for the pump not working. After this was corrected the pump worked like a "charm."

# Detection of Defects in Shafting and in Its Alinement after Erection

By Charles C. Klein

In spite of constant care in the manufacture of machinery for transmitting power, it often happens that defects appear after erection and as soon as the machinery is put in motion. It is the practice in some of the best shops to erect every line shaft upon the floor before shipment, and to test it by running it up to or beyond the speed which it is ultimately to have. Unquestionably, many risks of subsequent trouble are avoided by this system, but chances of injury in transit from the shop to the place of erection are yet to be met.

A shaft 2 inches in diameter and 20 to 24 feet long is a rather delicate piece of machinery and requires the most skilful handling. If such a piece of shafting is laid upon the floor on one day and, through carelessness, a piece of one inch board is left under it across the middle, it is likely that, upon erection the next day, it is found that the shaft has a long bend in it. Or, if the shafting to be erected lies upon the floor under the scaffolding, and a monkey wrench or hammer is accidentally dropped upon it, a decided "kick," when it is put in motion, is to be expected at the point where it was struck. Especially would this be the case if the shaft were raised slightly at the point where it received the blow.

Defects which exist in shafting and in its alinement usually manifest themselves through the eye, the ear and the touch, but in many cases the discoveries made by these senses are simply symptoms of a defect which may elude for a time the grasp of the engineer or the practical millwright. A bend in a shaft or a defect in a coupling may be transferred through the spaces between adjacent hangers 40 or 50 feet; the knock or screech which is so strongly perceptible at one point may have its origin at quite a distance from it, and the heat which the casual touch detects, and to which the smell of burning grease also bears testimony, may be caused by widely different defects.

The writer will endeavor, by the aid of greatly exaggerated drawings, to follow up the symptoms as they exhibit themselves to the eye, and determine from them the nature of the defect and its location.

In a transmission system, as long as no other motion than that of rotation appears, it may be said to be in good condition, but as soon as incidental motions manifest themselves they are a sure indication of defects in the shafting or in the couplings. The nature of these incidental motions which may appear either in the bearings or in the shafting, gives [illegible] a very correct clue to the existing defect and assists also in locating it.

of round" or not parallel, and yet no indication will be given thereof by incidental motion. But as soon as defects exist which disturb either the true axial

motion is often termed "yanking." Apparently it is caused by two opposit bends in the shaft, one at each end of th bearing but actually a single bend in :

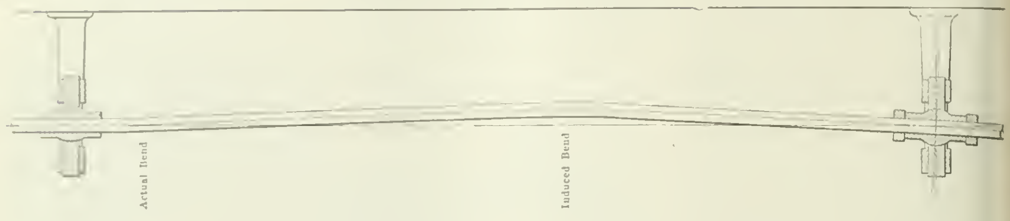

FIG. 1

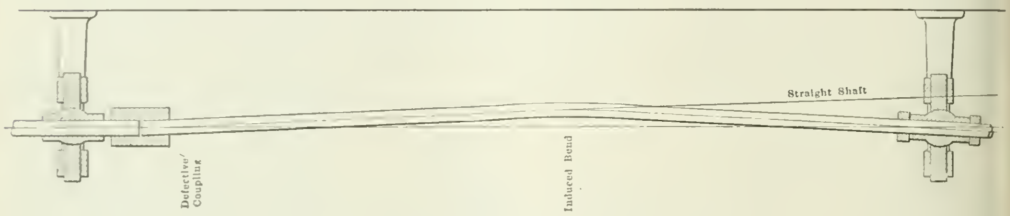

FIG. 2

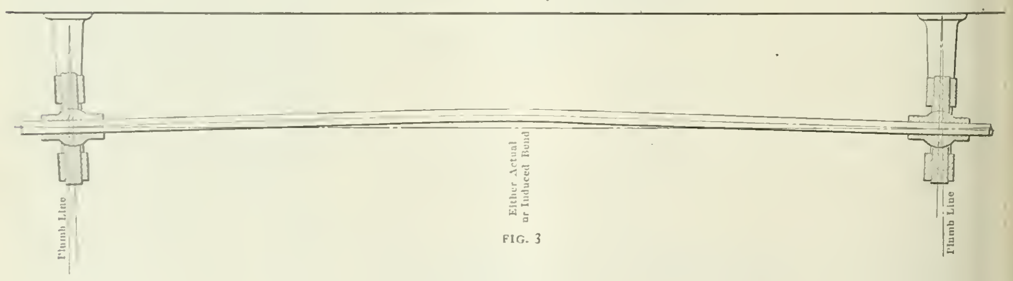

FIG. 3

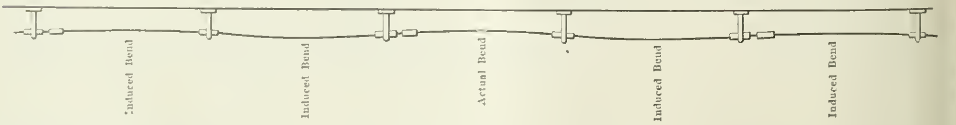

FIG. 4

Power, N.Y.

ECCENTRIC MOTIONS OF HANGER FRAMES AND BOXES

In many cases a vibratory motion in a hanger or in its box conveys the idea to the inexperienced that a defect exists in the hanger itself. Such is not the case, however, for no amount of imperfection in a bearing will cause it to have any motion. The bore of a box may be too large or too small; it may be "out line of the shafting or which will cause even the slightest eccentricity in it, they will at once appear to the eye when the shafting is in motion.

The most common of these incidental motions is that in which the ends of a ball-and-socket hanger box describe small circles around the true axis, the eccentricity at one end being opposite to that on the other. In millwrights' parlance, this shaft or a defective coupling may b the cause and the defect may be locate quite a distance from the spot where th symptom appears. This will be made clea by Fig. 1. The single bend which exist in the shaft on the right side of the firs hanger affects the shaft in such a wa that the hanger box in the second hange is compelled to swing in its ball-and socket joint.

### Defects in Coupling

In Fig. 2 precisely the same effect is produced on the hanger box, although the piece of shafting is perfectly straight. Here the defect lies in the coupling in which the hole is not straight or parallel or in which another defect exists which prevents the axis of the coupled shaft from coming true with the rest of the line. Straining the shaft into the hanger produces temporary flexure, which may disappear when released from the hanger or when loosened in the coupling. The quickest remedy is the displacement of the defective coupling by a perfect one.

An exceedingly small defect in the bore of a coupling will produce very ring symptoms in light shafting, as the discrepancy multiplies itself in the ratio of half the length of the coupling to the length of the shaft. Thus a shaft 1½ inches in diameter and 18 feet long, entering a coupling 3 inches, will be thrown out of line at its extreme end nearly ¾ of an inch by a discrepancy of only 0.01 of an inch in half the length of the coupling.

### Oscillation of Hanger Frames

The defects shown in Figs. 1 and 2 do not always produce the "yanking" motion of the hanger bearings, such motion being limited to the ball-and-socket type and to such bearings as have grooves worn into them circumferentially and are thereby prevented from sliding lengthwise upon the shaft. Collars upon the shaft at each end of the hanger box also prevent endwise motion upon the shaft.

When, however, both shaft and bearing are perfectly smooth and well lubricated and when tightness or imperfection of the ball-and-socket joint prevent its motion, the perceptible motion of the hanger frame and box may be a pendulum-like oscillation of the former and a sliding lengthwise upon the shaft of the latter. This motion is caused by the tendency of the hanger to maintain a perpendicular line with the axis of the shaft, as shown in Fig. 3, and should always be taken as an indication of the same defects as those shown in Figs. 1 and 2. This pendulum-like motion produces, of course, a very severe strain in the hanger frame.

### Defects Affect Distant Parts

The bend in the shaft in Fig. 1 and the defect in the coupling Fig. 2 may show themselves not only where these faults are localized, but in spaces between the hangers quite a distance from the source of the disturbance, owing to the transfer of the bend through straining from one hanger to the other, as is illustrated in Fig. 4. This transference may take place either on one side or on both sides of the point where the defect exists, but it may be taken as conclusive evidence that the true location of the defect is where it shows the worst.

### Detection of Defects by Noise

Another class of defects in shafting is detected by the ear. The symptoms are generally known as "knocks" and "screeches." Shafting which is more or less "out of round," and especially that which has defects diametrically opposite, approaching an elliptical form, gives most frequent rise to "knocks." The defects are introduced in turned shafting by a poor or too loosely-set steady rest, and in cold-drawn shafting by defective dies. There is no other remedy than to replace the defective shaft by a round one, or to "doctor" the bad spot with a dead-smooth file, by taking the glazed spots off from time to time, until approximate roundness is secured. Such a proceeding as this, however, is not advisable, except in rare cases, as the extreme cheapness of cold-rolled shafting offers more inducement to buy a new shaft than the expenditure of a large amount of labor to eliminate a defect.

Knocks may also be caused by the contact of rough, unfaced surfaces moving upon the ends of hanger boxes, couplings or hubs, or even by finished but untrue collars.

In shafting running at a high speed, knocks may be caused by unbalanced parts in the transmission in conjunction with a bearing which is too loose a fit. Obviously the remedy in this case lies in the perfect balancing of the moving parts and a close running fit of the bearing.

A "screech" is usually caused by moving parts in contact without a lubricant between them. If the screech is in a bearing where the motion is intentional, thorough lubrication will promptly effect a cure, but occasionally the noise proceeds from a coupling or other part which, under normal conditions, is rigid and free from motion upon the shaft. Remedial measures should not stop at tightening the loose member, but efforts should be made to discover the primary cause of its becoming loose. When that is discovered and removed, the time required in tightening up in future will be saved.

It is very rarely the case that a blow or knock perceptible to the touch cannot be detected by the ear and, therefore, the only symptom of defects yet to be mentioned is that of heat.

### The Heating of Bearings

The heating of hanger bearings may result from a variety of causes. A single grain of sand dropping upon a bearing from a nearby mortar joint may make such havoc with it that dangerous heating and rapid destruction is the consequence. Defective lubricants or inferior means of applying them are also a prolific source of heat, but we will confine ourselves to inherent defects of construction and erection from which this trouble may be expected.

A hanger box bored so small that it would not admit the shaft, if the box were not made in halves, should be avoided, for it would pinch the shaft at the edges of the halves so tightly that quick and destructive heating would be the inevitable consequence. A box bored too large is equally objectionable as, in this case, the shaft would have a bearing only upon a line instead of on a surface. The half of a hanger box, if rubbed upon a lightly greased shaft, should show touch marks on every part of its interior surface, but a box one-thousandth of an inch above standard size in its bore is to be preferred to one which is one five-thousandths of an inch below.

Other causes of heating may be found in boxes not bored parallel or cylindrical, by which sufficient surface is lost to make the pressure upon the remaining bearing excessive, or neglect to remove the bur left by the drilling of oil holes may cause a hot box to make its appearance.

In the erection of shafting, heating of the boxes is often induced by drawing up the vertical adjusting screws too tightly, thereby pinching the frail box upon the shaft so firmly that the excessive pressure and consequent exclusion of lubricant soon start the generation of heat. Excessive pressure upon a bearing, caused either by its being out of line or by undue tightness of a belt, is a frequent cause of hot boxes.

Improperly fastened collars may also contribute to the trouble. Ample play should always be left between the ends of the hanger box and the collars, as a slight motion of the shaft endwise is not a detriment but rather a benefit, insofar as it helps to produce, in conjunction with the revolving motion, that smooth, glazed surface upon the bearings which is so desirable. Two collars upon the shaft, one at each end of the box of one hanger, should be depended upon to keep the line in place endwise, and it is advisable to put these upon the heaviest shaft in the line.

While it is prudent to put also a collar at each end of the line, inside of and bearing against the box of the end hanger, as a precaution against accident by a shaft pulling out of a coupling, care should be taken, as already mentioned, to leave sufficient room between the collar and hanger box to permit the expansion of the line. The longer the line is the more playroom should be allowed.

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There should be placed in the feed pipe to each boiler a check valve and a stop valve, the stop valve being between the check valve and the boiler, so that repairs can be made to the latter while the boiler is under pressure. Feed pipes and check valves should always be arranged so that the water cannot back out of one boiler into another. The main return pipe to a heating boiler (gravity-return system) should have a check valve, and between this check valve and the boiler there should be placed a stop valve.

# Uncle Pegleg's Philosophy

## I Find Out the "Why" of the Rule for Areas of Circles. Where the Decimal 0.7854 Comes from and a Short Cut in Multiplication to Use It.

"I've figured out why that boiler had single-riveted roundabouts and double-riveted lengthwise seams?" asked Pegleg a day or two later.

"Oh, I figured out that the pressure is trying to push the boiler apart endwise by pushing on the heads, and the girth seams are holding it that way, and it's trying to burst it lengthwise by pushing on the sheets, and the lengthwise seams hold it that way, and there's more sheet than there is head, so there's more pressure in that direction, and so it takes a double row of rivets to hold it."

The old man smiled a quiet smile.

"ALL YOU'VE GOT TO LOOK OUT FOR IS TO HAVE THE RIGHT HAND FIGURES GO DOWN LIKE A FLIGHT OF STAIRS"

"That's pretty good speculating," he said. "Now do some reasoning. A whole lot of folks speculate and that's what makes most of the engineering asininities. If a boiler was twice as long it would have twice as much shell, wouldn't it? Well, would it be twice as liable to burst?"

I allowed that it wouldn't.

"Why not?"

I didn't see and wasn't quite so sure that it wouldn't after all.

"You've got more metal to hold it together, haven't you?" he suggested. "Imagine your boiler divided into rings an inch long. You have the pressure on that inch strip of shell tending to burst it, but you have an inch length of metal or of seam on each side to hold it together. Each ring takes care of itself, so it don't make any difference how long the boiler is.

"Now, to pull it apart lengthwise you have the pressure on the head, and to hold it together you have the ring of metal that would be exposed or parted if the boiler was sawn or pulled in two if it was a cylinder without joints; or you have the girth seam in a boiler. What you want to figure is how the metal or seam that has to do the holding compares with the bursting force in the two cases.

"I will make it easy for you. Suppose you have a plain cylinder, headed up, so that we get rid of all idea of joints and tubes. How would you find the pressure on one of the heads?"

"Multiply the pressure per square inch by the number of square inches in the head."

"Good! Now, do you know how to find the number of square inches in the head?"

"Multiply the diameter by itself and by 0.7854," I answered, quoting with self-satisfaction a rule I had cut out and pasted away.

"Why do you multiply by 0.7854?"

"Because the rule says so."

"Oh! I see. What do you get whe
you multiply the diameter by itself?"

"The square."

"What square?"

"The square of the diameter."

"Yes, you get the area of a square lik
this (Fig. 1), each side of which is a
long as the diameter. The area of th
circle is some less than this becaus
the corners (*a b c d*) come out, an
somebody has found out that the are
inside of the circle is 0.7854 of the are
of the whole square, eh?"

I was beginning to see new sense to th
rule.

"Do you know how to get the area o
a triangle?"

While I was puzzling over it, I
sketched and handed me Fig. 2.

"Is it plain to you," he asked, "that
you multiply the base of a triangle by i
hight you get the area of a square o
rectangle *a b c d* in each case; and n
matter what the shape of the triangle
will just fill one-half of the rectangle
It's plain enough in the first case isn't it
Just as plain in the second, eh? We
take the piece *A* that sticks outside of th
rectangle in the third case and turn
over into the space *B* and it will be ju
as plain for that case.

"The area of a triangle then is on
half the product of its base and altitud
Is that plain?"

"Yes. Multiply the width and higl
together and divide by 2 and you get th
area."

"Correct! I said 'base' and 'altitud
because that's the way the books o
geometry and trigonometry speak o
them. Know what trigonometry is
Know what 'tri' means? Know what
triplex pump is?"

"One with three cylinders."

"Sure. And 'tri' means three. Loo
in the dictionary and you will see a lot
words commencing with 'tri': triplicat
and so forth, all with the 'three' idea
them. 'Gono' means angle. 'Metry' mea
measurement. 'Thermometry,' the mea
urement of temperature; 'calorimetry' th
measurement of heat; 'trigonometr
measurement of or by the triangle.
big word but simple enough when yo
pick it apart. Well, I'll let you have yo
'hight,' if you prefer it to altitude, b
I am going to stick to 'base' instead
width because some triangles, like t
last case here (Fig. 2), are wider tha
their bases."

"Now," continued the old man, sketc

ing and handing me Fig. 3, "it wouldn't make any difference, would it, if the triangle had a curved base like this? What it loses at *a* it gains at *b*, don't it?"

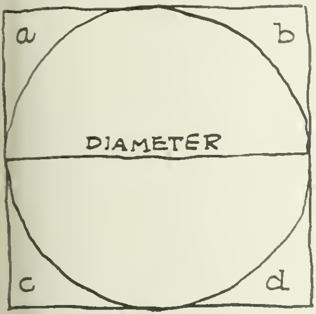


Fig. 1.

I said that it looked like it, and he assured me that it could be proved if I understood geometry.

"No matter what size a circle may be, the circumference is a certain number of times the diameter. We have no exact expression for this number of times, be-

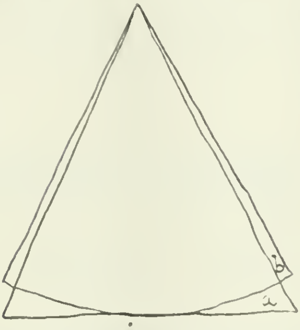


Fig. 3.

cause it doesn't come out even, at least so far as it has been figured out. Here is a fellow (reaching down a book and

Generally 3.1416 is used. We take 3.1416 instead of 3.1415 because 3.14160 is nearer to 3.14159 than 3.14150 would be. Always when you drop a decimal raise the last figure that you keep by 1 if the part rejected is more than 5."

"What is that rule for the triangle again?" he continued.

"Multiply the base by the hight and divide by 2."

"Right. Now considering the circle as a triangle, or equal to a triangle, what is the base?"

"3.1416 times the diameter."

"What is the hight?"

"Half the diameter."

"Right. Now, we have got to multiply the base, 3.1416 × diameter, by one half the diameter, and divide by 2:"

$$3.1416 \times diam \times \frac{diam}{2} : 2.$$

You know that to divide a fraction you multiply its denominator. To divide $\frac{diam.}{2}$ by 2 we write:

$$\frac{diam.}{2} : 2 = \frac{diam}{2 \times 2} = \frac{diam.}{4}.$$

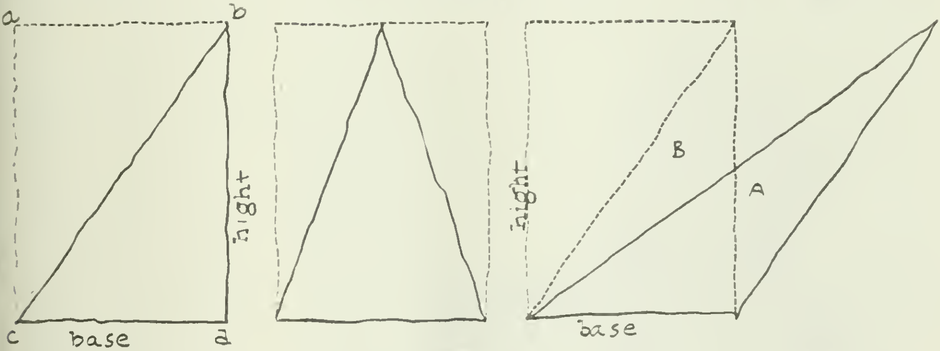


Fig. 2.

"Allowing that it is so, it is just as e of a wide as of a narrow triangle. t as true of this (Fig. 4) as of the g. 3."

I supposed so.

"Well, where are you going to stop?"

"I'm not going to stop," I returned gl ngly, for want of something better say.

That's right, don't. It is just as true a half circle as of a quarter, and just true of a whole circle as of a half. A le is nothing but a triangle with a rved base equal to its circumference l an altitude or hight equal to its ius, or half of its diameter."

couldn't see how a circle with no gles at all was a triangle, which according to its name ought to have three.

"Well, let's put it this way, then. The a of a circle is equal to the area of a angle having a hight equal to the radius the circle and a base equal to its circumference."

After a little study of the pictures I owed that this was so.

showing me the place), who figured it to 127 decimal places and still had a remainder: 3.14159265358979323846264338327950288419716939937510582097494459230781640628620899862803482534211706798214808651328230664709384460 +. In 1873 a Mr. Shanks carried it out to 707 places.

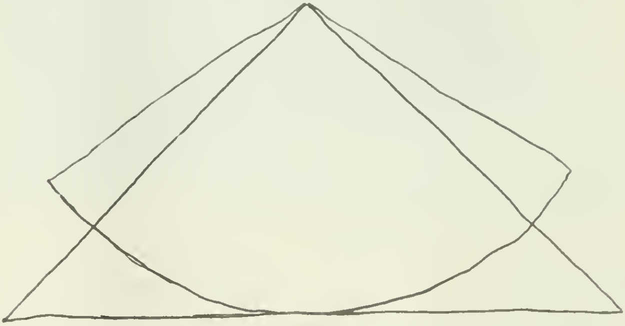


Fig. 4.

To multiply a fraction we multiply its numerator:

$$3.1416 \times diam. \times \frac{diam}{4} = \frac{3.1416 \times diam \times diam}{4},$$

and ¼ into 3.1416 = 0.7854, so that the formula comes out:

*Area* = 0.7854 × *diam.* × *diam.*

just as you had it."

"Gee," I said, "a feller that knows that trick can't need rules. He can make 'em."

"Well, somebody's got to make them. Multiply 4239 by 0.7854."

I did it the usual way, and he started to do it at the same time. Long before I was through he sat waiting for me and passed me this:

```
      4239
         7
     -----
     29673
      29673
       59346
        59346
    ---------
    3329.3106
```

The answer was the same as mine but he had done it much more quickly.

"What kind of figuring is that?" I asked.

"Well, I multiplied by 7 first, then I wrote the same product one place to the right, then I doubled it, going one place to the right again; 59346 is twice 29673. Then I wrote the same figure again still another place to the right. Then I added them up and pointed off four places of decimals because that's what there is in 0.7854. All you've got to look out for is to have the right-hand figures go down like a flight of stairs. You will get it right when you write the second figure because you set this one place over anyhow. Now, when you multiply by 2 put the unit figure (6 in this case) one place farther still, and you can't go wrong. If the first two figures of the number you are multiplying are 72 or more, there will be one more place in the doubled product. For instance, try it on

```
      8763
         7
     -----
     61341
      61341
     122682
       122682
    ---------
    6882.4602
```

You see 122682 has 6 figures in it and 61341 only 5. What I want you to be careful about is to put that unit figure (2 in this case) one place to the right so that the figures on the *right* go up like a flight of regular stairs, each line one place farther to the right on this side. Never mind how they go on the other side; sometimes they will be regular like the first example and sometimes irregular like the second."

"But why does that multiply by 0.7854; just happen to?"

"That's the spirit. Get to asking 'Why?' No! Nothing 'happens so.' I suppose it's too much for you to dig out yet, but its simple when you know it. The first time I multiplied was by 0.7; then I multiplied by 0.07, because I used the same product one place to the right. If I had used the same product still another place to the right, I should have multiplied by 0.007, but I used twice this product, which was multiplying by 2 × 0.007 or 0.014, and then I multiplied by 0.0014 by using this product still another place to the right. Altogether I multiplied by

```
 0.7
 0.07
 0.014
 0.0014
 ------
 0.7854
```

Now, take these along and get them into your noddle and the next time perhaps you can figure out that boiler and know how you are doing it."

# Friction in Water Pipes

By R. M. Neilson

Many formulas are given for the loss of head due to friction in water pipes, and it is well known that the results given by these formulas differ very greatly, so that an engineer has great difficulty in determining the requisite size of pipe to convey a given quantity of water a given distance in a given time with a given loss of head, or in estimating what the loss of head would be with a given size of pipe. In this connection previous experience under similar conditions has generally been found to be immensely more valuable than all the formulas obtainable; and this is quite comprehensible when one knows that the friction may be several hundred per cent. greater in one pipe than in another of exactly the same internal diameter.

If often happens, however, that frictional head has to be estimated without previous experience, and the designer must then rely on a formula. In such a case particularly, but generally—although possibly to a less extent—in all cases, it is of advantage to understand the manner in which the frictional head varies with varying conditions.

Most formulas for the friction in water pipes are of, or can be readily converted into, the form,

$$H = \frac{L Q^2}{K \times 10^6 D^5}, \qquad (1)$$

or

$$H = \frac{v^2 L}{k D}, \qquad (2)$$

where

$H$ = Frictional head (or loss of head by friction) in feet.

$Q$ = Gallons of water per hour.

$L$ = Length of pipe in feet.

$D$ = Diameter of pipe in inches.

$v$ = Velocity of water in feet per second.

$K$ and $k$ are coefficients, the values of which vary greatly in different formulas.

Formulas (1) and (2) are really the same and can be converted one into the other. This will be obvious when it is considered that

$$v = \frac{Q}{6.24 \times 60 \times 60} \div \frac{\pi D^2}{4 \times 144} \qquad ($$

Formula (1), as being generally tl more useful, will be considered; but will be obvious that the following r marks can be applied with suitable mod fications to formula (2).

Most formulas make out $K$ to be i dependent of the diameter of the pip This is approximately correct for larg diameter pipes—say about 8 inches diameter—but is very far from corre for small pipes. Comprehensive exper ments were made by Darcy who, as result, gave a formula as follows:

$$H = Z\left(1 + \frac{1}{12\,d}\right) \times \frac{4\,L}{d} \times \frac{v^2}{2\,g}, \qquad ($$

the letters representing the same quant ties as in formulas (1) and (2) exce that $d$ is in feet, $g$ is the acceleration d to gravity and $Z$ is a coefficient. Dar gave values for $Z$ for different pip For new cast-iron pipes he gave $Z$ a val of 0.005. Darcy's formula is not so co venient to use as formula (1), but shows that $K$ in formula (1) is ve much dependent on $D$ in pipes of sm diameter.

Formula (1) will give the same valu for $H$ as Darcy's formula applied to ne cast-iron pipes if $K$ is given the follo ing values for the following pi diameters:

| $D$ | $K$ | $D$ | $K$ |
|---|---|---|---|
| 0.5 | 1.27 | 4 | 3.05 |
| 0.75 | 1 63 | 6 | 3.26 |
| 1.0 | 1.90 | 8 | 3.38 |
| 2 0 | 2.57 | 10 | 3.46 |
| 3.0 | 2.85 | 12 | 3.51 |

By supplying in formula (1) the val of $K$ given in the table, the frictior head can be obtained for new cast-ir pipes. This method of obtaining the fr tional head may appear to be clum from a mathematical point of view, but practice it will be found to be convenie It cannot be expected to give absolut accurate results in every case becau cast-iron pipes differ much among the selves. Moreover, exact dimensions regards bore are not to be expected cast-iron pipes; and a small increase decrease in bore makes a consideral difference in the frictional head. The of the formula as suggested will, ho ever, allow one to rely on obtaining much more accurate estimate of the fr tional head than is possible by the use any formula simpler than Darcy's.

For pipes with internal surfa smoother or rougher than those of n cast-iron pipes, the values for $K$ giv in the table should be increased diminished by multiplying by a qualify coefficient or factor greater or less th unity as the case may require. The wri regrets that he cannot mention suital qualifying coefficients that he knows fr experience to be reliable.

# A Common Type of Electric Elevator Machine

## Construction and Operation of One of the Early Otis Designs, with Details of the Stop-motion Mechanism and Magnetic Safety Attachment

### BY WILLIAM BAXTER, JR.

The Otis Elevator Company has de- ped many types of electric elevators. e of the earlier designs, which has n extensively installed, is shown in 61. In this machine both the con- ller (which is mounted upon the t r), and the brake are operated by bar *A*, which is moved by the rota- n of the operating sheave *C*, mounted the end of the shaft of the winding n *D*. The sheave is not rigidly se- ed to the shaft, but is rotated by the r through the action of the stop-mo- mechanism in a manner that will ently be explained. The brake, which cated back of the stand *B*, is applied the weight *W'*, and is released by the ment to one side or the other of lever *B'*, by the horizontal motion of bar *A*.

he stop motion, which is located at operates on substantially the same ple as that of the Haughton ma- e which was fully described in the last ; in fact, most stop motions work the same general principle. The gear portion of which appears under the ve *C*, is a part of the stop motion. weight *W"* is a portion of the slack device and acts through the stop ion to stop the machine if the cables me slack. It will be noticed that at ere is a shaft that carries an arm *J'*. the opposite end of the drum there is er arm *J'* mounted on the shaft *J*, between the lower ends of these two a shaft *K* is carried, on which a grooved wheel *K'* revolves freely also moves along the shaft. The g ropes run up in the groove in this l The arm *J"*, which is also ted on the shaft *J*, carries at right-hand end a weight which s the wheel *K'* against the lifting s. From the left-hand end of the r *J"* a chain runs upward and over heaves shown, and thence down to th lever of the slack-cable stop upon the weight *W"* is mounted, thereby ng this weight up. If the lifting become slack, the weight near the will drop and raise the left-hand end e arm *J"*, slacking the chain and al- ng the weight *W"* to descend. When weight descends it moves a clutch locks the stop motion and causes the l to move toward the central posi- and stop the rotation of the drum *D*. The position of this clutch is shown in e drawings, Figs. 62 and 63, and is ed *G*.

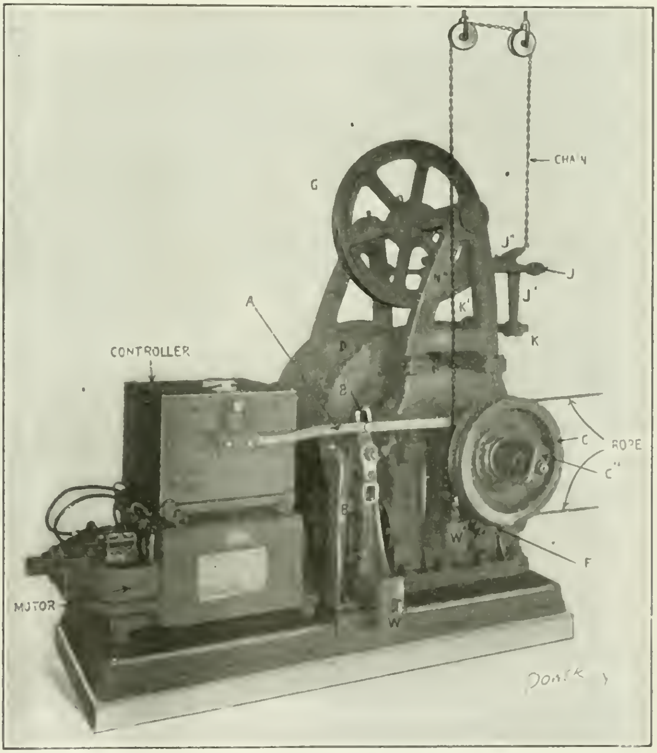


FIG. 61. AN EARLIER FORM OF OTIS ELECTRIC-ELEVATOR MACHINE

In Fig. 63 the yoke that moves the clutch is shown at *G'*, and to the lower end of this is attached the bar that carries the weight *W"* of Fig. 61. The left-hand half of the clutch revolves with the drum shaft, but can slide freely endwise, a feather being used to prevent independent rotation. When the slack cable stop goes into action the movable part of the clutch moves to the right and engages with the part that extends through into the hub of the sheave *C* and is fastened to it; hence, the sheave is rotated, and through it motion is imparted to the gear *F*, and through this *C"* is moved and this part in turn moves the operating bar *A* Fig. 61, to stop the motor. This can be made clearer by the aid of the drawings of the stop motion, but before passing to these it is best to consider another slack-cable device, shown in Figs. 62 and 63, at *H*, *H'*, and *H"*. The bar *H* is located under the drum, as shown in Fig. 63, and with the side extension *H'* is supported on a pivot at *H"*. On the outer end of *H'* there is a switch that is normally kept closed by the weight of a cap that covers it When the ropes on the drum become slack and drop down upon the bar *H* their weight overcomes the weight that holds the switch closed, and opens it, breaking the circuit of the motor and causing it to stop. The construction of the slack cable switch and that of the bars *H* and *H'* can be seen in Fig. 64, which shows the switch in the open position.

Figs. 65 and 66 show the details of the

[illegible] the first being a [illegible] with the shaft and [illegible] with the operating [illegible] except the [illegible] The [illegible] which the gear F rotates, [illegible] F' which is carried around by the gear but is not made fast to it. The gear F is [illegible] with a lug, shown on the upper side, and this projects over the [illegible] of F' and moves between [illegible] on F'. By means of this construction there is a certain amount of lost motion obtained between F and F', the object of which will be presently explained. The part C' rotates freely upon the sleeve extending from the right hand half of the clutch G, and as may be seen from Fig. 66, C' meshes with F'. Now if the operating sheave C is rotated, the pinion F'' will be rotated as it is a part of C; hence, the gear F will be rotated, but as there is a certain amount of lost motion between the gear F and the pinion F' the former will move some distance before the latter will begin to move at all. As soon as F' begins to move, C' will move and the control bar A will be shifted. When the operating sheave C has been rotated far enough the pinion F'' will rotate the gear F [illegible] to bring one of the cam faces on top and the corresponding face [illegible] on the pinion F'' will slide over this [illegible] and the gears will be locked in this position, which is the running position; if the sheave C is turned around any farther it will simply cause the surface [illegible] to slide on the [illegible] surface [illegible].

The lost motion between the gear F and the pinion F' is provided to make it necessary for the operating sheave C to be turned a considerable distance in either direction before the controller begins to move. If this provision were not made, it would be difficult to stop the car by means of a hand rope because if the operator did not move the rope far enough, the controller would not be returned to the full-stop position, and if he moved the sheave a trifle too far the controller would be carried over to the reverse direction of rotation, and the car would then stop and immediately start to run in the opposite direction. This type of stop motion is called a "lost-motion stop motion." If the elevator is intended to be operated by means of a hand rope, the lost motion is made much greater than if it is to be operated by means of a wheel or lever in the car, because with the latter type of operation the operator can see by the position of the wheel or lever when the controller is in the "stop" position.

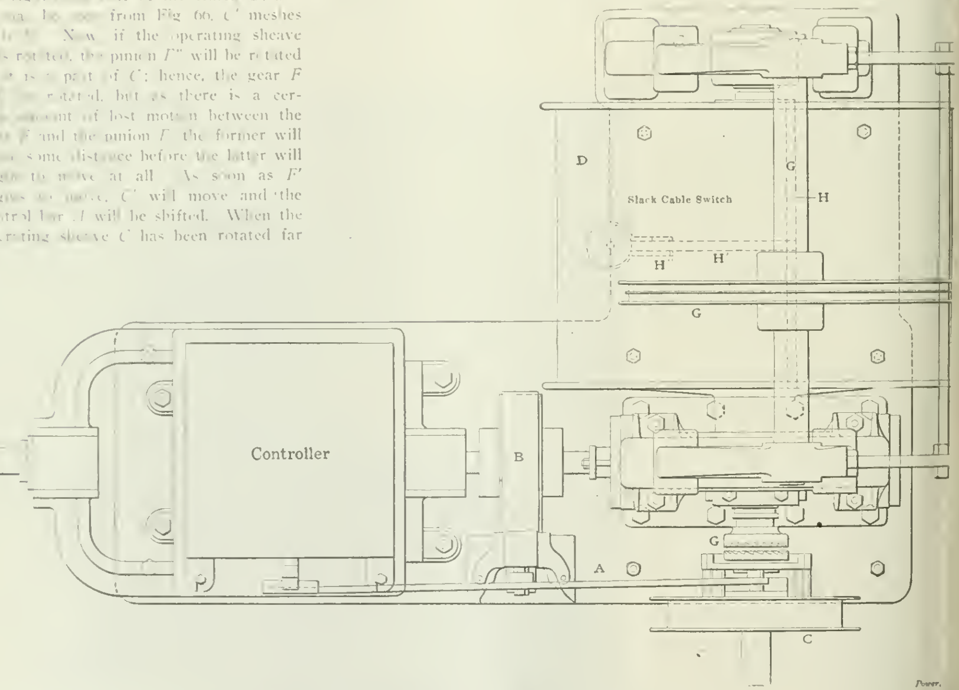


FIG. 62. PLAN VIEW OF THE ELEVATOR MACHINE IN FIG. 61.

The construction and operation of the brake of the machine in Fig. 61 is illustrated in Fig. 67, which shows an elevation at right angles to the shaft and a front view. The brake bands are attached to bolts pivoted at G in the upper end of a stand placed at the back of the brake wheel; the front ends of the bands are pivoted to the lever D, at the points F, F. The lever D swings around the stud E and is depressed by the weight shown at W in Fig. 67. The brake bands are raised away from the brake wheel by upward pull of the rod C, which is actuated by the lever A. It is evident that no matter in which direction A i be moved, the coupling B will be rai and when this is raised it lifts the ro This rod is not tight in B, but it slide freely, and is provided with a through the upper end, so that B move upward some distance before raised. This is done because the dist through which A is rocked by the trol bar to give the controller the pr movement is more than is necessary raise the brake bands. When the leve is returned to the stop position, as sh in the drawing, B compresses the sp around C and assists the weight on D to apply the brake. If the brake not stop the rotation of the shaft

quickly as may be desired, the weig moved toward the end of D to inc its leverage, and *vice versa*.

This brake, as generally made, is ped with a safety device that ac stop the car if the circuit outside motor is broken or if the current s should fail while the car is running when the motor is raising the loa operating current dies out, the car stop, and if the worm through whic motion is transmitted from the mot the drum is of very coarse pitch, would be for a high-speed elevator weight of the car is liable to cause run down and drive the elevator chine backward. With the safety

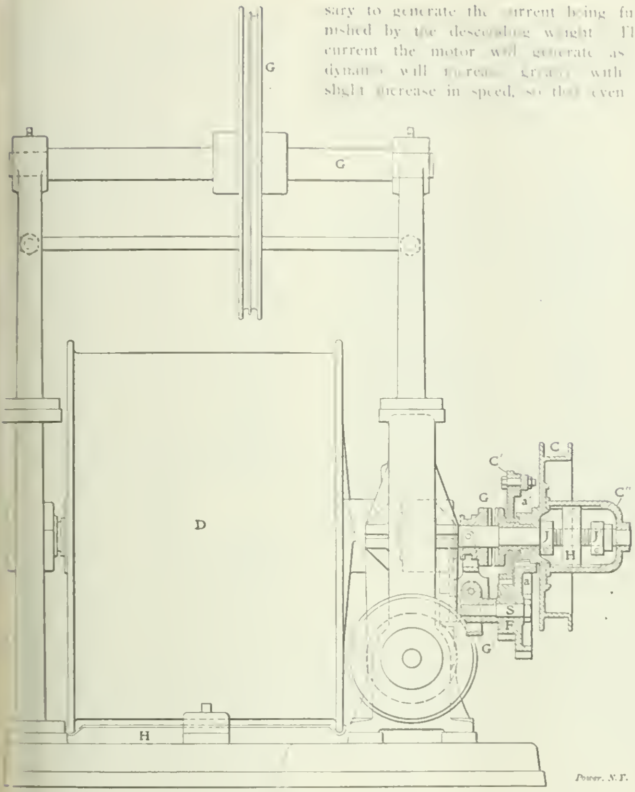


FIG. 63. END ELEVATION AND SECTION OF CONTROLLING MECHANISM

ned this cannot occur, because as as the current dies out the safety goes into action and applies the

when the car is running down l, under the influence of gravity, ircuit outside of the motor should roken in any way, the car would

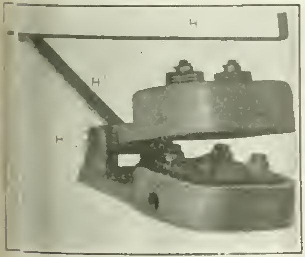


FIG. 64. SLACK CABLE SWITCH

away, unless restrained. As long as ircuit remains closed, however, the annot run away because the motor ct as a dynamo when driven slightly normal speed, the power necessary to generate the current being furnished by the descending weight. The current the motor will generate as a dynamo will increase greatly with a slight increase in speed, so that even if the car were heavily loaded it would not drive the motor much above the normal running velocity. This is true so long as the outside circuit remains closed, because the current generated by the motor will circulate in this circuit, but if the circuit should break, there would be no circuit for the generated current to flow into, and there would be no resistance to retard the motion of the car, hence, it would run away. In such a case, however, the safety device referred to would apply the brake and hold the drum from rotating.

This safety device consists of a magnet

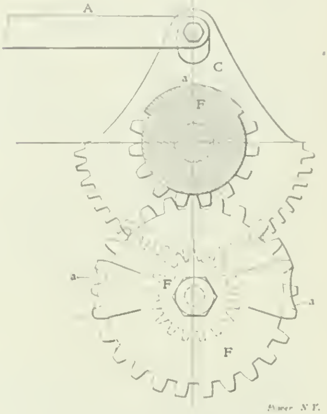


FIG. 66. END VIEW OF STOP-MOTION MECHANISM

that is located in the stand at the back of the brake wheel and acts to throw the brake on whenever the current that operates the motor dies out. The way in which this magnet is arranged and its action can be understood from Fig. 68. The magnet M is so connected that it is energized all the time the elevator is in service, the closing of the main line hand

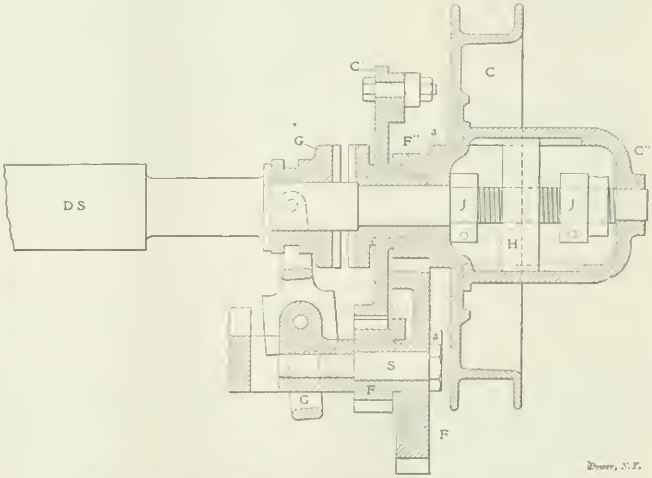


FIG. 65. VERTICAL SECTION THROUGH STOP-MOTION MECHANISM

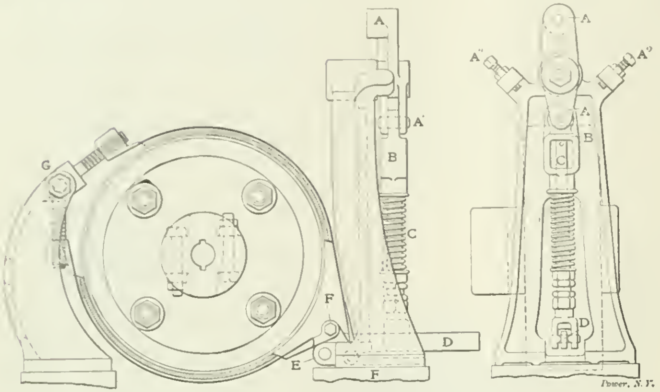


FIG. 67 BRAKE MECHANISM USED WITH MACHINE IN FIG. 61.

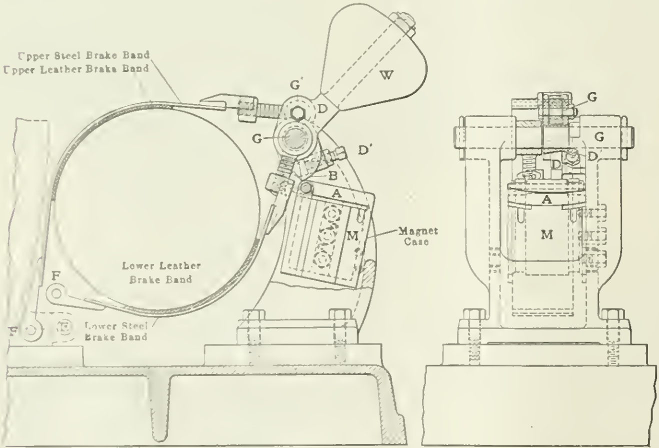


FIG. 68. MAGNETIC SAFETY ATTACHMENT TO THE BRAKE MECHANISM

switch to turn the current onto the elevator motor connects the magnet *M* in the circuit, and it remains so connected until the main line switch is opened. As long as the magnet *M* is energized it will hold down the armature *A* in the position in which it is shown in drawing. The armature *A* is provided with a catch that prevents the catch *B* on the casting *D* from moving past it, but if the current through *M* dies out, the armature *A* will raise and then the catch *B* will move clockwise around the pivot *G* under the influence of the weight *W*, and, by pulling on the upper pivot *G'*, will apply the brake and stop the motion of the elevator. When this action has taken place the elevator cannot be operated again until the device is reset, which is done by raising the weight to the position shown, after opening the main-line hand switch, and then closing the switch again so that the magnet may hold *A* in the position in which it is shown in Fig. 68. The way in which the magnet *M* is connected in the circuit will be made clear in connection with the explanation of the wiring diagram that shows the action of the controller.

It will be noticed from Fig. 68 that the safety brake acts independently of the main brake, the latter applying or releasing the brake bands by the movement of the ends that are pivoted to the main brake lever *D* at the points *F* and *F*. When the elevator is running, the pivots *F* and *F* are in the position that releases the brake bands, but when the magnet *M* acts, the pivot *G'* is drawn over to the right and applies the upper band, and the weight *W* is made of sufficient weight to provide all the braking force required.

# Locating Insulation Faults i Electric Circuits

By W. T. Ryan

There is a feeling among most erators of electrical machinery that l crosses, grounds, short-circuits, etc., r very difficult to locate and that it ca be done successfully only by electrical x perts of long practice and conside experience. It is the writer's obje present a few simple methods which cover most of the cases which aris ordinary practice. Too often, wire cables are cut and then tested for f instead of first accurately locating fault and afterward removing it with trouble and expense.

Broken wires, down wires, swi contacts, grounds on steam pipes, are very often easily located by s making an inspection.

### Magneto Tests

Open circuits, short-circuits grounds can often be detected an cated with a magneto. The line tested must be idle and disconnected all other lines. Connect one termin the magneto to the line and the one to the earth. If the magneto the insulation resistance of the line earth is probably between 5000 and ohms, and the line is probably grou The line should next be opened connections and each section tested arately.

If you suspect that the line is cr with another line, connect the ma terminals to the lines in questio the magneto rings, the insulation ance between them is too low and are probably crossed.

The magneto, however, should n relied upon for testing any but circuits. Underground circuits, esp cables, may have sufficient electr capacity to permit the magneto t even though no fault exists.

### Voltmeter or Drop Method

Since the freedom of any circuit grounds and short-circuits depend marily on the insulation resistan easy method of detecting the faul also finding out how bad it is, is to ure the insulation resistance of th pected circuit. If this is found some high figure, depending on quirements of the case, the line n considered all right. If it falls this minimum value, the line is to h sidered faulty. This method may b to measure the insulation resistanc line to earth, from line to line, fr armature coils to the frame of a d or motor—in fact, it may be used termine the insulation resistance b any two conductors.

A voltmeter $Vm$, of known res

*V* is connected across the circuit wires, a shown in Fig. 1. The drop between e er side of the line and the ground ken with the same voltmeter. Let *r* esent the insulation resistance of the *A* and suppose the insulation resist- of *B* to be extremely high, say, sev- undred megohms. The same cur passes through both the voltmeter the ground, hence the current will qual to

$$I = \frac{V}{R} = \frac{E - V}{r}.$$

ing for *r*,

$$r = R \times \frac{E - V}{V} \qquad (1)$$

$r$ = Insulation resistance of the wire *A*,

$E$ = Line voltage,

$V$ = Deflection of the voltmeter when connected between the wire *B* and the ground,

$R$ = Resistance of the voltmeter.

y,

$$r^1 = \frac{E - V^1}{V^1} \times R \qquad (2)$$

e

$r^1$ = Insulation resistance of the wire *B*,

$V^1$ = Deflection of voltmeter when connected between the wire *A* and the ground.

Tl method is all right as long as only wire is faulty. If both wires are r less faulty, which very often is , it is necessary to touch the free d the voltmeter alternately to one re nd then the other and observe h eflections before the insulation re- tai of either wire can be determined. An xamination of Fig. 2 shows at once e two leaks form a closed circuit it the voltmeter now has not only ia in series with it but also one in ral. Suppose for example that the tmer resistance *R* is 100,000 ohms, $E = 00$, $r = 100,000$ and $r^1 = 100,000$. C dir ily the flow of current through e f lts *r* and $r^1$ in series would be 500 ÷ 200,000 = 0.0025 ampere. As soon as the voltmeter is put in the circuit, the joint resistance of the fault $r^1$ and the voltmeter in parallel is 50,000 ohms.

The current is then 500 ÷ 150,000 = 0.00333 ampere. This causes a drop across the voltmeter terminals of

$$V = \frac{(0.0033\tfrac{1}{3} \times 100{,}000)}{2} = 166\tfrac{2}{3} \text{ volts.}$$

Transferring the free lead of the voltmeter to the other line wire, the same result will be obtained. If this value for *V* is substituted in the first and second equations, incorrect values of *r* and $r^1$ will be obtained. For example, the first equation would give

$$r = \frac{500 - 166\tfrac{2}{3}}{166\tfrac{2}{3}} = 200{,}000,$$

which is just twice what *r* actually is.

An electrometer would give the relative drops across the faults and would indicate the relative resistances, but would be no indication of the actual resistance of either fault. When a voltmeter is used as shown, nothing is known of the currents passing through either the fault or the meter; hence, we can get no expression for their relative relationship. However, we can get an expression for the distribution of the line voltage in the circuit. Assuming the free lead of the voltmeter attached to *B*, as in Fig. 2, the joint resistance of the voltmeter and $r^1$ in parallel would be

$$\frac{1}{\frac{1}{R} + \frac{1}{r^1}}$$

and the voltmeter indicates the drop across this resistance, the remainder taking place across the fault *r*. Since the full line voltage is applied to the circuit and is distributed according to the resistance it meets, we have in either test the proportion:

Drop across meter: Drop across the fault in series with the meter: Resistance of meter and fault in parallel: Resistance of the fault in series with the meter.

Expressing this proportion as an equation,

$$\frac{V}{E - V} = \frac{\frac{1}{\frac{1}{R} + \frac{1}{r^1}}}{r},$$

and transposing this to solve for $r^1$:

$$r^1 = \frac{V R r}{RE - RV - rV}. \qquad (3)$$

Transferring the free lead of the voltmeter to *A* and representing the deflection by $V^1$,

$$r = \frac{V^1 R r^1}{RE - RV^1 - r^1 V^1}. \qquad (4)$$

Substituting this equivalent of *r* in the preceding equation gives the rather complicated-looking formula

$$r^1 = \frac{\frac{V V^1 R^2 r}{RE - RV^1 - r^1 V^1}}{RE - RV^1 - \frac{V V^1 R r}{RE - RV^1 - r^1 V^1}};$$

but when this is cleared of fractions it reduces to the comparatively simple equation

$$r^1 = \frac{R[E - (V + V^1)]}{V}. \qquad (5)$$

Substituting in this equation the values obtained in the example given above, the following is obtained:

$$r^1 = \frac{100{,}000[500 - (166\tfrac{2}{3} + 166\tfrac{2}{3})]}{166\tfrac{2}{3}} = 100{,}000$$

which is the correct value.

Similarly,

$$r = \frac{R[E - (V + V^1)]}{V^1} \qquad (6)$$

Equations (1) and (2), although given in several textbooks and in some handbooks, are not of much value unless but one side of the line is faulty. Equations (5) and (6), though not very easy to derive, are just as simple and just as easy to use, and have the merit of being correct.

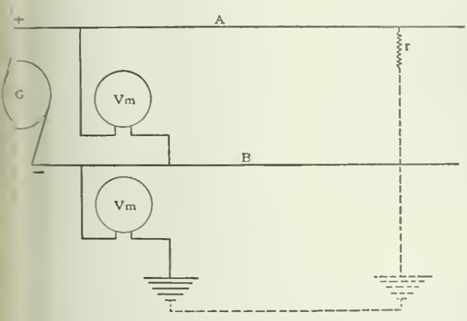


FIG. 1. LEAKY INSULATION ON ONE LINE-WIRE

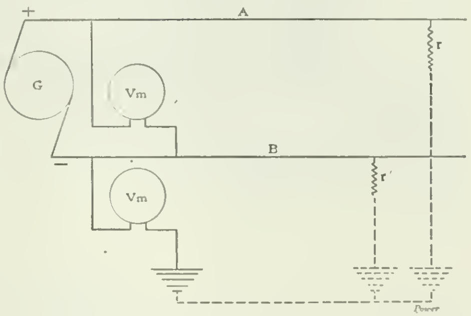


FIG. 2. LEAKY INSULATION ON BOTH LINE-WIRES

## Catechism of Electricity

1103 *Show another alternating-current generator arranged for exciter to be belt driven from the shaft of the alternator instead of being direct driven by it.*

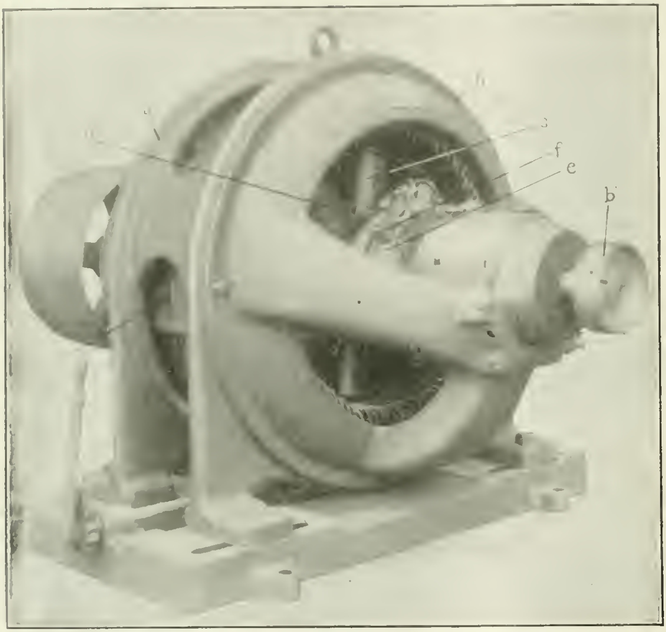


FIG. 338. BELT-DRIVEN ALTERNATOR WITH EXCITER PULLEY

A 200-kilowatt three-phase Fort Wayne alternator is shown in Fig. 338 arranged to be belt driven, and fitted with an exciter pulley *b* for the purpose mentioned.

1104 *Describe this generator.*

The main frame is of cast iron made in two parts *a* and *h*, and bolted together through the sheet-iron laminations *c* of the armature core. The laminations are in sections and have inwardly projecting teeth and projections extending out from the usual symmetrical outside circumference. In these projections are punched the holes through which the bolts pass, clamping the core and the two halves of the field frame together. Air spaces are provided at the ends of the core and between laminations at regular intervals to take advantage of ventilating draft produced by the fanning action of the revolving field magnet when the machine is in operation. The coils are held in place by wooden wedges driven into grooves in the slots.

The revolving field magnet of the alternator is provided with eight poles, fitted into a central laminated spider having a dovetailed joint and taper keys to hold them in position. After the poles are inserted in the spider, end plates are bolted to each end of the core, closing up the joints. The poles are built up of sheet steel, punched to shape and assembled under pressure between two cast-metal end plates and riveted.

The field magnet coils *n, s,* etc., ar
strip copper, wound edgewise and pu
place on the insulated pole before
pole is mounted on the spider. The
tended pole tips on the magnet core
the coil firmly after the pole is in
position on the spider. The field coils
intended for 125 volts excitation.

The collector rings *e*, etc., are mad
cast iron; each ring is in one piece.
bon brushes *f*. are used. The b
holders are held by brass studs insul
from but mounted upon lugs cast on
bearing cap. Each ring has two bru
so that one can be removed for in
tion or replacement without interru
the operation of the machine.

1105 *Describe the principal fea*
*of the type of alternator shown in*
*339.*

This is a low-voltage 225-kil
belted three-phase alternator design
run at 300 revolutions per minute.
built by the Westinghouse Electric
Manufacturing Company. The fra
this type is shown separately in Fig.
It is solid and made of cast iron
dovetailed slots into which the lami
core of the stationary armature is
Openings at *c*, etc., in the back pr
air passages for the ventilation o
core. The frame forms no part o
magnetic circuit, its only function
the mechanical support of the arm
core, as in the machines previousl
scribed. The armature core *a*, Fig.
is formed by assembling dovetailed p

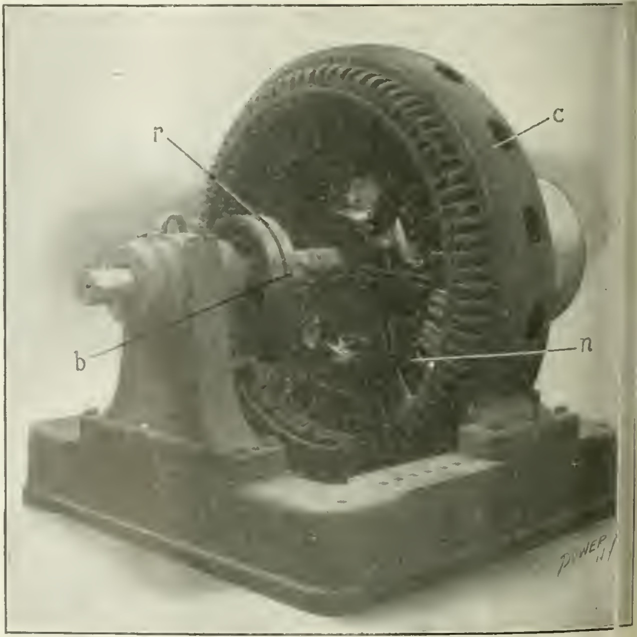
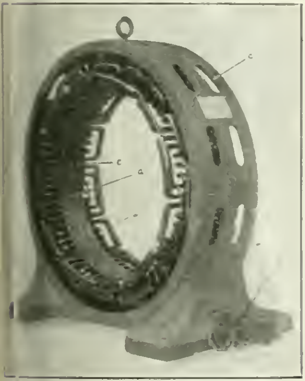


FIG. 339. BELTED THREE-PHASE ALTERNATOR

is of soft sheet steel within the slotted frame. At suitable intervals, depending on the capacity and size of the alternator, the punchings are separated as shown etc., by plates, leaving ventilating s in the core. The punchings are d to receive the armature winding which is of the open type. The coils a separately wound, pushed through the slots and afterward connected. Flexible leads *l* are brought through the frame the bottom for connection with the

construction of the field magnet is t similar to that of the armature, that the laminations are dovetailed a rotating spider instead of a stationary frame. Ventilating ducts are pro in the core of the field magnet, register approximately with the



340. FRAME OF TYPE OF ALTERNATOR SHOWN IN FIG. 339

sponding ducts of the armature core. ield coils *n*, etc., Fig. 339, are wound over the projecting poles and are position by wedges which are between the poles in the slots near s. These wedges are made of cop l, besides holding the coils, serve pers to reduce any hunting which set up when running in parallel her machines. These dampers are mes made in the shape of a grid. field magnet coils are wound in , and made of copper strap bent se. The strap winding is insulated n turns with asbestos strips and s are held together by a few turns d

collector rings *r*, Fig. 339, are upon separate spiders which are to the field-magnet hub. They are skeleton or open type to secure num ventilation and are usually of cast iron. The brushes *b* are of arbon.

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tch the safety valves carefully to be that they do not corrode fast to i seats.

# Gas Engine Cooling Water

By H. W. Jones*

About six months ago I sent an article for publication to one of the journals devoted to internal-combustion engines. My efforts were rewarded by a return of the manuscript to which was pinned a printed card bearing the mystic words

"Quit your Kicking."

So I did for a while, but I'm going to start at it again with new vigor and with renewed determination. As a matter of course we have all noticed the wonderful improvement in gas-power engineering, but that is no reason why we should "quit kicking" if kicking is justified; to my mind, kicking is the cause of the improvements that have already been made.

Just as an illustration: A certain power user in Chicago secured the services of a chief engineer. The manager of the plant told me that "Smith" was the most persistent kicker he ever met. He kicked about the boilers and he "kicked" out the firemen; he "kicked" about everything they did have and he also kicked about everything they didn't have. He kicked every day, all day; he kicked hard and persistently and incessantly, until the same manager confided to me that "that man has kicked our operating expenses down fifty-five hundred dollars per year, after deducting his raise of salary from two thousand to thirty-five hundred dollars per year. And now that prince of kickers is kicking for four thousand per year, and d——d if I don't believe we will be kicked into giving it to him."

My kick is now on the abuse of the process of cooling gas engines. In every case that has come under my observation, the engine jackets are supplied with just as much water when pulling half load as when pulling full load, and even when the load is entirely off the engine, the cooling water, like Tennyson's brook, still goes on undiminished. A gas-engine cylinder should be kept as nearly as possible at a constant temperature, and this can be done. I know it because I am doing it; at full load, half load, or no load, the water leaves the jacket of a 65-horsepower single-cylinder engine at 150 degrees temperature, Fahrenheit. Judging from my experience this practice is good, I may say very good. The engine seems to work better and it requires less gas to do the same work, furthermore, we save water and save oil, there is no carbonization, no clogging of the exhaust pipe, no fouling of valves, no charred oil on the igniter points, and no overheating of the engine.

To cite an example of the other kind, I was called on to ascertain whether a gasolene engine in a dairy establishment could be changed to use city gas. It was a 25-horsepower single-cylinder hit-and-miss engine. They had in use a bottle-washing machine that, when it was running, carried the load up to the full power of the engine, which also drives a 10-ton ice machine. They used a 50-horsepower boiler to heat the water for the bottle machine, and I noticed they were discharging the hot water into the sewer, so I suggested that the hot water from the gas-engine jacket be delivered into the boiler, to save water and coal. But the "engineer" in charge said, "Nonsense; we'd have our milk smelling of gasolene." However, that is merely incidental. The bottle-washing machine was run about five hours a day and while it was in operation the water temperature was 160 degrees at the outlet of the cylinder jacket. But when the washer was not in use, the water temperature fell to 100 degrees; the full supply was always on. The engineer informed me that they never had any trouble with full load, but when light load is on, the smell of gasolene from the exhaust is very annoying, and the igniter fouls on light load. All this could readily be corrected by putting a thermostat in the jacket-water discharge and arranging it to control the supply.

Kick? Of course I'll kick, and I think this kick is justified. I have seen many articles in POWER as to how to cool gas-engine cooling water. My suggestion is to *put it to work;* superheat it with the exhaust gases and make it work.

I want to register one more kick. In the case of vertical gas engines the jacket water is admitted at the bottom of the cylinder, where it is not particularly needed, and by the time it gets to where cooling is really necessary, the water is hot. This surely is not logical and it should be corrected.

In conclusion, I invite other kickers to join in and kick the gas engine into the position where it belongs and where, sooner or later, it will be, namely, the principal prime mover of the world. It has been said that the steam engine can have several things wrong and still run, while if a gas engine has one thing wrong it immediately shuts down. I am convinced that if the average steam engine were as unintelligently handled and as much neglected as the average gas engine, in isolated plants, the central electric power stations would all have to be enlarged.

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*Superintendent, The Peoples Gas, Light and Coke Company, Chicago.

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Use crosses with brass plugs in the blind ends on feed-water piping instead of elbows, to permit of cleaning with a wire in both directions. Cleaning should be done frequently, particularly with scale forming waters. Also examine the check valve every time the boiler is cleaned.

# What "Tom" Sawyer Wants

By F. L. Johnson

It was late in the afternoon of a cold, dreary, rainy autumn day. I sat at my desk, wishing that the chill which had penetrated to my very bones could by some mental process be converted into a feeling of comfort which would make me satisfied with my surroundings, and that disagreeable and captious letters would not always arrive on rainy Mondays. Someone entered, stood an umbrella in the rack, hung a rain coat on a hook, and took a chair. I looked up from the letter I was reading and saw Sawyer filling a brier pipe with "Master Workman" cut plug. Returning the tobacco box to his hip pocket, and getting a good light, he smiled as he asked:

"What means this marble-heart expression? If I have done anything that you are sorry for, I am ready to be forgiven."

I replied:

"You have got me into no end of controversies by the fairy tales you have been telling me, and which I was thoughtless enough to repeat as nearly in your own words as I could remember them. Of course, I cannot take the time to discuss all of the criticisms that have been handed to me, but here is one that, if not exactly a criticism, is inclined that way. One paragraph of this letter I wish to read to you. It says: 'Your man Sawyer says a whole lot of things about men who can but will not make certain experiments which he names in a vague sort of way that is hardly in keeping with the preciseness of the language which he uses when he charges that technically educated men are too bigoted to make certain investigations in which he alone seems to be interested. Now, will you please tell me exactly what this man Sawyer wants, if you know, and if you do not know, will you please ask him to tell us what he wants?' This is only one of the many letters that I have received on your account, but it is the one that calls loudest for reply. Now, what do you want?"

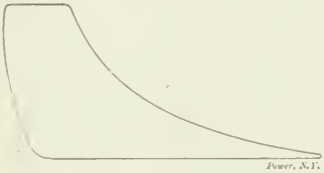

*Power, N.Y.*

FIG. 1. COMPRESSION TO INITIAL PRESSURE

"What do I want? Well, that's easy. I want to take an engine, a simple condensing or noncondensing Corliss engine, say, 14x42, or any other size that is big enough to carry a load of commercial proportions, and the water consumption of which will not need to be weighed with druggist scales. By means of a prony brake, water rheostat, or any other practical method, put a fixed load on this engine and with this load I want four different valve settings tried: The first with compression carried to initial pressure; the second with compression carried to about one half the initial pressure, which Heminway says is about right; the third with compression no higher than the terminal pressure, and lead enough to have full initial pressure on the piston at the beginning of the stroke; fourth, and last, compression as before, only to the terminal pressure and an opening of the steam valve so late that full initial pressure will be realized on the piston only after it has traveled at least five per cent. of the stroke."

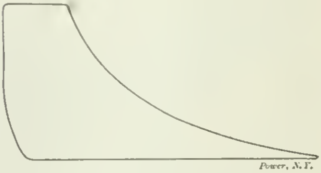

*Power, N.Y.*

FIG. 2. COMPRESSION TO ONE-HALF INITIAL PRESSURE

Taking a pad and a pencil, he was busy for a few moments; then, looking up, he said:

"These four imaginary indicator diagrams will tell better than words what I mean. I want the load identical for each of these different diagrams. I want the water per brake horsepower-hour measured. I want the water per indicated horsepower-hour measured, and I want the indicated horsepower per brake horsepower measured. I should, of course, like to see these experiments made both with simple and compound engines, both condensing and noncondensing, and when exhaustive tests by reliable, competent men have been made, I should like to see the results published. I have long contended that steam should be used in an engine for the purpose of turning the crank shaft, and that pressure on the piston produced either by compression or lead has no tendency to rotate the shaft but, quite the contrary, produces friction which retards this rotation and adds to the load that the engine carries, and to the steam needed to do the work. At the time I formed these conclusions (I did not form them, they were forced upon me), they seemed so obvious that seeking proof s to me like a work of supererogation.

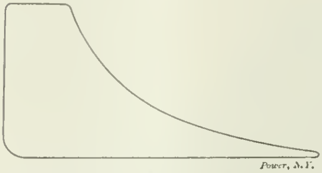

*Power, N.Y.*

FIG. 3. COMPRESSION TO TERMINAL PRESSURE WITH LEAD

"In the engine and the boiler room work was solitary and my views narr and I expect to feel more or less the fluence of those years all my life; since I have been seeking the hen of hundred annual egg power, my vi have broadened some, and I see this in the power plants that I did not no before, and they interest me. And as s very earnest men seem to think days of the steam engine as a pr mover are numbered, I want to see t days days of the highest efficiency, in which with the full knowledge of utmost possibilities, it may be give chance to do its best work unhamp by the strictures of technical bigotry unskilled operation. I want its last y to be its best years, and for that rea I want these experiments made and widest publicity given to the results. small powers I know the steam engin inefficient and in large units it util but a small percentage of the en stored in the fuel; but it is the best know, and when it is laid on the s with the spinning wheel and the h loom may it be with honor. I wan know the truth before that day comes

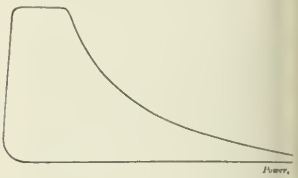

*Power,*

FIG. 4. COMPRESSION TO TERMINAL P SURE WITHOUT LEAD

He stopped, and as I said nothing pensive expression spread over his tures, and more softly than I had heard him before, he whistled: "Sh Auld Acquaintance Be Forgot?" as went out into the rain.

# Bearing Metal Mistaken for Sil

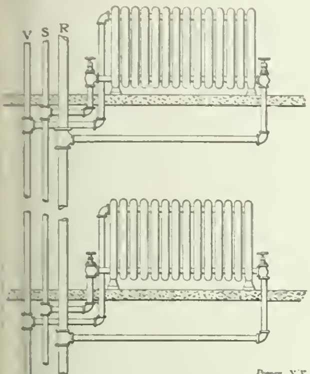
An odd mistake was recently mad the police and reporters of Buffalo w investigating an unusual case of coun feiting brought to their attention by discovery of many spurious coins an old suit case containing molds and m in a ditch alongside the Erie rail tracks. The report of the incident r "Further investigation uncovered sev plaster paris molds, a bar of lead another bar of silver. The silver marked Dodge Manufacturing Comp Mishawaka, Ind., U. S. A., copper h ened. Part of the metal had been u

It will be of interest to note that silver referred to was nothing more ordinary bearing metal for use in the gine room.

# Practical Kinks to Lessen Cost of Heating

By William Kavanagh

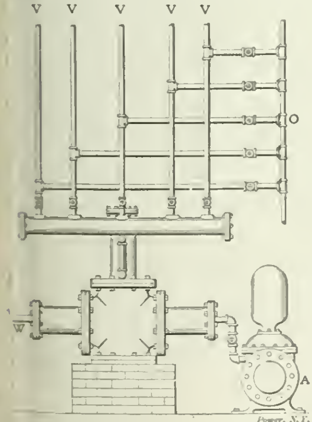
Following are some of the most practical methods to employ to lessen the st of heating a building. Where direct ve steam is used, it is a good plan to



Power, N.Y.

1. METHOD OF CONNECTING RADIATORS

nect a pump to the returns and to roduce a jet or spray of cold water the pump suction. Either the steam return valve should be choked suffi- tly so as not to interfere with the



Power, N.Y.

2 RETURNS FROM HEATING SYSTEM

am circulation; the amount to close t valve can be readily determined by w trials.

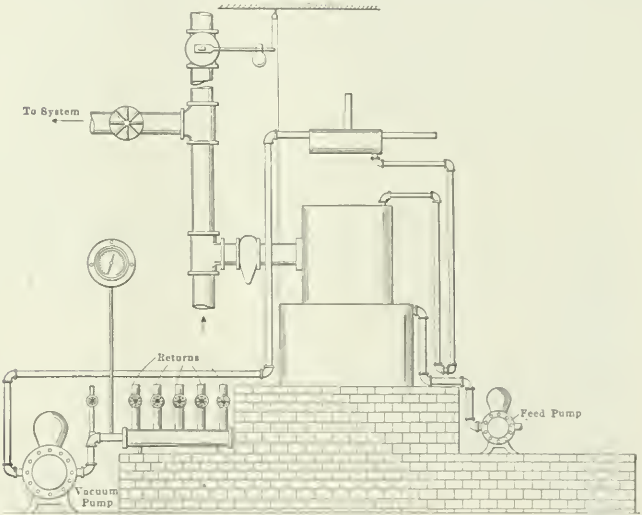
nother plan is to have a pump attached to the returns as described above. instead of closing down the main m or return valves, the bonnets of valves on the radiators are removed a slot is filed in the disk of each e. The valves are then closed and the steam is wiredrawn through the slot.

A third plan tending toward economy is shown in Figs. 1 and 2. Fig. 1 illustrates a vertical section of a building showing a portion of two floors, with a radiator on each. The riser *S* is the steam main, *R* the return main and *V* the air line. The radiators are tapped for $\frac{1}{8}$- or $\frac{1}{4}$-inch pipe, for connection to the air line *V*. In most cases the air valves are removed and the radiators are connected directly to the air line *V*, which in turn is connected to the main air-line return header, as shown in Fig. 2. The radiators are grouped off in regular order, the return pipes *V* acting for a particular section or group of radiators, and hence the number of sections into which the building is divided is denoted by the number of return air pipes connected to the return header. In Fig. 2 five sections are indicated. A pump is attached to the header, and it is run during the heating season. A fine water spray is connected to the header at *W*, and this spray acts to condense any steam before it is drawn into the air pump *A*. A gage glass is connected to the main header. Any particular air line can be opened to the atmosphere as indicated at *O*.

The above plan can be used with either live or exhaust steam, and where this system is in operation it is found to give entire satisfaction with respect to steam circulation and the elimination of water hammer. It is sometimes used in conjunction with the vacuum system of heating illustrated in Fig. 3, and where the combination is in use there is an advantage gained. Should the vacuum pump need repairs or renewal of parts, the air-line vacuum pump will materially assist to maintain the circulation during the stoppage of the main vacuum pump.

Fig. 3 is a modern vacuum system. At the left will be noted a cold water spray connected to the suction of the vacuum pump. The manipulation of this spray either hastens or delays heat circulation throughout the system. Should the vacuum fall below a predetermined point, the water spray is increased, and as the vacuum rises the amount of water may be decreased. The vacuum can also be increased or lessened by running the vacuum pump either faster or slower. It is, however, more satisfactory to allow the speed of the pump to remain uniform and manipulate the spray valve to suit conditions.

The water used for cooling the pump is discharged from the vacuum pump along with the returns, so there is no water lost from using the spray. When the system is working properly very little water is required; usually the extra amount is supplied through the spray valve, which makes up for the inevitable leakage and waste at drips.



Power, N.Y.

FIG. 3. MODERN VACUUM-HEATING SYSTEM

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In the case of a horizontal tubular boiler, the feed pipe should enter through the front head above the top row of tubes and below the water line and at one side between the shell and the outermost tube. Thence the pipe should extend back about two-thirds the length of the boiler, cross over, and discharge through a plain elbow downward and forward between the center rows of tubes. The use of a feed pipe discharging in this way will prevent a deposit of scale on the side sheets and will also prevent the straining of the sheets from cool water.

# Practical Letters from Practical Me

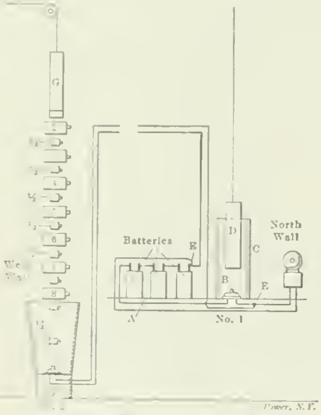
Don't Bother About the Style, but Write Just What You Think,
Know or Want to Know About Your Work, and Help Each Other

## WE PAY FOR USEFUL IDEAS

### Electric Alarm Systems

I have two electric signal systems working that I have never seen anything like. They are simple and work so nicely that [illegible] illustration worth while.

As shown in the sketch there are two different signals coupled up with one set of three dry cells and a 6-inch gong bell. System No. 1 is a signal for the water-works standpipe, which is 115 feet high and about 500 feet from the building. The letter A indicates a shelf nailed to the wall, B is a common push-button switch, C a box with back and sides and open front, and D a weight which is fastened to a light copper window chain running up through the ceiling and out through the side wall to the standpipe, where it is fastened to a large float. The weight D works up and down for a distance of only 1 foot, so that it never gets out of the guide box.



TWO ELECTRIC-SIGNAL SYSTEMS

When the standpipe is full the weight will descend upon the push-button switch and close the circuit, causing the bell to ring. Then all that is necessary is to take the weight out of the box, pull down a little on the weight to take up the slack and place it in a half-moon notch directly in front of the push-button switch. By so doing it is not necessary to use any other switches in the battery line. As soon as the water goes down a little, the weight will pull up over the push button into the guide box, and is again ready to descend and close the circuit.

No. 2 is another electric alarm of similar construction and is used in connection with the air lift receiving reservoir. The signal apparatus is placed upon the floor. The weight has a 9-foot travel. Eight squares, about 3x4 inches, were painted in bright red upon the wall, and half way between the larger squares half-foot marks were made. White paint was used for the figures. The weight G is piece of 2-inch gas pipe painted bright red, with the exception of a ring around the bottom, about 1 inch wide, painted in white. A white strip was painted on the red squares, and as the white ring on the weight G coincides with one of the white bars, it can be told at a glance how many gallons of water there are in the receiving reservoir. This helps the engineer out wonderfully in working an air lift, and in making experiments as to the best results and economical operation of the air compressor.

M. C. REYNOLDS.

Carey, Ohio.

### Added Lap on Valve

In the institution where I am at the present time, we have, in addition to other equipment, two Atlas high-speed engines, 17x15-inch cylinders, rated 200 horsepower each. While the engines have never kicked themselves off their bases, the manner of their running has caused much irreligious criticism from divers persons, including the writer.

The accompanying sketch, Fig. 1, shows the design and dimensions of the valves for these engines. I observed, when first taking the plant, that the exhaust from these engines was very uneven, and on investigating found that the setting of the valves on both engines was far from correct. I adjusted the valves as well as I could without the indicator, because the former engineer had broken the attachments for one engine, and had lost or destroyed part of the attachments for the other.

I noticed that the inside lap of the valve had been increased by adding strips ½ inch wide. When examining the valves I found that one of these strips had come off, and was uncertain for a time whether the builders had added them, or whether they had been added by some i responsible dunce.

I was not surprised to find, when th indicator had been applied, that the

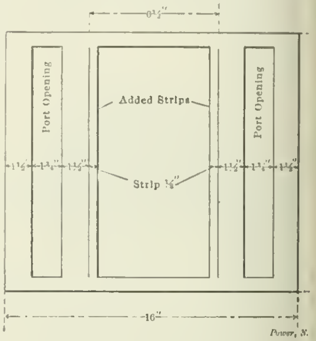


FIG. 1. FACE OF VALVE

strips had been added after the engin left the shops, as the compression wa excessive, and release somewhat tardy.

Fig. 2 shows diagrams taken from th engine running with light load and th strips in position, while Fig. 3 shows th same, but with more load, and Fig. shows diagrams after the strips were re moved. The compression is excessiv but about the only way the steam dis tribution can be helped would be t back the eccentric a little, which, I thin would cause the engines to show up nice ly. The speed is 277 revolutions pe minute.

It will be noticed that the adjustmen shown by Fig. 4 is not good, there bein more compression on the head end tha on the crank end, and that cutoff is late on the head than on the crank end, b it can hardly be made better. If w undertake to equalize the compression w

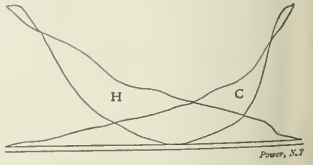
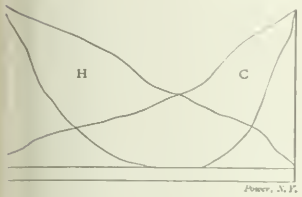


FIG. 2.

would have to increase the lead on th crank end and since this is already great er than on the head end, we do no want to do that. If we undertake t ualize the cutoff, we are up against same proposition.

The valves of these engines are of the lanced pressure plate type, and from beginning, under some conditions of l, these valves, like all others of their ily, would slap and rattle. The en er would not tolerate this, and had prings between the steam-chest cover



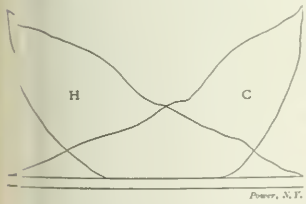
Power, N.Y.

FIG. 3

stronger, but while this had the of reducing the amount of slam g, it had the effect that when the did slam it slammed with exceed- viciousness and energy. Thereupon took out the springs, and filled the between the steam-chest cover with nd washers, so that when the n-chest cover was in place the pres- plate would be held down firmly, no getting away. He cracked the r in his effort to screw it down, as a

der light load these valves are t sure to do some slamming, due to fact that as load becomes lighter vents become earlier as the cutoff is ened by the governor, and the com- n becomes excessive.

ile I am not a noncompressionist, I ve that most high speed engines have t much compression. If we will com- the usual diagrams from Buckeye speed engines with some others and their smooth running, we cannot to be convinced of this, for these s are usually run with much less ression than many other engines



Power, N.Y.

FIG. 4.

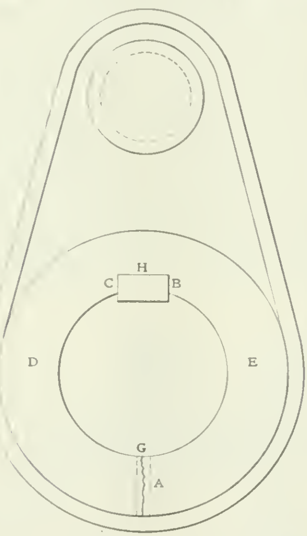
ing at the same speed. I believe that ression in excess of that required to ring the reciprocating parts of the e to rest without shock is simply a ra put upon the engine, and as a well known engineer has said, "is taking out power that it has cost good money to put into the engine." It is manifest that when an engine works as a compressor, doing negative work during half the stroke, it is not doing economical work as a power producer.

WILLIAM W[illegible]

Lincoln, Neb.

## Repairing Loose Crank

A few years ago the cast iron crank of a 20x30-inch reversing engine gave trouble by coming loose. It was decided after a time to put a tin liner around the shaft and shrink the crank on. When the crank was heated to redness, it was seen that a much thicker liner could be used, so the crank was put back on the fire, while a sheet iron liner of what was supposed to be the proper thickness to make the crank tight on the shaft beyond was made. Right here it should be noted that the intentions of those doing the work were very commendable. After the crank was placed on the shaft and the temperatures of the parts began to equalize, the former let go as shown at *A* in the drawing.



CAST-IRON CRANK

After investigating the conditions, some thinking was done that gave the desired results, i.e., made the shaft and crank practically a unit. The original trouble was caused by the key being a tight fit sidewise only, as at *C B*. As the shaft was but two or three thousandths too small for the crank, a space was chipped out of the bottom of the crank as shown by the dotted lines. The crank was then put on the shaft and a pair of square steel bands shrunk onto it: the key was properly fitted and driven, and the job was finished.

A little real thinking should convince one that a key, to resist torsional stresses, should have an excellent surface fit top and bottom, a taper of about one per cent., and driven till it has produced a tension of about 5000 pounds per square inch in the sides of the hub, as at *D E*; this assumes the crank to be made of cast iron. Under most circumstances, the friction produced between the shaft and hub at *G*, and hub and key at *H*, is sufficient to resist all torsional strains.

SAM BURGOYNE.

Youngstown, O.

## Lagging an Engine Pulley

It is sometimes necessary to lag an engine pulley, and if the diameter of the wheel is to be increased only, say, ½ inch, it can be done with a good piece of belting. After beveling the ends, which should lap over each other about 6 inches on both ends, the face of the pulley should be covered with a cement or glue composed of the following: Obtain a sufficient quantity of the best isinglass and rub it until it breaks into a powder, then put it in a bottle and add enough acetic acid to wet it through; stand the bottle in boiling water and the paste will dissolve and be ready for use. It should be warm when used.

Fig. 1 shows the manner in which the lagging should be put on the pulley. If the load carried is very heavy it would be well to drill a number of 3/16-inch holes in the face of the rim and drive pins in them, allowing the pins to extend above the face of the wheel about half the thickness of the leather lagging. This is to help the cement hold the lagging in place.

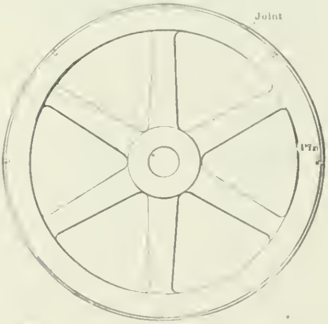


FIG. 1. LAGGING WITH LEATHER BELT

If the flywheel is to be increased in diameter an inch or more, probably a wood rim would be best. This could be accomplished by obtaining the exact diameter of the flywheel and then cut out a segment about 3 feet long, or long enough so that a certain number would form a true circle, the inside diameter being the exact diameter of the flywheel face. These segments should be made of dry maple wood, and about 1 inch in width, and a little more than the desired amount in thickness, so as to allow for trueing up the outside surface after the rim has been completed.

Fig. 2 shows the manner in which the segments of wood should be fitted together. The rim of the wheel should be turned coning as in the case of any wheel. This can be done by obtaining the tool rest from a lathe in any machine shop and so rig it that it will be convenient to run the tool over each half of the wheel face.

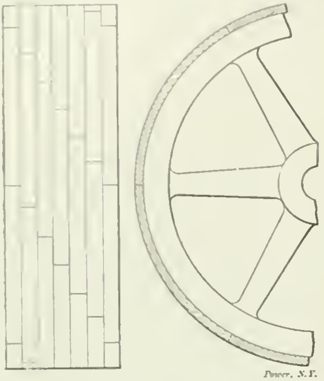


FIG. 2. WOOD RIM FOR PULLEY

A good cement for wood and iron is as follows: Melt a sufficient quantity of rosin and stir in calcined plaster until reduced to a paste, to which add boiled oil in sufficient quantity to bring it to a consistency of honey and amply warm. Another is to melt 180 parts rosin and stir in 30 parts of burnt umber, calcined plaster 15 parts and boiled oil 8 parts.

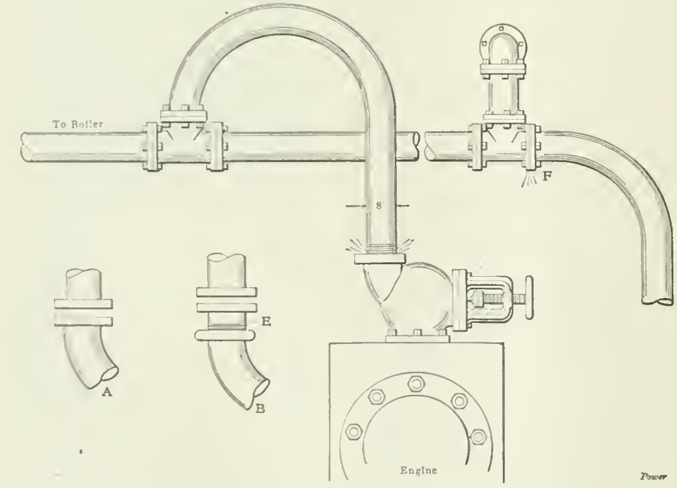
E. Price.

Cleveland, O.

## Vibration and Leaky Joints

The vibration found in some steam lines is serious, and it requires only a little time until the line is leaking at the various joints. A steam line should be well stayed, as well as supported on expansion rollers, and in cases where the steam line from the header to the engine is called upon to carry more steam than it should, and as a consequence causes the pipe to vibrate, a steam drum should be installed directly over the engine. A case of this kind is shown in the drawing. The cross line leaving the header at right angles was a pipe of considerable length and also too small to deliver the steam required for the engine. It would cause the entire header to vibrate, and soon the flanges were leaking. A Corliss engine of this type requires the steam in an instant and the valves close quickly, so that the steam pipe will vibrate more than with a high-speed engine, in which the flow is more constant.

A peculiar piece of pipe fitting is shown in the way the 8-inch bend from the cross line is fitted to the throttle valve. Instead of a threaded joint, the valve should have had a set of flanges, and the connection made as at *A*. But as long as the connection had been made, a short nipple, as at *E*, and flanges above would have helped matters. While this latter plan would make one more joint, in a case of this kind it would be an improvement over the first method.



LEAKY JOINT AT THROTTLE

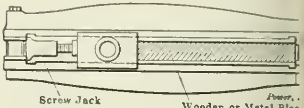
C. R. McGahey

Cincinnati, O.

## Safety Suggestions

The horrible engine disaster at Ca Dover, O., the early part of Octob when three men were squeezed to de in the air tub of a vertical blowing gine, has awakened engineers and mas mechanics to the necessity of prope blocking engines when making repairs

At Canal Dover three machinists w sent into the air tub of a vertical blo ing engine to adjust the rings in the ton. The flywheel had previously b blocked on both sides. The men ente the cylinder through a bonnet and w working on the upper side of the pist between the piston and the head. Fr some unknown cause the blocking at flywheel gave way, allowing the eng to turn over. The three men were press into an unrecognizable mass in the cle ance space of the cylinder.



METHOD OF BLOCKING CROSSHEAD

Blocking of the flywheel is an uns isfactory and dangerous method, and above accident will add to its disfav The flywheel is too far from the sou of trouble. A more satisfactory and sa way to effectually block an engine see to be at the crosshead. The engine sho be spotted and a suitable block inser between the crosshead and separa block between the guides on the one si On the other side of the crosshead screw jack should be similarly placed a tightened, taking up all movement of crosshead, as shown in the illustration

The flywheel and pit should be tirely inclosed by a railing or guard. large engines hand railings should placed for the safety of the oiler w climbing in places where a man is lia to slip. The mistake should not be ma of setting the railings so high that af a man has fallen he cannot reach railing. The throttle valve should locked or a tag placed on the valve c tioning anyone from meddling with while repairs are being made on the gine. All swiftly moving parts should protected by guards and all set screws projections should be guarded where man is liable to have his clothes caug

Above all things, the engine should provided with a reliable engine stop t could be operated from any part of engine room. In case of the engine spe ing up or moving away and the eng p not acting, it ought not to be nec- ssary for the engineer to run to the rottle, which is usually on a line with e flywheel, to shut off his engine A w dollars spent for protections will ng big returns in the reduction of ac- lents.

N. L. Daney.

Elyria, O.

## Homemade Pressure Regulator

The pressure regulator described here- h was designed to regulate a com- ssed-air oiling system, but by using vy glass and brass connections the strument can be used on higher pres- res.

The regulator consists of a U-shaped s tube $\frac{1}{8}$ inch in diameter. Glass s are fitted on the ends, as shown. fusing a wire into a glass tube re-

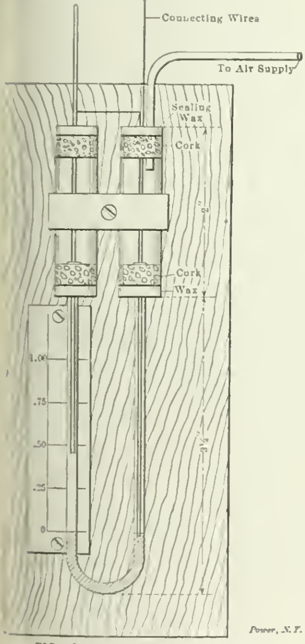


FIG. 1. PRESSURE REGULATOR

qres platinum wire and no little pa- te. I made the cup connections very re with corks and wax, as the draw- in shows. This makes the ends the ngest part of the cups. Two No. 20 er-insulated copper wires are in- ed through holes in the cups, and ed in after being adjusted to the de- d pressure and cut to the same lgth. Each wire must be scraped bight ⅛ inch on the end.

brass tube also enters the top of the ri t-hand cup and is connected to the ai space in the oil reservoir. In the regulator which I made, a valve was placed just above the cup, a nipple connecting the cup and valve.

Fig. 2 shows the electrical connections, which run to a solenoid *O*. The solenoid was taken from an old arc lamp, and has considerable lifting power. If the screw on the back of the stop cock *S* is loosened and the valve well oiled, no trouble will be experienced in making the solenoid operate the cock. A trip magnet *M* allows the arm *A* to fall and cut off the air supply when the circuit at the regulator is closed.

A glance at the diagram will show the principle of operation; a rise of pressure above a certain value forces the mercury up in the left-hand tube, closing the circuit *X* and shutting off the air supply. A drop in pressure will cause circuit *Y* to energize the solenoid, opening the air valve. A little oil on the mercury surfaces will prevent sparking.

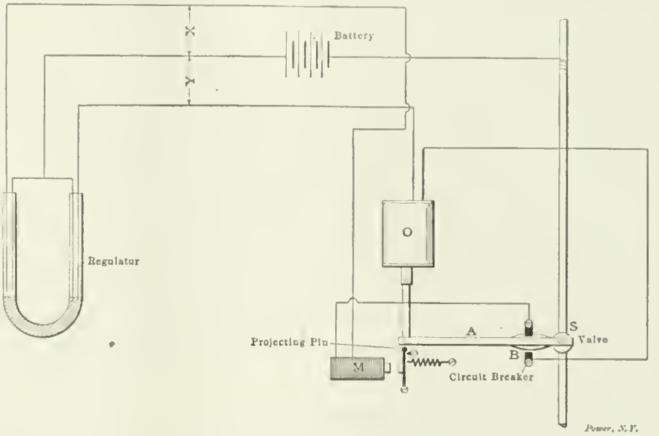


FIG. 2. REGULATOR AND CONNECTIONS

On high pressures the left-hand cup must be sealed at the top; on low pressures the top may be left open and the scale calibrated as follows: Open both ends of the tube to the atmosphere and, taking the mercury level as zero, make divisions 1 inch apart; each division then represents approximately 1 pound per square inch. For feet of water the divisions should be 7/16 inch apart, each division representing 1 foot of water.

The easiest way to make a cut-out switch that will open the circuit as soon as the valve changes is to fasten a blade of copper *B* to the arm *A*. Then the current cannot be restored until contact is made on the opposite side.

In case the apparatus is used for a water-tank regulator, the scale divisions may be made 4/5 inch apart, each division representing one foot of water. For this use it is better to make the U tube 18 inches or more in length.

R. S. Seese.

Urbana, Ill.

## A Reversed Field Connection

A small lighting plant had a direct current generator of about 40 kilowatts capacity. The operating engineer complained of the machine falling down under load. When over 20 kilowatts were thrown on, the voltage would drop off rapidly and the generator would refuse to carry any more load. It was run for several years in this fashion, developing less than half the rated capacity. Finally it was thrown out of the central station and installed in a summer hotel plant. The engineer at the hotel had the same trouble with the generator and finally an outside man, who knew a dynamo from an ice machine, was called in. He tested the generator out and tried reversing the series-field connections. When he did this he got plenty of voltage at full load, and the generator has carried its load since without any trouble. This generator might have been connected wrong when it left the factory, but it is more than probable that someone in the station reversed the connections while erecting or overhauling the machine.

Howard M. Nichols.

Kenyon, R. I.

## Trouble With Double-Eccentric Engine

I am running a double-eccentric, double-ported Corliss engine. When the governor is down on the safety collar, cut-off occurs at about five-eighths stroke, but when I let the governor down on a bracket, on the side of the collar, so that the valve will remain hooked on while stopping, the exhaust valve opens before the steam valve closes and steam passes through to the receiver and to the condenser. Should this be the case?

E. T. Boynton.

Memphis, Tenn

# Subjects Under Discussio

Comment, Criticism and Debate upon Various Articles, Letters and Editorials Which Have Appeared in Previous Issues

BRING OUT YOUR IDEAS

## Beading Boiler Tubes

In the account of the explosion of a Manning boiler at the Amoskeag mills, it was stated that the tubes were rolled, but not beaded over, and the result of tests made several years ago by the Hartford Steam Boiler Inspection and Insurance Company were given evidently in justification of such practice. There is no reason to doubt the correctness of those tests, or that tubes have been injured by beading over the edge of tube-sheet holes not properly rounded or chamfered. When this theory of simply rolling the tubes into place first came out, the writer was having some boilers built and specified that the tubes should not be beaded but left projecting ¼ inch through each head. The builders protested, but made them as ordered. The boilers lasted through twelve years of constant use, and while I cannot say that they ever gave any trouble, I must admit that they gave me a little concern the last year of their use, for the projecting tube ends on the back head had entirely disappeared, yet what remained held all right. The tubes of the boilers put in to replace these were beaded, and when in turn they were taken out, the beading and tube ends were intact, being practically a part of the tube sheet and protected by the water inside.

If the ends of the projecting tubes could be burned and wasted away on the back head of a horizontal boiler 10 feet from the fire, how much more likely are the ends of tubes in a vertical boiler to be burned and wasted, being directly over the fire?

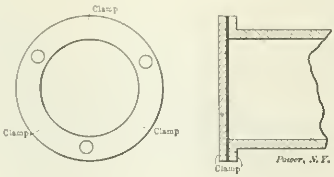
I believe that well annealed tubes properly beaded over a slightly chamfered sheet, cannot be injured by the fire so long as they are protected by water inside the boiler, and that they cannot be pulled out of the sheet by any allowable pressure. To account for any overheating of the tube ends, it would have to be supposed that the water was not only raised, but held in suspension for an appreciable period in order for the heating to occur. I am aware that it has often been alleged that water is raised in a body from heated surfaces, but have never seen it satisfactorily proved that such was a fact. It is, however, of frequent occurrence for quantities of water to be carried over from the water line whether it is high, low or normal, if the rate of evaporation is too rapid. I think the rest of the battery will be reasonably safe when the tubes are beaded as the article says is being done.

PETER H. BULLOCK.

Concord Junction, N. H.

## Clamps for Cylinder Heads

The editorial "Emergencies Bring out the Man," calls to mind the following experience I had along this line. Some time ago my boiler-feed pump started to behave badly. An examination showed that it was necessary to send the pump to the repair shop at once, so orders were given to send up a pump for use during the time our pump was getting repaired. Before disconnecting our pump, the boilers were filled with as much water as was safe, and all piping was made ready for the change. When the spare pump was connected up and started, the gasket blew out at the water end. These were renewed, but with the same results. A number of new gaskets were put in, but would not hold. I was at a loss as what to do, as the water was getting low in the boilers and it was a case of getting the pump to work or shut down the plant, when I happened to think of using iron clamps to hold the gasket more tightly between the cylinder face and head, as the pump had been built for low pressure and there were only three studs to hold the gasket and cylinder head. In our case the pump had to force the water against a high head.



CLAMPING CYLINDER HEAD

Another gasket was put in and the nuts on the studs drawn up tight; then three iron clamps were placed between the studs over the cylinder head and flange on the cylinder, as shown in the drawing. When the pump was started again, the gasket held.

H. JAHNKE.

Milwaukee, Wis.

## Receiver Pressure

In the November 2 issue, page 752,
A. Baldwin tells of his trouble with
ceiver pressure; assuming his engine
be a Corliss, and cutting off in the hi

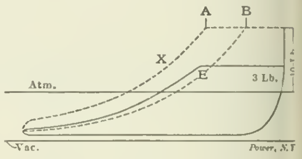


FIG. 1.

pressure cylinder at ⅜ stroke and sin
eccentric on the high-pressure cylin
the circumstances present rather a pec
iar case. It is plain that we can
shorten the low-pressure cutoff with
raising the receiver pressure, and t
receiver pressure is resistance on
high-pressure the entire length of str
as at D, Fig. 2, and is bound to lov
the high-pressure governor and cause
high-pressure cutoff to lengthen. N
suppose he is running with three pou
receiver pressure and cutting off at 33
cent. in the low-pressure and, say,
per cent. or about ⅜-stroke in the hi
pressure cylinder, which conditions
represented in the full lines in Figs.
and 2.

He says if he raises the receiver pr
sure to 10 pounds by shortening the l
pressure cutoff, the high-pressure v
not unhook, but follow the whole len
of the stroke. This is not surprisi
when we consider that the engine is

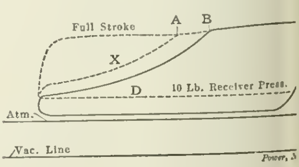


FIG. 2.

ready working near its range of cut
in the high-pressure cylinder, which w
any lap on the steam valves is bound
be inside of half stroke before the r
ceiver pressure is raised. When he rai
the receiver pressure, the high-pressu
cutoff lengthens, and, since it can
lengthen much before it reaches its lin
of range, the only thing it can do is,

se to unhook and follow the whole length of stroke, which is represented in Fig. 1, dotted line *E*, and Fig. 2, dotted, full stroke. It is easily seen why he cannot get the same results in raising receiver pressure by shortening the low pressure cutoff, as he can by raising receiver pressure by the additional steam from the pump exhaust, which is practically the same as opening the live steam pipe attached to all receivers, because in one instance he gets the 10 pounds by shortening the low-pressure cutoff, Fig. 1, dotted line *E* to *B*, and in another instance he gets the 10 pounds more by letting the low-pressure cutoff remain where it was, Fig. 1, full line, and letting the pumps exhaust into the receiver, raising it to 10 or more pounds, Figs. 1 and 2, dotted line *X*.

By noting the difference between the low-pressure cutoff in Fig. 1, *A* and *B*, and the high receiver pressure, it is not surprising that with the pump exhaust going into the receiver, and cutoff at *A*, Fig. 1, that it would do 20 horsepower more than the short cutoff at *B*, Fig. 1, and cause the low-pressure cylinder to keep the engine up to speed, and allow the high-pressure cylinder to keep within range of cutoff.

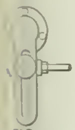


FIG. 1

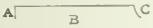


FIG. 2

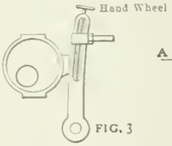


FIG. 3

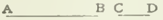


FIG. 4

Power, N.Y.

It seems the only and the practical thing to do in this case is to let the pump exhaust make the receiver pressure, providing resistance due to this, 10 or more pounds is not so great as to interfere with the speed of the pumps.

A. C. Waldron.

Lynn, Mass.

When a reader attempts to think over the reasons for the trouble, he is confronted by that omnipresent stumbling block—insufficient data. He may have a Corliss engine, or he may have a shaft-governed compound, and the low pressure cylinder may or may not be under the control of the governor. A set of cards from this engine under the various conditions would, no doubt, clear the mystery. But to show that results are governed solely by conditions, the following are two causes that I have known to make the high-pressure cylinder take steam for the full stroke upon raising the receiver pressure. The low-pressure cylinder of a cross-compound Corliss was hand governed, and the cutoff was changed by moving the end of the knockoff cam rod in a slotted casting of the style shown in Fig. 1. The various positions of the sliding head *A* to give certain receiver pressures were known to the operating engineer, who had the habit of promptly moving it from the two-pound to the ten-pound position. The effect of the sudden change was to slow up the engine, and cause the high-pressure cylinder to take steam for the full stroke. The reason for this action was an abnormally large receiver, and its effect is best illustrated by a supposition. Let the line *A C*, Fig. 2, be the steam line of the low-pressure diagram, which we will suppose is doing half of the engine load of 500 horsepower. Now, suppose that the cutoff was quickly changed for the purpose of raising the receiver pressure, so that now the valve closes at *C*. It is very evident that about half the load, 125 horsepower, is instantly thrown off the low-pressure cylinder and must be assumed by the high-pressure cylinder. In ordinary practice the receiver pressure would quickly come up and cause the low-pressure side to take its share again. In this particular instance, however, the receiver was so large, that some time would elapse before the receiver pressure would build up and an inexperienced engineer would become alarmed and quickly change the sliding head back again, and come to the hasty conclusion that a high receiver pressure was impossible on this engine.

The other case happened on a shaft-governed engine, the cutoff of the low-pressure cylinder of which was hand governed by shifting a movable block close to the eccentric, as shown in Fig. 3. Changing the position of block *A* changed the angularity of the eccentric rod, which resulted in unequal points of cutoff. The receiver pressure here would vary from 2 to 10 pounds according to the load, but when an attempt was made to reach 15 pounds by shortening the cutoff, the governor would invariably start hammering on its stop. An investigation showed that the comparative lengths of the two steam lines under the conditions looked like the lines *A B* and *C D*, Fig. 4. With an admission equal to *A B* the condenser was unable to take full hold right at the beginning of the return stroke, resulting in a loss of vacuum equal to in total $1\frac{1}{2}$ pounds mean effective pressure. Calculating the gain in the low-pressure cylinder by raising the receiver pressure, other conditions being normal, would give 18 horsepower. The loss by the failure of the condenser figured to 16 horsepower. The net gain then was equal to

18 — 16 = 2 *horsepower.*

The loss in power of the high-pressure cylinder by raising the back pressure was 19 horsepower. Total loss then was

19 — 2 = 17 *horsepower.*

This meant that the high-pressure cylinder had to furnish steam equal to an extra load of 17 horsepower, and that at a time when every horsepower, on or off, would tell on it.

As to admitting steam from the pumps to the receiver, it is clear that no variation of the point of cutoff in the low-pressure cylinder will be necessary, as the extra steam of itself will raise the receiver pressure the required amount. Hence, the points of cutoff remain equal. I hope that these two examples will show Mr. Baldwin the absolute necessity of supplying all available data concerning these out-of-the-ordinary cases.

L. M. Leslie.

Cambridge, Mass.

## Writing for Catalogs

I quite agree with the reader quoted in the editorial on "The Educational Value of Advertisements." A man who is desirous of advancement, can obtain information from the different catalogs that he cannot very well obtain elsewhere; but what a difference among manufacturers. For instance, take the case of a young man employed as coal passer fireman or oiler, as the case may be. He wishes to advance, and taking a technical paper, he readily sees that he can get a vast amount of information from the catalogs of the firms advertising in its columns. So some night he scribbles off a few postal cards and in due time receives the catalogs. Pretty soon "follow-up" letters begin to come, and the first thing he knows he is visited by an agent or two. Then he feels like kicking himself, and very likely the agent feels like lending a helping foot.

So he changes his tactics. No more postal cards for him. In future he writes a letter stating how he is employed and encloses stamps. Some of these evidently get lost in the mails. A few firms write that their new catalog will be off the press shortly and that they will be pleased to forward him one—but forget. While a very few send him the catalog and also write him a courteous letter along with it.

The former he dislikes, and the latter he regrets having caused any trouble. Altogether he feels as if it's another case of "What's the use?"

A. F. Oakley.

Bedford, N. Y.

## Some Erroneous Ideas

With regard to the stress or strain in the bolts on a cylinder head, as given by Mr. Hartley and others in the October 26 number, I believe there are conditions which have been overlooked. In practice it is proved that if the bolts are set up when the cylinder walls are cool, a certain strain is put on the bolts which has a tendency to draw or stretch them, this strain being proportional to the length of the wrench, the pitch of the thread and the force applied. The elongation of the material of which the bolts are composed must also be considered.

On admitting steam to the cylinder, expansion takes place in both the cylinder head and bolt. Take for example a cylinder head 2 inches thick, and bolts 3 inches long. The extra length of 1 inch in the bolt over the thickness of the head allows of greater expansion, so that the strain on the bolts is less after steam is applied, not taking into account the reaction between the steam pressure and the initial bolt stress. When the head is first set up, a certain elongation takes place in the bolts, and the expansion in the bolt increases this elongation, as is proved by the nuts becoming loose after steam is applied.

**Howard Phillips.**

East Walpole, Mass.

Going back to "Some Erroneous Ideas" presented in the September 14 issue, page 456, of Power and The Engineer, the piston-ring proposition should not be dismissed lightly without considering some of the conditions under which they may be required to work.

Regarding piston rings so constructed that they may be free to expand outwardly against the cylinder walls, whether they have lips or flanges, or just plain rings set into grooves in the pistons, it seems, indeed, a mistaken idea to believe that steam pressure will not assist to force these rings hard against the cylinder walls, for thus far no one has devised and brought out such a piston ring that will exclude the steam pressure from the inside diameter of the ring to the extent that it can be used successfully under all conditions.

An expanding ring does very well, in most cases, under low pressures and low speeds, and even under high pressures with low speeds, as in slow running vertical boiler-feed pumps, even though the cylinders receive no lubricating oil, except what may be carried in on the piston rods; but for high pressures, high speeds and no lubrication, it has been demonstrated, time and time again, to the conviction of everybody concerned, that the use of a piston ring constructed so there is a chance for steam pressure to spread it out against the cylinder wall is entirely out of the question.

Such piston rings wear out in a very short time, and not only that, but the cylinders are also ruined and will have to be rebored to put them into proper shape again. I refer to some of the marine practices, and have seen a few rings and cylinders going to the bad on account of steam pressure forcing the rings outwardly, and to offset any possible claim that the rings did all this, because of the springs or spring in the rings forcing them against an unlubricated cylinder wall, I had the opportunity of noting in a 48-inch stroke, high-pressure cylinder, a ring $\frac{3}{4}$ inch thick wear down in some parts to $\frac{3}{8}$ inch thick in the short time of about three hours. Before this ring was removed from the cylinder it was especially noted that it had worn so much that it did not spring of itself tight against the cylinder wall, but rather lay away from it, contracted like. This in itself showed that it was the steam pressure kept this plain ring against the cylinder wall so that it wore the way it did while the engine was in operation, and when steam was shut off it relaxed from the cylinder wall.

While this type of ring works successfully without lubrication in many instances, it does not mean that it will do so in all cases. It may, therefore, be of interest to mention that in four vertical triple-expansion marine engines, all of 42-inch stroke, piston speeds about 900 feet per minute, with steam pressures about 160 pounds, two engines were of about 5500 indicated horsepower each, and two of about 8500 indicated horsepower each, the expanding type of piston ring worked successfully without lubrication; but when it came to using the same type of rings for strokes of 48 inches in the same type of engines of about the same indicated horsepower, piston speeds and steam pressures as those with the 42-inch strokes, these rings were practically flat failures, and as a rule they have proven to be failures in both large and small high-speed engines of the above-mentioned type since high pressures of steam came into use, say, anywhere from 200 to 300 pounds per square inch.

Quite a number of years ago the writer's first experience with no lubrication in the cylinders ended with discouragement. This was with an old-fashioned horizontal-compound marine, with large, flat slide valves. The low-pressure piston ring was about 6 inches wide. The engine made from 50 to 60 revolutions per minute with the boiler pressure from 50 to 60 pounds per square inch. The chief engineer said that as some engines had started out to show themselves satisfied to run without the internal application of oil we would give our engine a fair show to do the same. The internal oil feed was therefore taken off duty, and it seemed the old engine did not mind it in the least, for she kept
going without a groan or grunt for abo
five days; but that night she surely g
awake to the fact that she had be
cheated or neglected somewhere, and
let everybody know, awake or asleep, sl
let out a couple of ripping grunts th
shivered every timber in the ship a
then refused to do another stroke.

In order to get her on the job again
soon as possible, cylinder oil was pour
into the low-pressure cylinder, throu
the indicator connections, after whi
steam was turned on, and she went
work as contented as ever, and the lub
cator on the high-pressure steam ch
was again called to duty to allevia
further internal troubles.

Steam pressures, speeds, designs a
material have been changed considerab
since those days, and here we are no
with a pair of vertical four-cylind
triple-expansion marine engines, each
8000 indicated horsepower, all piston sli
valves, seven for each engine, cast-st
pistons and cylinder heads. All rings f
pistons and valves are of cast iron a
made up solid so there is no chance f
them to spread against the cylinder wa
and cause damage. Thus, each engi
has 18 solid rings running witho
internal lubrication, except what little
may work in on the rods and valve ste

It is probable that these engines, co
sidering size, are in a class by themselv
in regards to the steam pressure us
and the piston speed at which they trav
under full speed. With the throttle wi
open and a steam pressure in the hig
pressure steam chest six or seven poun
short of the 300 mark the piston spe
will run very close to 1200 feet per mi
ute. They have shown themselves pro
against breakdowns due to priming
boilers when the piston speed is abo
800 feet per minute, and at that spe
they can handle all the water given the
the only effect is that they will slow the
selves down until they have cleared the
selves by working the water through
the condensers, when they will get back
speed again.

This fact was discovered on a r
across the Atlantic, when a slight le
developed, letting a little salt water in
one of the condensers, and it was d
sired to make port without stopping,
possible. The boilers being of a wate
tube type, each tube contains but a sm
amount of water, and these boilers refu
to work without priming unless giv
clean, fresh water. The result was th
the water in the boilers got salty, little
little, day after day, and the engin
made the run of the last couple of da
on what seemed to be more water th
steam. The engines made no great noi
about it, the pressure in the high-pressu
steam chest would simply drop very lo
and the engines slowed down accordingl
It was thus found that the water wou
clear quicker by leaving the throttle op

d simply open the drains, because the gines did not seem the least concerned ut what running fluid they received; y were on the job to stay.

sides these two engines there are at t 60 steam pistons in the auxiliary chinery, such as in pumps and smaller gines. All these pistons are fitted with anding rings and operate without be lubricated, and six of them work rizontally, but none of them work under boiler pressure, the feed pumps com nearest to that. The rings in the s are of very good design and well All the rings work very well, ex the common ordinary snap ring does damage at a piston speed as 600 feet per minute under a steam re of about 100 pounds per square The ordinary snap ring is no doubt eap one to manufacture, but proves ny cases the meanest and most ex ive ring found in steam engines when mes to the account of the user's f it.

P. O. Jameson.

ston, Mass.

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## ection of Lap in Stack Joints

the issue of October 26 there was an le by W. N. Zurfluh advocating the f an iron smokestack being placed wn by Fig. 2, in previous article. is by no means a new subject. It been discussed repeatedly and very arguments have been presented vor of both methods, although it is n practice to put the lap as in Fig. hich I think is logical and proper the reasons that the travel of the is at no point impeded by the der of the lap, and the drainage on utside of the stack drips clear of the

is true that wet ashes are a detri- al element but there is a very small ent embodied in the question of the lodging on the top of the joint A ing subject to continued dampness rain storms. Rain is not a daily to contend against; and I doubt n would enter very far on account e smallness of the drops and the f the stack when in service. Cer- it is true, any rain entering on gle would strike the side of the before it had gone a great distance the top, and only the few upper ould be affected, while the heat of ck would quickly dry the ash in art of it. If soft coal is burned the of the stack would naturally be socted up, which would have a ten- to preserve rather than injure the as it would prevent the moisture getting at the actual iron.

stacks were constructed as shown in Fig. 2 every joint would be wet when it d, and until such joints were completely filled with paint so as to close the angle, water would lodge on the top of the joints to the detriment of the iron.

I think that any comparison of wear and tear on the two arrangements that would show more wear on the stack in Fig. 1 than that in Fig. 2 would be due to the quality of the iron and the application of proper paint rather than the method of lapping the joints

Charles H. Parson.

New York City.

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## Pound in an Engine

In the number of October 19, Mr. Scott wishes to know which reason for the pound seems the more plausible. Not knowing the size of the engine or speed, it is a hard matter to place the pound, as the stroke and speed would make quite a difference, but from the facts given I should say that Mr. Scott is nearer right than the engineer.

An old engineer once gave me this advice: In engines that run under, if a pound develops, look to the crosshead pin first and the crosshead second, as in nine cases out of ten the pin boxes will be at fault. If it is the crosshead, the pound will come just after the crank has passed the center, while the pound from the boxes will be exactly on the center where the direction of motion changes. The reason for this is, that the thrust on the crank, due to the pressure of the steam on the piston is in a straight line, and the steam pressure acting on the piston will force the boxes up against the pin very suddenly. In the case of the crosshead, the thrust of the piston against the crank acts at an angle as soon as the crank passes the center, and just as soon as that angle becomes great enough, it will force the crosshead against the upper guide and produce a pound. This is when the engine is running underloaded. The pull of the piston on the opposite stroke will produce the same effect.

With an engine running without load and the throttle shut, it will have exactly the opposite effect, that is, as the engine approaches the end of its stroke the momentum of the flywheel acting through the crank will force the crosshead up against the guide, and as soon as it passes the center will drag it down onto the lower guide. On the outer center the same effect will be produced, only by opposite forces. If Mr. Scott will take notice he will find that the majority of air compressors with air cylinders in tandem with the steam cylinders run under, for the reason that the work done acts on the crosshead in the same direction that it would in an engine doing work through a flywheel or direct-connected generator and running over.

In general, an engine running under will not be as noiseless and smooth running as one that runs over. Why this is so I confess I do not know. If it were possible to take a Corliss or any girder-frame engine and set it on end, making a vertical engine of it, would or would it not run smooth and noiseless in either direction? I am of the opinion that it would. Then the only reason that I can see why it will not run quiet in a horizontal position is on account of the weight of the piston, crosshead and connecting rod, for the thrust of the steam pressure on the piston would be the same in either position

A higher-speed, short-stroke engine would be less likely to pound under load, or rather when steam is entering the cylinder, than a long-stroke, slow-speed engine, for the reason that the high compression near, or to, initial pressure would have a tendency to keep the crosshead close to the upper guide, and having a short stroke the weight of the crosshead, piston, etc., being at all times near the cylinder stuffing box and packing, it would to a certain extent, be supported by them and not drop down at the end of each stroke. Mr. Scott's engine is probably of this type, and that is the reason it does not pound when running under its load. A diagram from the engine would probably show compression to, or a little above, initial, with admission a little late. The crank going over the center has a gradually increasing pressure up to admission, and the steam entering a little late gradually provides, as it were, an elastic cushion that lets the crosshead down and up again without any serious pound.

The only remedy I know of is to keep the crosshead as tight in the guides as it will run without heating and the wrist-pin boxes up as tight as they will run. Then, if the engine is in line, it will run as quietly as should be expected.

W. E. Sargent.

Franklin, Mass.

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The engine was a 250-horsepower marine compound. There was a knock somewhere around the crosshead. The engine would run for days without anything seeming to be wrong, then an ever increasing pound would start, especially if there was much reversing done. Examination showed everything right around the crosshead, but still the pound continued. It was found that setting up on the rod gland would either make it worse or help it, and by adjusting the packing just so, the knocking would stop for a time. The rod packing was finally taken out. An examination showed the bushing that held the rod central in the cylinder had been worn. When the packing became worn or was not adjusted close enough to hold the piston rod steady, the crank, in going over centers, would spring it, with the crosshead, out and in enough to cause the slap or pound against the guides. A new bushing stopped the trouble.

# Conservation of Coal Lands and Water Power

## Private Investment in Water Powers Should Be Made Profitable and Safe, but Neither Profit nor Safety Require Perpetual Rights

### BY HERMAN B. WALKER

Two statements made public almost simultaneously by two men as much in the public eye as Gifford Pinchot, Chief Forester, and Richard A. Ballinger, Secretary of the Interior, giving their views as to the necessity for conservation of water power and the methods to be adopted for heading off a hydroelectric-power monopoly, recently added a new and interesting chapter to the conservation controversy, and made it certain that the matter of further protecting and regulating the development of the coal lands and water-power sites on the public domain will receive attention from Congress at the present session.

In view of the fact that Ballinger had previously, on more than one occasion, expressed himself as skeptical of the existence of a water-power trust, and the further fact that almost since he entered the Taft Cabinet he has been under suspicion and attack by the friends and supporters of the Roosevelt conservation program, as entertaining opinions and views hostile to that policy, his report was surprising. It not only did not attack any part of the conservation program directly, but it contained many recommendations for legislation distinctly in keeping with the Roosevelt idea. The only portion of the report looked upon by the conservationists as positively hostile is that containing recommendations for cutting down the Government's activities in irrigation work, which, if adopted by Congress, will practically reverse the whole reclamation program of the Government as established under the Roosevelt administration.

Concerning the disposition of power sites, Secretary Ballinger said:

"In anticipation of new legislation by Congress to prevent the acquisition of power sites on the public domain by private persons or corporations with the view of monopolizing or adversely controlling them against the public interest, there have been temporarily withdrawn from all forms of entry approximately 603,355 acres, covering all locations known to possess power possibilities on unappropriated lands outside of national forests. Without such withdrawals these sites would be enterable under existing laws, and their patenting would leave the general Government powerless to impose any limitations as to their use.

"If the Federal Government desires to exercise control or supervision over water-power development on the public domain, it can only do so by limitations imposed upon the disposal of power and reservoir sites upon the public lands, the waters of the streams being subject to State jurisdiction in their appropriation and beneficial use. I would therefore advise that Congress be asked to enact a measure that will authorize the classification of all lands capable of being used for water-power development, and to direct their disposal, through this department, under substantially the following conditions:

"1. That the title to such lands be reserved in the Federal Government, and only an easement granted for the purpose of developing and transmitting electrical power for private and public use, and for the storage of waters for power, irrigation, and other uses.

"2. That such easement be granted for a limited period, with a maximum of at least thirty years, and the option of renewal for stated periods upon agreed terms.

"3. That entry should be accompanied by plans and specifications covering the works sought to be installed, and covering the maximum horsepower capable of development at such site; also, that a substantial entry fee be paid to show good faith, and that a transfer to the United States of the necessary water rights to permit of the estimated power development be made.

"4. That the construction period allowed entrymen for the development of at least 25 per cent. of such power shall not extend beyond four years, or such further time as may be granted by the Secretary of the Interior upon a proper showing.

"5. That a moderate charge shall be made on the capital invested, or upon the gross earnings of the project for the first ten years of operation, adjusted at each subsequent ten-year period, and equitably determined by appraisement.

"6. That all rights and easements shall be forfeitable for failure to make development within the limitations imposed, or upon entry into any contract or combination to charge or fix rates beyond a reasonable profit on the investment and cost of operation, or entry into any agreement or combination to limit the supply of electrical current, or failure to operate the plant; and

"7. That all books and accounts shall
always be subject to the inspection of t
department.

"Unreasonable or narrow restricti
beyond the necessity of public protecti
against monopoly, or extortion in charg
will, of course, defeat development a
serve no useful purpose. The stat
should, therefore, while giving full pul
protection against the abuses of the pr
ileges extended, so far as consistent
courage investment in these projects; a
it must always be borne in mind tl
excessive charges for the franchise w
fall upon the consumer. Legislation
this character proceeds upon the the
that Congress can impose such c
tractural terms and conditions as it s
fit in the sale or use permitted of Gover
ment lands, so long as such limitati
do not conflict with the powers exerci
by the State wherein they may be
nated."

In commenting upon the general mo
ment for conservation of natural
sources, Secretary Ballinger said:

"It is to be regretted that we, as a
tion, were so tardy to realize the i
portance of preventing so large a meas
of our natural resources passing i
the hands of land pirates and speculat
with no view to development looking
the national welfare. * * * In this pr
ent policy of conserving the natural
sources of the public domain, while
velopment is the keynote, the best thou
of the day is not that development sh
be by Government agencies, but that w
utilization shall be secured through priv
enterprise under national supervision a
control. Therefore, if material progr
is to be made in securing the best of
remaining public lands, Congress must
called upon to enact remedial legislatio

The Pinchot statement was contai
in a letter written to Lyman Abbott,
New York. It appeared a day or t
after the publication of the Ballinger
port, and in it the chief forester
swered a number of questions as to
meaning and purpose of the conservati
program, and its several phases, wh
Mr. Abbott had asked. The Pinchot l
ter, in part, was as follows:

"Conservation stands for the same k
of practical common-sense managem
of this country by the people that ev
business man stands for in the handli
of his own business. It holds that
sources now public property shall not
come the basis for oppressive priv

nopoly; it demands the complete and lerly development of all our resources r the benefit of all the people, instead the partial exploitation of them for benefit of a few. It recognizes fully right of the present generation to use t it needs and all it needs of the ral resources now available, but it gnizes equally our obligation so to e what we need that our descendants all not be deprived of what they need.

The danger to the conservation cies in the coming session of Conss is that the privileges of the few y continue to obstruct the rights of many, especially in the matter of er power and coal. Congress must le whether the great coalfields still public ownership shall remain so, in r that their use may be controlled due regard to the interests of the sumer, or whether they shall pass into ate ownership and be controlled in t monopolistic interest of the few.

Congress must also decide whether ensely valuable rights to the use of r power shall be given away to ial interests in perpetuity and with- compensation instead of being held controlled by the public. In most s actual development of water power est be done by private interests acting under public control, but it is neither l sense or good morals to let these ble privileges pass from the public rship for nothing and forever. Other rvation matters will doubtless re- action, but these two, the conserva- f water power and of coal, the sources of power of the present and uture, are clearly the most pressing."

answer to the question: "Why is it rtant to protect the water powers?" M Pinchot wrote:

t is of the first importance to prevent water powers from passing into te ownership as they have been do- cause the greatest source of power now is falling water. Furthermore, he only unfailing source of power. coal, the experts say, is likely to be sted during the next century, our ral gas and oil in this. Our rivers, forests on the watersheds are prop- handled, will never cease to deliver r. Under our form of civilization, few men ever succeed in controlling urces of power, they will eventually l all industry; they will necessarily l the country. This country has ved political freedom: what our e are fighting for now is industrial m. And unless we win our in- al liberty, we cannot keep our al liberty. I see no reason why we d deliberately keep on helping to the handcuffs of corporate control ourselves for all time merely be- the few men who would profit by e heretofore had the power to com- el

" e essential things that must be done to protect the water powers for the people are few and simple. First, the granting of water powers forever, either on non-navigable or navigable streams, must absolutely stop. It is perfectly clear that one hundred, fifty or even twenty five years ago our present industrial conditions and industrial needs were completely beyond the imagination of the wisest of our predecessors. It is just as true that we cannot imagine nor foresee the industrial conditions and needs of the future. But we do know that our descendants should be left free to meet their own necessities as they arise. It cannot be right, therefore, for us to grant perpetual rights to the one great permanent source of power. It is just as wrong as it is foolish, and just as needless as it is wrong, to mortgage the welfare of our children in such a way as this. Water powers must and should be developed mainly by private capital and they must be developed under conditions which make investment in them profitable and safe. But neither profit nor safety requires perpetual rights, as many of the best water-power men now freely acknowledge.

"Second, the men to whom the people grant the right to use water power should pay for what they get. The water-power sites now in the public lands are enormously valuable. There is no reason why special interests should be allowed to use them for profit without asking some direct payment to the people for the valuable rights derived from the people. This is important not only for the revenue the nation will get. It is at least equally important as a recognition that the public controls its own property and has a right to share in the benefits arising from its development.

"There are other ways in which public control of water power must be exercised, but these two are the most important."

The Ballinger report recommended a Letter classification of all public lands, and the enactment of a law permitting the leasing or sale of coal deposits and the right to mine coal separately from the soil. In other words, that the sale of the surface should not carry with it the right to mine coal under the surface. No mention was made in the report of the Alaska coal-lands scandal, however, of the controversy over the Secretary's action in restoring to entry water-power sites in Montana withdrawn by his predecessor, James R. Garfield, nor of any of the other phases of the controversies in which Ballinger has been embroiled almost since the day he entered the Cabinet. This fact caused general surprise, as it was expected the Secretary would make use of his annual report as a method of in part, at least, defending himself from or answering the numerous charges and attacks of which he has been the object.

No mention was made in the report, either, of the Glavis charges, which had then but recently been brought anew to public attention by their publication in the newspapers throughout the country. L. R. Glavis, an employee in the Land Office, was sent to inspect what was known as the "Cunningham group" of coal land claims in Alaska. He found evidences of fraud in the claims, and reported against allowing the lands to be patented. Despite his protests and report, Ballinger ordered the claims clear-listed for patent. This was last summer. At that time Glavis went to the President and presented, in writing and verbally, a long statement of what he knew about the Alaska claims. Before he went West, the President issued a statement exonerating Ballinger from blame or criticism in connection with the cases, and authorizing him to discharge Glavis from the Government employ.

Soon after the publication of the Glavis statement, the President announced that the specific charges and allegations of facts it contained were new to him, as he had not read the statement before making his first decision, and that the letter he signed deciding the case in Ballinger's favor had been prepared by a subordinate in the Interior Department, under Ballinger's directions. Mr. Taft announced that the Glavis charges would be carefully investigated by the Attorney General, with a view to determining whether, as specifically charged, Ballinger had, among other things, violated the law by prosecuting land claims before the Land Office, as an attorney, within two years after resigning as the chief of that office.

The Glavis charges showed that Ballinger had taken a retainer to advance the interests of the syndicate controlling the Cunningham claims, shortly after he left the Land Office, and that it was these claims he had sought to push to speedy patenting soon after he became Secretary. The effect of the Glavis charges was that Ballinger had used his official position to help the Guggenheim interests, which are powerful in Alaska, in an attempt to grab large and valuable coal lands there under claims which he knew to be fraudulent.

In remarkable contrast to the tone of the Secretary's recommendations in his annual report is a statement credited to him in *Hampton's* magazine for December. John L. Mathews, writing on the water power question in that publication, quotes Ballinger as having said, in the course of an interview:

"You chaps who are in favor of this conservation program are all wrong. You are hindering the development of the West. * * * This whole big domain is a blanket. It is oppressing the people. In my opinion, the thing to do with regard to this domain is to divide it up among the big corporations and the people who know how to make money out of it, and let the people at large get the benefit of the circulation of the money."

POWER AND THE ENGINEER

DEVOTED TO THE GENERATION AND TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.
355 Dearborn Street, Chicago.
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of POWER solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "POWPUB," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During 1908 we printed and circulated 1,836,000 copies of* POWER.

*Our circulation for November,* 1909, *was (weekly and monthly)* 162,000.

*December* 7............ 40,000
*December* 14........... 30,000

*This paper reaches* 40,000 *separate readers each month and* 30,000 *each week.*

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*

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## Extension of the Marine Steam Turbine

The marine steam turbine is essentially a thing of today, and yet it was not yesterday nor last year that a shipbuilder said to an American visitor: "I am showing you this engine because it will be only a few years when you will have to go to a museum to see one." Had the shipbuilder been the American, the visitor might have accused him of bluffing, for the Parsons' company at that time understood its limitations and estimated the ships to which it could then apply turbines as not more than one-fifth of the number afloat.

Now the engineering profession is striving in various ways to remove the limitation, by use of reduction gearing, by combination of turbines with reciprocating engines, by combination of turbine and electric motors and by substitution of electric motors. In the last two cases the current for the motor is generated by an electric generating set essentially equivalent to the land power station.

In POWER of November 19 there is described a form of gearing patented by Melville and Macalpine, with a floating frame which is intended to assure equal distribution of pressure on the face of double helical gears of the type used for the De Laval turbine. They estimate that 6000 horsepower can be eliminated through such a gear with 1¼ inches pitch and admit that a lack of alinement of one-thousandth of an inch would lead to excessive stress. Accustomed as we are to the marvelous accuracy of modern machine tools, we may be excused for having an expectant frame of mind while this problem is under practical test.

A combination of turbines and reciprocating engines is no new thing because the Vilox, built in 1903, had a reciprocating engine on the middle shaft (which alone was used for cruising), and two turbines on the wing shafts taking steam from the engine. The combination appears as a makeshift and was not repeated.

At the August meeting of the Institute of Engineers and Shipbuilders in Scotland, a description was given of the steamship "Otaki," for the New Zealand trade, fitted with two triple engines on the wing shafts, and a low-pressure Parsons turbine on the middle shaft. The turbine is used only for full speed ahead, the ship being manoeuvred by the engines, which then exhaust each into its own condenser. In the normal running the two engines exhaust into the turbine which is connected to both condensers. The distribution of power among the engines is not given in the article, but it is stated that the theoretical available heat units per pound of steam are 200 for the two engines and 120 for the turbine, so that an approximately even distribution of power appears to have been aimed . But the ratio probably is more nearly the ratio of 100 to each of the two e gines and 130 to the turbine. This co clusion can be reached as follows:

The initial pressure in the high-pr sure cylinder is 196 pounds absolute, a the exhaust pressure of the turbine one pound, which leads to a theoretic steam consumption on Rankine's cycle 7.7 pounds, while the ships steam co sumption was 12.35 at full speed, the in cated horsepower being taken for the e gines and the shaft horsepower for t turbine. If we take the effect of fricti of the engines to be represented by t factor 0.9 for the combination, the e gines and turbine have a factor of ab 0.7 for their use of heat. If this be tributed to the engine, the entropy will increased from about 1.54 at entrance the cylinder to 1.64 at entrance to t turbine and at that entropy the adiaba available heat between 9.8 pounds and pound is, as already stated, about thermal units.

In order to allow for the introducti of the turbine and the raising of the ba pressure from (perhaps) two pounds 11.5 pounds, the ratio of the high-pr sure cylinder to the low-pressure c inder was made 1 to 5.6 instead of to 7.93 as used for the sister sl "Orari." The displacement was at same time increased to allow for 30 to increase of weight of the combination m chinery as the owner did not desire reduce either the boilers or the bunk capacity. But the saving of coal for round trip was 500 tons, half of wh being allowed for the outward trip wou show a good margin of increased ca capacity even if the displacement had b maintained unchanged. The engine-ro space was not increased, and the possi reduction in bunker capacity would ea have offset the space required for th tunnels. Although the propulsive ciency of the turbine ship was 0. against 0.555 for the ship with the recip cating engines, there was a clear gain economy of 14 per cent.

The turbine drum had a diameter 7½ feet and made about 225 revoluti per minute, which gave a peripheral sp of about 88 feet per second, which is c servative for steamship practice. T blades were 4¾ inches long in the f expansion and 12$\frac{11}{16}$ in the last.

The combination appears to be a fav able one, using the engine when it operate most favorably and the turb when the mechanical and thermal con tions are advantageous.

Since the "Otaki" has a trial speed 14.6 knots and was designed for a sp of 12 knots, the steam turbine may considered to be an established fact ships of medium speeds.

At the recent meeting of the Society Naval Architects and Marine Engine

V. I. R. Emmet, of the General Electric ompany, presented a paper giving two r positions for electric propulsion of ips; one he calls the "combination riven" and the other the "electric riven." The first method was proposed the Navy Department in bids for the nited States steamships "Arkansas" and Wyoming," but of both Mr. Emmet says: These plans—if opportunity offered, ould be contracted for and fully ranteed." and such a proposition comg from a company such as he represents not be treated as academic.

For the combination drive two proers are proposed and on each shaft ere is to be a low-pressure steam ture and an electric motor, the power at speed being in the proportion of two-ths for the turbine and three-fifths for e motor. The parallellism with the mbination of the reciprocating engine d turbine is evident, except that in this se the motor has the same speed as the rbine and there are but two propellers. e turbines are provided with nozzles r high-pressure steam and can drive ship at 19 knots, the full speed being 5. The combination is worked out for rious speeds from 12 to 21 knots, with water rate per shaft horsepower varyg from 12 pounds up to 13.5 pounds d back again to 12 pounds, as the ed increases from 12 knots up 21.

Mr. Emmet naturally prefers the aight electric drive especially as it kes a much better showing when ghts are considered. For this electric ve he estimates the steam per shaft sepower from 12.3 up to 13.4 and back 12.3 for the screw range of speed as f the combination drive. As a basis of c parison he has chosen the guaranteed ghts of proposed Parsons turbines for ich the weight of the turbine is 484.5 s. His estimate for the combination de is 520 tons and for the electric drive i 54 tons. For either case a notable red tion of boiler weights could be att ed in consequence of the improven t in steam economy.

t, however important the boiler and e ne-room weights may be, the real adv age from either method would be f d in the steam and coal economy, a would find its most notable expressi in the increase of steaming radius. M Emmet estimates that the electric d e would enable the ship to carry ly a tenth more coal and that the t ming radius at 12 knots would be n eased by 69 per cent.

sum up, the combination of engines a low-pressure turbines, extends the apication of the latter without threatenin the former; but the established succe of either reduction gearing or the el ric drive would open the door to the m eum of antiquities for our reliable fr d—the marine engine.

## Ventilation of Boiler Rooms

In a recently proposed boiler inspection ordinance for a western city, provision was made for the supervision by the city boiler inspector of the arrangement and ventilation of boiler rooms. Objection was raised to this clause, on the ground that the ventilation of a boiler room had nothing to do with the safety of the boilers which was all the city boiler inspector should concern himself with; that ventilation was beyond the scope of his official duties, etc.

We believe that the drawer of the ordinance is correct, and that the objection is unwarranted. To give special weight to our opinion, we will quote a specific case which came under our notice some time ago.

In the boiler room in the basement of a hotel, there were three 250-horsepower water-tube boilers, working somewhat beyond their capacity. The boiler room was, of course, underground. It was small, dark and hot. During the month of August, the hottest month in the year, *one hunndred and ten firemen were hired to fire these three boilers.* The men simply would not work under such conditions. Some of them, after being on watch a short time, went up the companion way leading to the alley and disappeared into the night.

This condition of affairs could not, of course, continue, and it was terminated by an accident to one of the boilers, which drew especial attention to their condition, which attention was followed by the installation of new boilers and other improvements.

In the old days of boiler simplicity, with their low pressure per square inch, and their low evaporation per square foot, the boiler inspector with his tallow dip and six-pound hammer, who, in his examination, did not look beyond the plates, the braces, and the tubes, if there were any—filled all the requirements of the time, but today we must have a man with an eye that looks beyond the boiler shell.

In the examination of a boiler, too many inspectors limit their breadth of view. A number of cases have come under our notice, which show that it is not sufficient to confine the examination to the boiler only, and that, beyond the boiler, unsatisfactory conditions which affect the safety of the plant should be criticized, as well as the boiler itself. We have in mind one plant—a quarry—where there were two boilers, located half a mile apart, with one man to attend both. As a result of his inability to be in two places at one time, the water got low in one boiler, and the flue collapsed. In such a case, the boiler inspector should have recommended one attendant for each boiler.

In another case, the forced-draft apparatus was so arranged that some of the products of combustion were forced into the boiler room; and there was but one door through which the fireman could escape in case a tube let go.

The boiler room must be habitable. If it is not, the boiler hazard is increased, from which it logically follows that if it is the duty of the city boiler inspector to reduce the boiler hazard, he must concern himself with the arrangement and the ventilation of the boiler room.

## Safety Necessities and Safety Devices

Some engineers advocate automatic low-water alarms, feed-water regulators, etc. Other engineers do not, and the latter class are often asked by the former why they use safety valves, or water gages, as these are similar devices.

These two natural differences of opinion are based upon a man's judgment as to whether a man or a machine is the more nearly infallible. The human mind cannot be reduced to a mathematical basis; human nature will not do what you expect it to do, and a man will forget. On the other hand, no machine is perfect, and sooner or later it will wear out, or tear out, or burn out, or break, or buckle, or stop up with scale.

So each man is left to lay his own course between this human and mechanical Scylla and Charybdis. If the attendant is lazy and ignorant, we would choose the machine. If the attendant is bright and alert, healthy and dependable, we would cast our lot with the man, but, as a general proposition, we regard the safety valve, water glass and steam gage as "safety necessities;" low-water alarms, automatic-feed regulators, etc., as "safety devices," and believe that under ordinary conditions, these mechanical safety devices supplement the watchfulness and activity of the attendant. The danger is that the attendant may get to relying upon them too implicitly, and shirk his responsibility if they fail. The safe operation of a boiler depends most of all, upon the personal moral responsibility of the attendant.

## Warning!

A person representing himself as a subscription representative of POWER has recently been at work in the vicinity of Baltimore, Md., and is probably working South. He signs receipts in the name of Helltmill or Kenneth. He is an impostor and the publishers of POWER will be glad to reward anyone who can give information leading to his capture. All our regular representatives carry a card of authority, which they will gladly show upon application.

# Power Plant Machinery and Appliance

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

## The Reagan Stoking Grate

A stoker, according to the Century dictionary, is "one who attends to and maintains suitable combustion in a furnace," and a mechanical stoker an "automatic device for feeding fuel to a furnace and for keeping the grate free from ashes and clinkers."

Since the first definition includes in practice the putting on of the fuel as well as the burning of it, the term "stoker," as usually employed, conveys the idea of a device to feed as well as to manipulate the fire.

In applying the term to his new grate, however, James Reagan, of 209 North Front street, Philadelphia, Penn., uses it only in the sense of "working" the fire, breaking it up, lifting the clinker from the grate, doing in fact, what the human stoker does with his fire tools. The grate surface is made up of the three elements shown in Fig. 1 which are assembled as in Fig. 2. The long stationary member *C*, Fig. 1, is made in the form of a hollow truss of inverted U-shaped section, with great depth for its length, a favorable disposition of the metal to dissipate heat and sustain stresses, with ample air passages and with no sharp points or edges in the fire. Between these stationary bars are placed upon square rocking bars the short and heavy rocking bars *B* such as have long been used in the Reagan chopping grate. The essential feature of this grate, however, is the lifting bar *A* which does precisely what the human stoker does with his slice bar, with soft-coal fires, lifting the bed and slicing it without opening the fire doors and without torture to t firemen. These are placed in rows e tending the full length of the furnace, shown in Fig. 2, and are operated i dependently of the chopping bars oscill ing upon spools *D*, Fig. 1, which a strung upon the same square bar whi carries the chopping grates and which turn pass through the lifting bars at The bar is tilted to such an angle th the lugs upon the end of *D* will pa through the aperture in the circle, b never in operation are they tilted to a angle which releases them from the lu which thus hold them from sidewise m tion. The lifting bars are box-like section, having grated surfaces upon t side which admit air freely and are suf ciently subdivided to avoid heating an warping, and which prevent the fire fro falling in under the bar when it is lifte which would not allow of its comple return to the grate level.

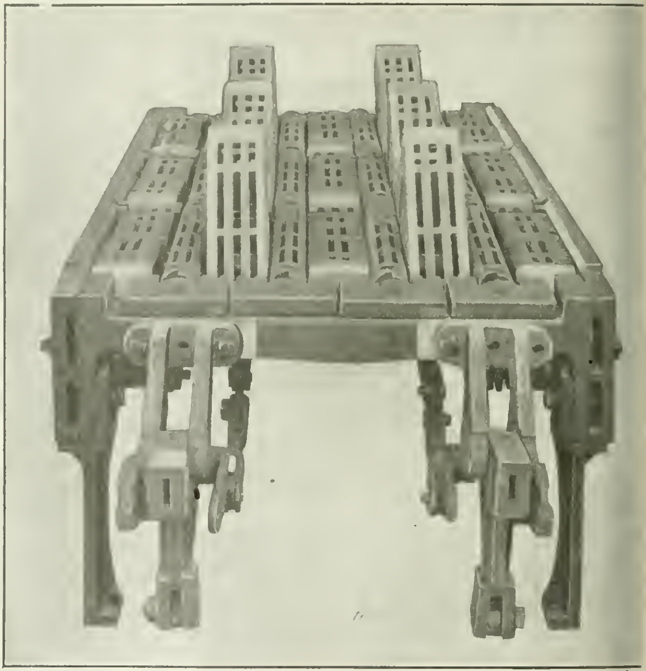


FIG. 2

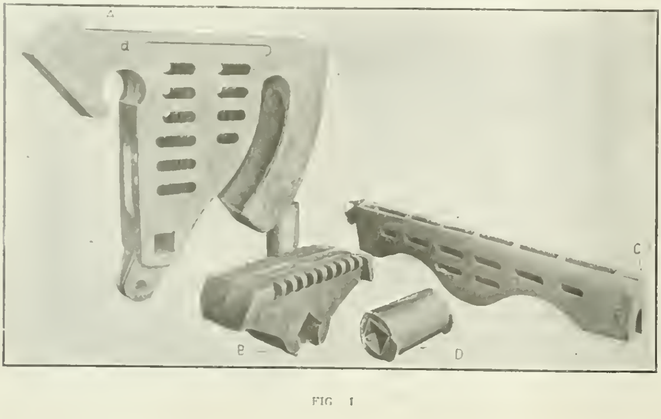


FIG. 1

With the advantage of being able

sl as well as to clean off the bottom the fire whenever necessary, to keep it and free and to do this without g doors and interfering with the ous process of combustion, Mr. n is able to considerably increase tput of a boiler without reducing iciency, which is in line with the re ments of the modern central station the efforts of progressive engineers.

## ulton-Corliss Speed-Limiting Device

e ordinary Corliss valve gear the ock, catch block, or whatever f detaching device is used, is caused se its hold on the steam valve by in contact with a knockoff cam, ition of which is controlled by the r, lengthening or shortening the cording to the load on the engine. r, the movable disk upon which this is located also carries another, or cam, which is designed to come y under certain circumstances. anything happen to the governor vernor belt, the safety cam is im- y brought into play by the action governor balls dropping to their position, the steam valves refusing up, and the engine stops.

has become standard practice on ngth of the argument that it is stop the engine, no matter how nt the load it is carrying, than to nces of its running away. This utting-down action occurs if the is overloaded sufficiently to de- the revolutions to a certain point an one of the annoying features of C ri engine operation.

T void this trouble engineers have been own to resort to the questionable practice of permanently blocking up the governors of their engines, thus running chances of disaster by eliminating all safety guards connected with the valve gear. It was to overcome this disadvantage that the Fulton Iron Works, St. Louis, Mo., brought out and patented the speed-limiting device illustrated herewith.

It consists, as shown in Fig. 1, of two separate governors, the main governor *A* being connected by rods with the knock-off levers and cams in the usual manner, and taking care of the variations of cut-off according to the load. The auxiliary governor *B* connects through a reach rod and bell-crank levers with the safety cams on each end of the cylinder. These are not attached to the knock-off disk, but swing on the valve stem to the same radius through slots in the disks, as shown at *C*, Fig. 2. Ordinarily the safety cams are held back so that the steam valves pick up at each stroke regardless of the speed of the engine, allowing the engine to hold on to the load as long as there is a pound of steam behind the piston. When at or below normal speed the auxiliary governor rests on its seat, and does not come into action in any way until the engine exceeds its speed limit due to the derangement of the main governor, when the safety cams are drawn around sufficiently to prevent the steam valves from picking up, and the auxiliary governor takes charge of the engine.

Either governor may be put out of commission entirely, and so long as the other one is in good order, the engine may be operated as usual until such time as it is convenient to make repairs, as each alone is sufficient to prevent the engine from running away.

When applied to a compound engine the main governor controls the cut-off on both the high- and low-pressure cylinders, as in usual practice, the auxiliary governor being applied only to the high-pressure cylinder.

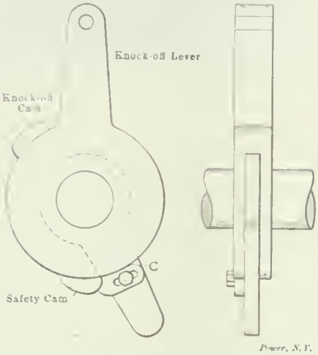
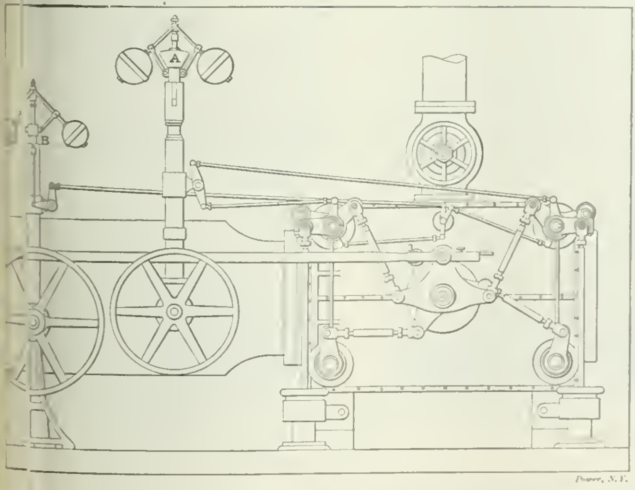


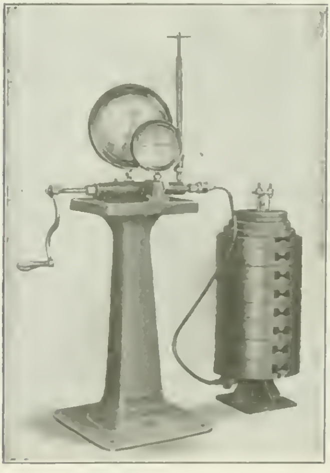
FIG. 2. SHOWING SLOT IN DISK



IG. 1. GENERAL ARRANGEMENT OF FULTON-CORLISS SPEED-LIMITING DEVICE

## Calibrating Apparatus for Hydraulic and Other High Pressure Gages

The bursting of machine parts and fittings from excessive fluid pressure is usually accompanied by considerable danger, expense and delays for repairs. This is especially true with the extremely high working pressures under which liquids and air are often used. It is, therefore, quite important to know the pressure conditions within any apparatus using these sources of power, and for this reason the gages should be calibrated at regular intervals. Under the higher hydraulic pressures it is frequently the case that the same gage will show different percentages of error at different pressure



WATSON-STILLMAN GAGE TESTING APPARATUS

readings, and these can be compensated for in ascertaining the true pressure only by comparing with a "master" gage of known accuracy or by loading with a known pressure.

The outfit illustrated herewith performs these two functions of testing by comparison with a master gage and of testing the accuracy of the master.

For the first, only the part on top of the stand is required. This consists primarily of a cross made of hydraulic bronze. The gage being tested, which may register any pressure up to 16,000 pounds per square inch, and the master are attached to the front and back ends of the cross, respectively. At the left is a crank-operated screw displacement piston, by means of which the desired pressure may be produced within the pressure chamber. A suitable stuffing box prevents leakage past the piston. To the right end is connected a stop valve and filling cylinder. This permits (1) some of the liquid to be withdrawn from the pressure chamber before removing the gage being tested and (2) filling after a gage is put on. There is thus no danger of spilling the oil.

For testing the master gage, the special weight-loaded, hardened and ground steel piston and cylinder are attached at the right by means of flexible copper tubing, as shown. These parts are cut out by a stop valve when not testing the master. The cylinder is long enough to have the center of gravity of the weight below the center of support. When the weights are revolved the friction due to lifting the weights is practically eliminated. The apparatus is made by the Watson-Stillman Company, of New York.

## Automatic Sight Feed Oil Pump, Model "A"

The illustration presented herewith, in Fig. 1, shows the Model "A" oil pump, which is built with from two to thirty feeds in multiples of two, and designed to pump oil to bearings on engines and other steam machinery where forced lubrication is necessary.

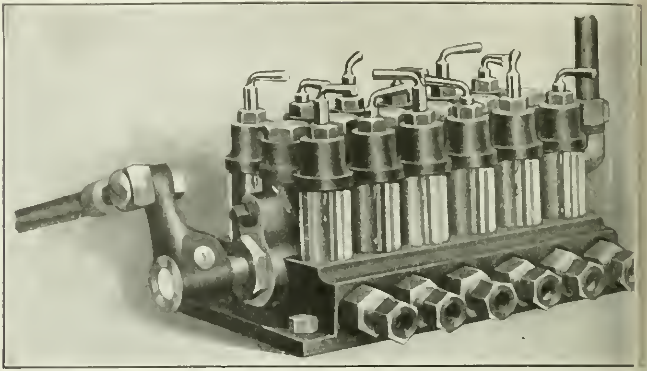


FIG. 1. MODEL "A" OIL PUMP

It is of compact design as shown, being but 9 inches long, 5⅛ inches high and 7¾ inches wide. It is suitable for air compressors, or vertical gas-engine work where a large number of feeds are needed, and where a bulky pump would be in the way.

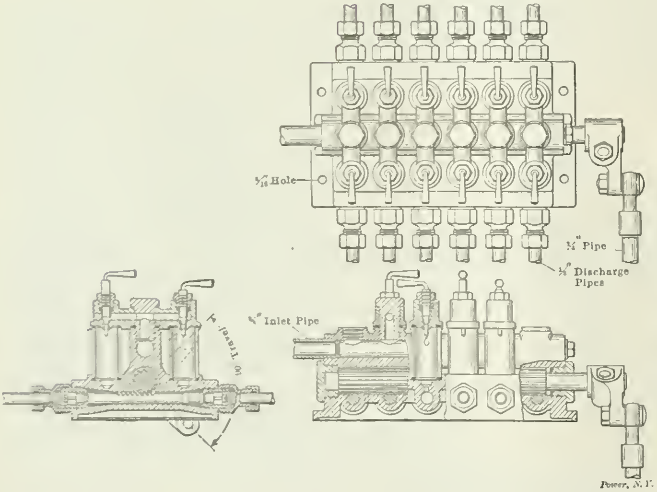


FIG. 2. DETAILS OF OIL PUMP

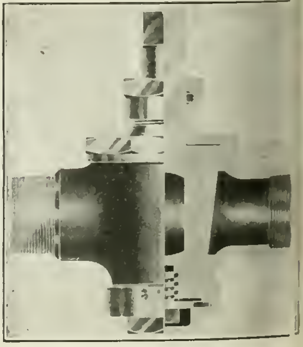
The feed valves are conveniently located; the plungers are made of polished-steel drill rods, working in hard-bal cones which can easily be tightene compensate for any wear taking place sectional view of the pump is show Fig. 2.

Oil supplying the pump may be tained from an oiling system, or o head tank, or a small tank may be cated at any convenient part of the gine or compressor as desired and feed regulated to feed a drop or floo bearing at will. A valve is placed the supply line, which allows all of oil being shut off by closing this valve without disarranging any of feeds. The lever travel operating pump plunger is positive.

This pump is manufactured by the S Feed Oil Pump Company, Milwau Wis.

## Ashton Improved Blowoff Val

A valve which has been especially signed for long service and ease of eration, which embodies simplicity construction and effective means of justment for taking up the wear of plug, is the improved blowoff va



IMPROVED BLOWOFF VALVE

manufactured by the Ashton Valve Company, 271 Franklin street, Boston, Mass.

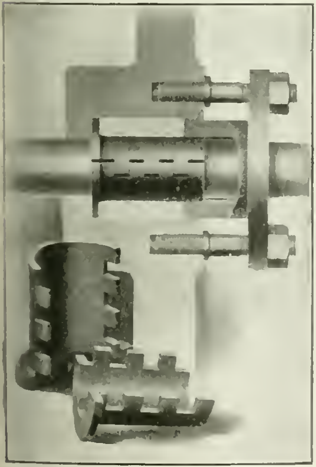
The valve is composed of a composition body with a plug inserted in the same. The novel and new feature about it is the screw adjustment, shown at the bottom, whereby on opening the cock the plug is raised slightly from its seat, which allows it to turn free in the case. In closing, the plug is drawn down to its seat, thus avoiding friction and sticking.

In order to adjust the cock after grinding, the plug is placed in its closed position, as shown, and the screws turned up tight at the bottom, and the outside bottom cap then screwed on tight to hold the screws in position. This valve is made of ⅛-, 1½-, 2- and 2½-inch size.

## Universal Flexible Packing

This type of packing, manufactured by the Universal Flexible Packing Company, 3109 Penn avenue, Pittsburg, Penn., is illustrated and described herewith.

It is composed of a metallic tube or sleeve which encircles the rod within the tuffing box, and is made in two semicircular sections provided with interlocking tongues or lugs, as shown in the illustration. These semicircular sections are capable of yielding circumferentially to take up wear, contraction and expansion, by means of play or clearance at he tongue extremities, and are also pable of preventing possible leakage of team, air or water by interlocking or losely engaging laterally.



UNIVERSAL FLEXIBLE PACKING

These sections are compressed around ie rod by soft, or fibrous packing, which urrounds the same within the stuffing ox, and is held in contact with the od by the pressure of the gland extension against the soft packing, which forms, it is said, a perfectly steam-, air- or water tight joint, capable of being maintained for a long period with little or no attention.

It is said that this packing can be applied to any kind of stuffing box without alterations or inconvenience, and without disconnecting any part. Each section is provided at the inner extremities with a small shoulder or flange which engages the fiber packing, thus preventing possible displacement by the pressure acting edgewise on the metallic section. This packing is made of special antifriction metal, which it is said preserves the rod from scoring and reduces the friction to a minimum.

## Little Giant Tube Extractor

As the name implies, this device is for the purpose of removing tubes from return- and water-tube boilers, without the necessity of disturbing any other than the defective tube.

Fig. 1 shows the device, also the starting tool. When a tube is to be removed, the three expanding pieces are placed in it, and the screw extension, which has a threaded taper at one end, is screwed into the tapered, threaded inner surface of the three expanding pieces.

The collar shown on the other end of the screw rod fits in the upper opening of the extractor, when the expansion pieces are forced apart by screwing in on the threaded rod. This causes the outside surface of the expansion piece to grip the inside surface of the tube

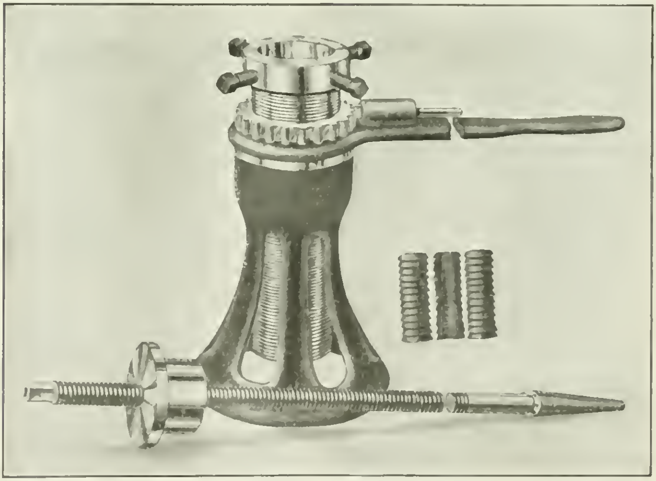


FIG. 1. "LITTLE GIANT" TUBE EXTRACTOR

The ratchet device is then brought into play, and by turning in the direction necessary to screw the long thread bushing out, the tube is drawn from the tube sheet. When it has been drawn sufficiently to admit placing the extractor over it, the device first used is removed, and the tube drawn out by tightening on the four set screws, as shown. Fig. 2 shows how the jack is adjusted to a tube. This device is manufactured by the Statenfield-Robertson Company, 621 Park building, Pittsburg, Penn.

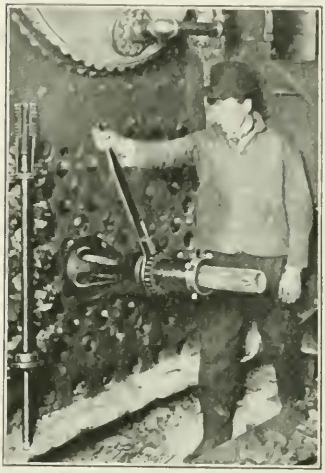


FIG. 2. DRAWING A TUBE

"Gas engines of 5000 horsepower are here," said Edward T. Adams, of the Allis-Chalmers Company, speaking recently of the state of gas-engine development, "and engines of twice 5000 horsepower are nearer to us than the first 1000-horsepower is, looking backward."

## Firemen's Licenses in Ohio

The following letter has been sent by W. F. Haswell, chief examiner of steam engineers for Ohio, to holders of firemen's permits or licenses:

Dear Sir:

Upon taking charge of this office November 15, 1909, I learned that on November 4, 1909, an opinion had been requested from the Attorney-General relative to the legality of issuing stationary-firemen's licenses to persons operating stationary steam boilers *only*.

November 20, 1909, the Attorney-General rendered an opinion that such licenses have heretofore been issued under a misconstruction of the law regulating the licensing of engineers, and that this department has no authority to issue any other than an engineers license to operate *stationary steam engines and boilers.*

Therefore, it becomes necessary to at once discontinue the issuance of such firemen's licenses either by examination or by renewals, and it is necessary for all persons holding such firemen's licenses to secure engineers' licenses before they may lawfully operate stationary steam boilers of more than thirty horsepower in the State of Ohio.

I desire to state that it is the intention of this department to request the general assembly at the coming session to pass some sort of remedial legislation permitting the licensing of persons to have charge of boilers *only*.

I have instructed the district examiners to notify all persons now holding firemen's licenses to report for examination for engineers' licenses at a date which will be fixed by the district examiners. It is impossible to examine at once all persons holding firemen's licenses, as it will be necessary to make certain arrangements in the way of preparing lists, arranging time, and the numerous other details that will be involved in examining such a large number of persons. Therefore, this department, on account of the above delay, will be very reluctant, as far as is consistent with the law and the general welfare of all persons affected by this ruling, to prosecute firemen for violation of the engineers' license law until after the date fixed by the district examiners for such examinations.

Yours very truly,
W. F. Haswell,
*Chief Examiner.*

The opinion referred to is as follows:

Hon. Wm. E. Kennedy,
*Chief Examiner of Steam Engineers,*
*Columbus, Ohio.*

Dear Sir:

I am in receipt of your letter of November 4, in which you submit the following for my opinion thereon:

The department of stationary steam engineers issues two classes of licenses, one called firemen's license, and the other called engineers' license. To be eligible for examination, applicants for either of the licenses are required to file the same application. The examination, however, is different. The engineer's examination is more difficult than the fireman's and a different list of questions is presented to each class. The engineers are examined upon the following subjects: Construction and operation of steam boilers, steam engines and steam pumps, and also hydraulics, while the firemen are not examined upon the construction and operation of steam engines, but are examined upon the other subjects. The engineers' license permits the holder to have charge of and operate any stationary steam boiler or engine in the State. The firemen's license permits the holder only to operate stationary steam boilers not connected with an engine.

You desire to know, first, if your department has authority to grant the class of licenses described as firemen's license, and, second, what is the status of one who has been granted such license?

I desire, first, to call your attention to an act relating to the licensing and examination of steam engineers, 95 O. L. 48, as amended in 97 O. L. 28. Section 1 of said act is as follows:

"That it shall be unlawful for any person to operate a stationary steam-engine boiler or engine in the State of Ohio, of more than thirty (30) horsepower, except boilers and engines under the jurisdiction of the United States, and locomotive boilers and engines, without having been duly licensed so to do as herein provided. And it shall be unlawful for any owner or user of any steam boiler or engine, other than those excepted, to operate or cause to be operated such steam boiler or engine without a duly licensed engineer in charge."

You will note the above section makes it unlawful for any person to either operate a *steam boiler* or *engine* of certain horsepower without first being a duly licensed engineer within the meaning of this act.

At this point I desire particularly to call your attention to the fact that the act under consideration nowhere makes any distinction between persons who desire to operate a *steam boiler* and persons who desire to operate a *steam engine* of a horsepower mentioned in the act. To operate either, one must be a licensed engineer, and if one may operate a *steam boiler* he may operate *a steam engine*, therefore, their qualifications must be the same. It is necessary to look to section 6 of the act, which is the only section which provides the method of obtaining an engineers' license. Section 6 is in part as follows:

"Any person who desires to act as a steam engineer shall make application to the district examiner of steam engineers for a license so to act, upon a blar furnished by the examiner, and shall su cessfully pass an examination upon t following subjects; the construction ar operation of steam boilers, steam engin and steam pumps, and also hydraulic under such rules and regulations as m be adopted by the chief examiner, whi rules and regulations and standard examination shall be uniform througho the State. If, upon such examinatio the applicant is found proficient in sa subjects a license shall be granted him have charge of and operate stationa steam boilers and engines of the hors power named in this act."

You will note this section requires th all applicants for steam-engineers' licen shall pass an examination in certa enumerated subjects under such rules ar regulations as may be adopted by t chief examiner, but in all cases the stan ard of examination shall be unifor throughout the State, and then if su applicant is found proficient he shall granted a license "to have charge of ar operate stationary steam boilers and e gines of the horsepower named in th act." The above provisions are ma datory, and condensing the same we hav

1. An examination in *certain enume ated subjects.*

2. Uniform standard of examination

3. If found proficient in the above tv provisions to be given a license to ha *charge of and operate stationary stea boilers and engines.*

Answering your first question, I b to advise that I am of the opinion th your department is without authority grant the class of license known "Firemen's License" for the followi reasons:

First, you are without authority grant any license except to have *char of and operate steam boilers and engin* and you cannot limit such license to on steam boilers. Any person entitled to license is entitled to a license to ha charge and operate both steam boilers ar engines.

Second, the examination which y have been giving to firemen does n cover all of the enumerated subjects me tioned in section 6, to-wit, firemen a not examined in the construction and o eration of steam engines.

Third, the examinations which have be given by your department are not *uniform standard* as required within t meaning of this act.

Answering your second question, I a of the opinion that a person holding firemen's license is without authority operate a steam boiler as he has n passed the examination required in se tion 6 to obtain an engineers' license, ar also that your department was witho authority to issue a firemen's license them; and as all the authority whi your department has is given to it statute, and such authority has not been given to you, the same cannot be exercised.

In conclusion I desire to advise that e present stationary-engineers' law was eld to be constitutional by the Circuit Court in the cases of E. R. Theobald vs. State, W. S. Judd vs. State and Frank Stepens vs. State, reported in 10 Ohio Circuit Court (n. s.), page 536, and af- rmed by the Supreme Court without re rt

Whether it was wise or unwise that this w was so drafted as to require the ve holdings, this office cannot change law as it reads. It is only for us to clare the law as we find it.

Yours very truly,
(Signed) U. G. DENMAN.
*Attorney-General.*

## Chicago Meeting of the National Gas and Gasolene Engine Trade Association

The first annual meeting of this organ- ation was held November 30 and De- mber 1 and 2 at the La Salle hotel, icago. The object of the association to promote, further and advance the rests of the trade, and to hold a na- al convention once a year for the rpose of promoting education and iability among the members. That the ects above outlined were abundantly alized at this meeting was evidenced m the large attendance and great unt of interest taken at the various ssions. Numbers of outsiders, including m engineers and others vitally in- rested in gas-engine development, were ited and all took advantage of the op- rtunity to be present and hear at first d what the latest developments in s line had been during the past year. the Wednesday evening session the ternal Combustion Engineers' Associa- n of Chicago attended in a body and k part freely in the discussion of vari- practical problems.

Among the papers presented at the ting were "Associations and Experi- es," by T. R. Fleming; "The Time ngth of Contact with a Special Refer- e to Marine Engines," by E. E. Hud- ; "Springs for Gas Engines," by F. E. ittlesey; "Advertising of Gasolene En- s and Accessories from an Adver- ter's Standpoint," by M. A Loeb; actory Costs," by O. C. Parker; "The proach of Theory and Practice in dern Gas Engines," by A. J. Frith; ome Features of the Mechanics of a s Engine," by A. W. Moseley; "Gas oducers," by F. P. Peterson; "The Gas gine Business from the Dealer's Stand- nt," by J. W. Moss; "Storage Bat- ies," by Martin Geiszler, Jr.; "Gas gines," by Harry T. Wilson. One of the unique features of the meeting was the series of ten-minute talks by men well qualified in their particular lines to give practical information on their chosen subjects.

The sessions ended with a banquet at the La Salle hotel with James W. Gardner presiding as toastmaster. Fun Night was the title of this last event on the program, and proved to be a suitable windup for the instructive meetings that had gone before.

Officers for the ensuing year were chosen as follows: M. A. Loeb, Cincinnati, O., president; C. O. Hamilton, Elyria, O., vice-president; Otto M. Knoblock, South Bend, Ind., treasurer; Albert Stritmatter, 224 East Seventh street, Cincinnati, O., secretary. Cincinnati was chosen as the place of next meeting.

## Society Notes

At a meeting held November 23, 1909, Brooklyn Association No. 8, N. A. S. E., passed appropriate resolutions on the death of William A. Powers.

Internal Combustion Engineers' Association meets second Friday, 8 p.m., each month at Fraternity hall, 70 Adams street, Chicago, Ill. Charles Kratsoh, secretary, 416 West Indiana street.

Newark No. 3, N. A. S. E., of New Jersey, will celebrate their silver anniversary by an entertainment and reception on Friday evening, February 4, 1910, at the new Auditorium, 81 Orange street, Newark, N. J.

Local No. 56 of the International Union of Steam Engineers, of Brooklyn, held its masque and civic ball on Saturday evening, December 4, at the Brooklyn Labor Lyceum. Prizes were offered for the best costume at the ball. The attendance was so large that there was scarcely standing room, and from all reports those attending spent a very enjoyable evening.

The next convention of the Wisconsin Electrical Association will be held at the Pfister hotel in Milwaukee, January 19 and 20, 1910. This association was organized during the past summer, and is an amalgamation of the old Northwestern Electrical Association, and the Wisconsin Electric and Interurban Railway Association. A strong program is being arranged and indications are that the convention will be unusually successful.

Fully two thousand members, guests and friends gathered at the New Amsterdam opera house on Saturday evening, December 4, to celebrate the twenty-second annual entertainment and ball of the Eccentric Association of Engineers, No. 1, of New York City. The proceeds of this yearly event is placed in the bank to the credit of the widows' and orphans' fund. This occasion always attracts a representative body of engineers and business men, and each year there has been a large increase in the attendance. The hall was neatly decorated. An excellent vaudeville entertainment was followed by dancing and a most enjoyable night was spent. The committee in charge of the arrangements included James Smith, chairman, Charles J. Drum, secretary, and Emil Sonnenberg, treasurer. The officers of the organization are: William Keogh, president; Richard Butler, vice-president; Thomas Mulvey, financial secretary; James C. Craig, recording secretary; Henry Bott, treasurer; Thomas Tobin, conductor; Patrick Quinn, warden.

The first concert entertainment, supper and ball of the combined associations of the National Association of Stationary Engineers of Philadelphia, Penn., was held at Lulu Temple on Friday evening, December 3. By eight o'clock nearly every seat in the large hall was occupied. An organ recital by Mr. Ross, the well known organist, of Philadelphia, was first on the program, and following a most enjoyable entertainment was given by the New York "Bunch." At the conclusion of the entertainment the assemblage was invited to the dining hall, and in a few moments upward of one thousand ladies and gentlemen were seated at the tables to partake of the appetizing dinner. A dancing program of sixteen numbers followed. Everybody voted the occasion a grand success. There were in attendance many prominent personages in engineering circles, and delegations from nearby cities, among them being National President William J. Reynolds and Past National Presidents Lynch, Stone and Carney. The combination includes the following associations: Quaker City No. 1, Tacony No. 9, Merrick No. 12 and Northeast No. 20. The arrangement committee comprised Lewis H. Covington, chairman; James Hobson, Frank Mellor, No. 1; F. Caldwell, secretary; L. G. Smith, Albert Schleher, No. 12; Enoch Carless, treasurer; Harry Blessing, Edward Burke, No. 9; G. F. Duemler, corresponding secretary; Richard E. Calvert, William Schofield, No. 20.

## Personal

Charles Robbins, who has for many years been connected with the Westinghouse Electric and Manufacturing Company in the industrial and power sales department in connection with the sale of industrial motors, has recently been appointed manager of this department. Mr. Robbins has been with the company since 1899, in which time he has been in the manufacturing department, the New York district office sales department and for the past three years in the industrial and power sales department at East Pittsburg. His headquarters will continue to be at East Pittsburg.

## Boiler Explosion at Shelton, Conn.

On December [illegible] a boiler explosion occurred in the plant of the Radcliffe Brothers' woolen mills, Shelton, Conn., resulting in the death of one fireman and a property loss to stock and building estimated at $[illegible]. According to early reports the building was badly damaged and a brick chimney standing next to the boiler room was toppled over. Details as to the cause of the explosion are not available, but an expert observer is on the ground for POWER and his report will be published at an early date.

## Business Items

E. A. Wilcox Manufacturing Company, of Chicago, reported an exceptionally good business in the sale of their Wilcox gasket, and have added to their line a new valve-stem packing to be known as the Target brand.

The Albers Brothers Milling Company, Portland, Ore., has placed an order with the Minneapolis Steel and Machinery Company for a 14 and 28x36-inch heavy-duty, cross-compound Twin City Corliss engine which will be used for driving its mill.

The Foos Gas Engine Company, Springfield, Ohio, recently received an order for six 150-horsepower three-cylinder vertical gas engines, from the Hazel-Atlas Glass Company, of Wheeling, W. Va. This order is for additional equipment and is placed after the use of eight or ten Foos engines during a period of eight years. The Foos Company is working two shifts of men to the full extent of the factory equipment, but is still unable to keep up with orders. A large addition to the plant is considered.

The Lukens Iron and Steel Company, Coatesville, Penn. will install a complete plant consisting of a 750-kilowatt, 250-volt, direct-current, Rateau Smoot low-pressure turbo-generator set, including a Rateau regenerator, condenser, etc. The Ball & Wood Company will furnish the Rateau-Smoot turbine and the Smoot generator. The Rateau Steam Regenerator Company are the general contractors for the plant. The Ball & Wood Company has also recently closed a contract with the Maryland Steel Company, Sparrows Point, Md., for two 750-kilowatt, 250-volt, direct-current Smoot generators, to be directly connected to Rateau-Smoot low-pressure turbines. In each of the above cases the units are to operate on exhaust steam. The Lukens installation at 16 pounds absolute and the Maryland steel installation at 10 pounds absolute.

The Dodge Manufacturing Company, power transmission engineers and manufacturers of Mishawaka, Ind., maintain stores and warehouses in many of the principal cities in the country, in connection with expert engineering departments. It has been the policy of the Dodge people to extend this service from time to time until it now takes in nine points. Announcement has just been made of the addition of Minneapolis, Minn., and Atlanta, Ga., to the list. The Minneapolis store is located at 202-204 Third street, South, and the warehouse at 312 to 320 First street, North, and Burke Richards, former resident salesman at Cleveland, O., has been promoted to the position of manager. The Atlanta branch and warehouse is located at 54 Marietta street, and S. L. Dickey, resident salesman at that place has been appointed manager. No change has been made with any of the agency connections in the south.

## New Equipment

The council at Aurora, Minn., has voted to purchase a new boiler for waterworks.

The Fergus Packing Company, Fergus Falls, Minn., will install a refrigerating plant.

C. A. Meyer, of Clarkfield, Minn., will install an electric-light plant at Hettinger, N. D.

Mr. Farrar, of Columbia Falls, Mont., has applied for a franchise for an electric-light plant.

Chas. Bond, Des Moines, Iowa, will erect a laundry building at Sixth and Chestnut streets.

The Consumers Ice Company, Sioux City, Iowa, will erect a plant of about 150 tons daily capacity.

The Upham Manufacturing Company, Neillsville, Wis., will install a 400-horsepower electric power plant.

Gehrlic & Shumlata Tile Comapny, Wapakoneta, Ohio, is contemplating the installation of a new 100-horsepower boiler and 50- or 60-horsepower engine.

Chas. Prochnow, chief engineer, P. O. Box 276, Flagstaff, Ariz., would like catalogs of power equipment for a sawmill of 100 000 feet daily capacity to be built next spring; also catalogs of machine shop equipment and iron roof construction for power houses.

## Help Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

WANTED—Erecting men to erect and start high-grade automatic engines; furnish references and state ability, etc. Address Erie City Iron Works, Erie, Penn.

WANTED—In New Jersey, a mechanical draftsman, familiar with general construction work, who has had some experience photography; state experience and salar Box 78, POWER.

SALESMAN WANTED for New Engla and Middle States, by a well known and established grate bar concern; must be perienced and have good references. Addre Box 90, POWER.

## Situations Wanted

*Advertisements under this head are inserted for 25 cents per line. About six wor make a line.*

MILLWRIGHT—Permanent position want as head millwright with construction company; nine years' experience erecting sug plants and steel mills; 28 years' old; married. Box 89, POWER.

WANTED—Position by mechanical engineer; technical graduate; large experience designing, erecting and operating power plan and mills; as assistant or designing engine or chief draftsman; highest references. B 85, POWER.

MARINE ENGINEER, 13 years licen wants position as assistant in ice plant, with erecting gang erecting same plants; c do machine, blacksmith or steam fitting; a 35 years; single; sober; go anywhere whe there is chance to advance. "B. M.," Box 8 POWER.

ENGINEER wishing to make a change a time after this year in January, 1910; han with tools; can handle engines, pumps, bo ers; will start doing anything until a pla is open; married; age 35; sober and hone working man; country preferred, but will any place. Box 87, POWER.

WANTED—Position in electric light water works by college graduate in engine ing; unlimited license; ten years handli alternating- and direct-current machines, co densing and noncondensing engines, pum filter plants, wiring and pipe work; best references. "Engineer," Box 88, POWER.

## Miscellaneous

*Advertisements under this head are inserted for 25 cents per line. About six wor make a line.*

PATENTS secured. C. L. Parker, Solicit of Patents, 4 McGill Bldg., Washington, D.

ANY FIRM or engineer in charge of steam plant that is troubled with scale in t boilers can get absolutely free, the best la cator and reducing wheel made, with velve lined mahogany case. For particulars, a dress Great Lakes Chemical Works, Manit woc, Wis.

JOBBING MACHINERY Supply Compa in Middle West, operating large and we equipped machine shop, desires to manufa ture some article of merit in the line of m chinery or mill supplies; have excellent f cilities for pushing sales. Anyone with good article but without facilities to man facture, write to Box 82, POWER.

## For Sale

*Advertisements under this head are inserted for 25 cents per line. About six wor make a line.*

FOR SALE—20x48 Wheelock engine a two 72"x18' high pressure tubular boilers good condition cheap. Address "Engineer Box 2, Station A, Cincinnati, Ohio.

I AM GIVING AWAY building sites f manufacturing plants, in the "cheap pow city" of Sioux Falls, S. D. For further i formation write, W. R. Green, Sioux Falls, S.

FOR SALE—Cheap six 66"x18' 0" secon hand tubular boiler shells with sixty-six tubes, good for 125 pounds steam pressur also four 42" steel stacks 90' 0" long an one 72" stack 90' 0" long heavy plate. A dress Box 76, POWER.

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| Crosby Steam Gage & Valve Co. | 10 |

# Simple Types of Small Hoisting Engines

## Interesting Descriptions of the Various Forms of Machine, Showing Different Combinations of Engine and Boiler and Methods of Driving

### BY WARREN O. ROGERS

It was but a few years ago when the st common type of hoisting device was man with an old clay pipe in his mouth d a hod on his shoulder, slowly toiling a ladder, rung by rung, Fig. 1. Today ny times the same load is carried up, ry after story, and delivered at the top the highest building while the obsolete d carrier would be thinking of packing s hod.

FIG. 1. AN OLD-TIME HOIST

FIG. 2. A NATIVE MINE HOIST

FIG. 3. WINDLASS HOIST

n the mines, the products were, and in some parts of the world, conveyed the surface of the earth on the backs natives, Fig. 2, who climb an improved ladder. A step in advance in hoisting was the windlass, the crank being operated by man power, Fig. 3, and then e a new development in power hoisting the form of a horse attached to a rope which ran over a pulley, the end being attached to the object to be hoisted, Fig. 4. Following the horse came the power-hoisting engine, which has played a most important part in the commerce and development of the country.

A simple form of mechanical-power hoitsing machine is shown in Fig. 5. It consists of a winding drum fitted in suitable bearings. On one end are attached a friction and friction gear which meshes with a gear on the driven shaft, as shown, one end of which supports a driven pulley. The power for operation is obtained by means of a belt from any available source.

An improved type of hoisting machine is shown in Fig. 6 in which the winding drum is operated by means of a single-cylinder engine, the crank shaft of which

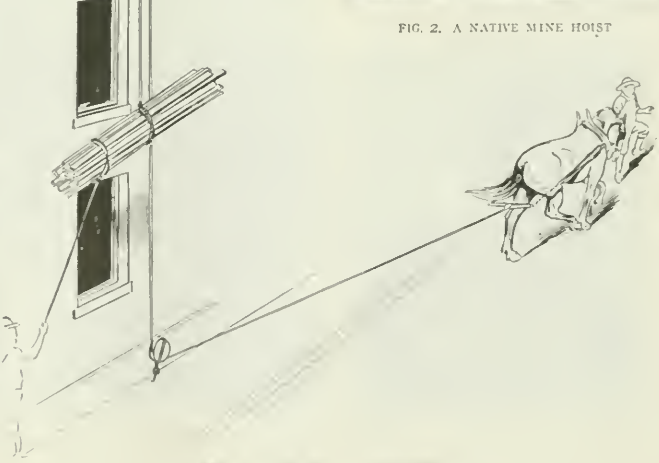


FIG. 4. HOISTING BY HORSE POWER

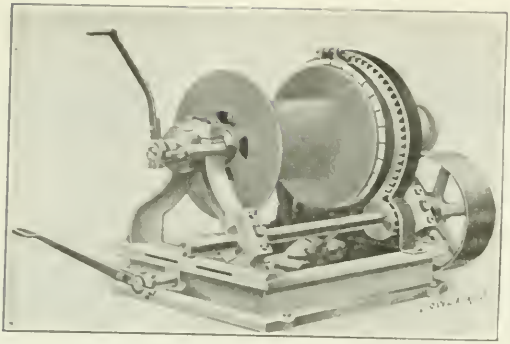


FIG. 5. SIMPLE FORM OF MECHANICAL-POWER HOIST

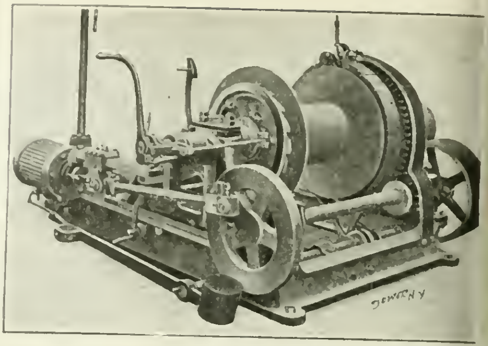


FIG. 6. SINGLE-CYLINDER ENGINE-DRIVEN HOIST

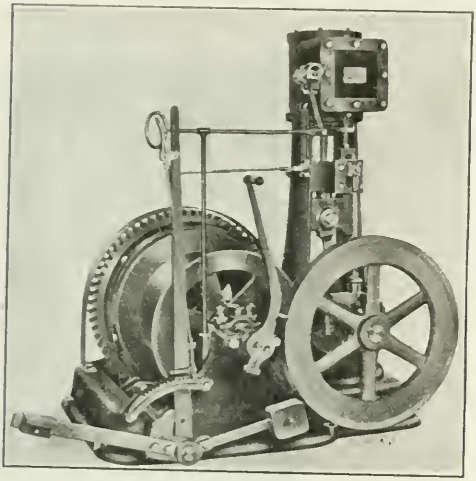


FIG. 7. HOIST DRIVEN BY VERTICAL SINGLE-CYLINDER ENGINE

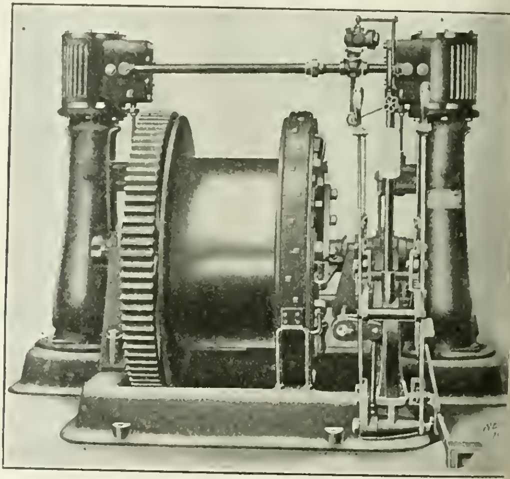


FIG. 8. HOIST OPERATED BY DOUBLE-CYLINDER ENGINE

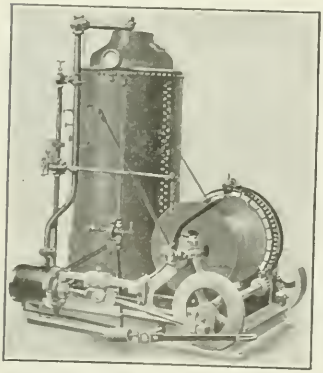


FIG. 9. COMBINATION BOILER, SINGLE-CYLINDER ENGINE AND WINDING DRUM

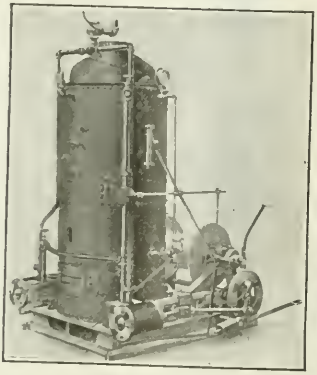


FIG. 10. DOUBLE-CYLINDER DRUM ENGINE AND BOILER

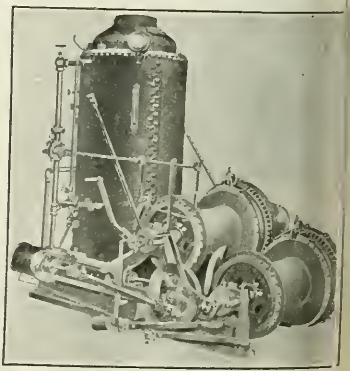
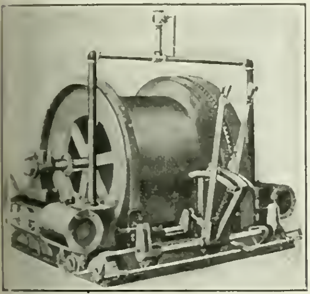


FIG. 11. BOILER WITH ENGINE DRIVING DOUBLE-DRUM HOIST

pports a gear wheel, the drum shaft ing fitted with a large gear wheel. The um, being free to revolve on the drum ift, is rotated by means of a friction utch, shown between the drum flange d gear wheel, the friction being thrown and out by means of a hand lever.

Fig. 7 shows another design of single-inder hoisting engine which is of the tical type. The eccentric is screwed idly to the shaft, so that the engine s in but one direction, as in the case the type shown in Fig. 6. The opera- of the winding drum is also prac-lly the same. This type of hoisting m is also arranged to operate with a ble-cylinder engine fitted with a fixed centric, Fig. 8, and also a link gear en using the reverse motion.

The hoisting machine is also arranged h a horizontal double engine, fitted



F 12. HORIZONTAL DOUBLE ENGINE-DRIVEN DRUM

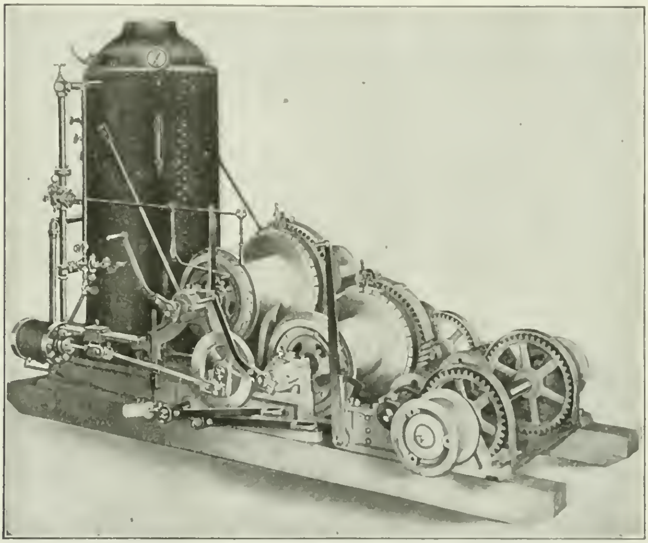


FIG. 13. BOILER, ENGINE, DOUBLE-DRUM HOIST AND DERRICK-SWINGING GEAR

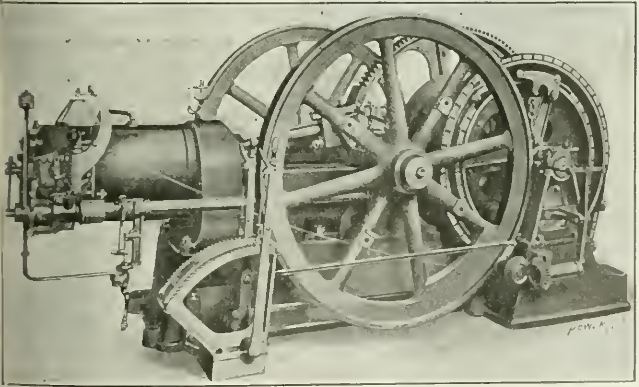


FIG. 14. GAS-ENGINE-DRIVEN HOIST

w both a fixed eccentric and link moti as shown in Fig. 12. These engines ar designed to operate with steam genered from separate sources. With the re rsible-link motion the drum and gear ar keyed to the shaft, and the load held in any position by a suitable band br e.

combination boiler and engine outfit is shown in Fig 9. The size of the boiler generally differs, according to the service to which the engine is to be put. Usually the boiler is smaller in comparison with the engine than found in power plant practice. This is because the demand for steam is for short periods and after each drain of steam from the boiler it has a chance to regain what has been used, so that the steam pressure remains practically constant.

If the engine were operated for long intervals with a load, the size of boiler usually supplied with such equipment would be found altogether too small; the boiler is of the ordinary upright type. Generally, boilers of about 32-inch diameter have double riveted longitudinal seams and up to 8½ feet in hight are made of one plate Some builders calk the seams inside and outside, the idea of calking the inside seam being to prevent moisture from getting between the plates and causing corrosion. The engine and boiler are mounted on the same bed-plate and a pressure of 100 pounds per square inch is generally carried.

The outfit is termed a portable hoisting engine and is suitable for all general hoisting purposes. The disadvantage of a single-cylinder hoisting engine is that it will occasionally get caught on the centers. In the type shown in Fig. 9 the cylinder is fitted with cylinder cocks arranged to open simultaneously by a movement of a lever, as shown, which to a certain extent enables the operator to get the engine over the center by releasing the steam in the cylinder.

A durable cylinder friction-drum engine and boiler are shown in Fig. 10. The engine has fixed eccentrics and runs in but one direction. As there are two engines with the cranks connected to the same crank shaft and set at an angle of 90 degrees, there is no dead center, one engine always being in a position to start the load. It is, therefore, much more preferable for general purposes than the single-cylinder hoisting engine.

In the illustration so far shown but one drum has been used. For general work a double-drum arrangement, such as is shown in Figs. 11 and 13, has its advantages. The latter also has a swinging gear for swinging derrick booms.

Hoisting machines are not confined to the types illustrated herewith, but are built to very powerful designs and are, in some instances, rather complicated machines, especially when equipped with steam auxiliaries for operating the brake, reversing gear, etc. They are not confined to steam power, either, for of late years the electric motor has taken the place of the steam engine in some instances, making a very compact machine. Fig. 15 illustrates a double-drum electric derrick hoist, with swinging gear attached. The two front swinging drums are friction driven and reversible. It will be noted that the operating levers are placed in a convenient manner for the operator.

The motors are generally of the series-wound type and are made to operate on either alternating or direct current. A comparison of the machine shown in Fig. 15 with that shown in Fig. 13 shows the relative difference between the steam- and motor-driven machines.

Another method of driving the hoisting engine is shown in Fig. 14. The motive power is a gas engine, a gear on the crank shaft meshing with a larger gear on the drum shaft. The hand levers are so located that the operator can keep the engine drum and rope under observation at all times. The drum is loose on the shaft, and is operated by a friction clutch.

One feature of interest in this type of engine is that when running idle the governor weight is automatically lifted off the governor by a spring, thus reducing the speed and fuel consumption. When the operator moves the hand lever to start the engine the governor weight drops and the engine is brought up to normal speed before the friction brake takes hold of the drum.

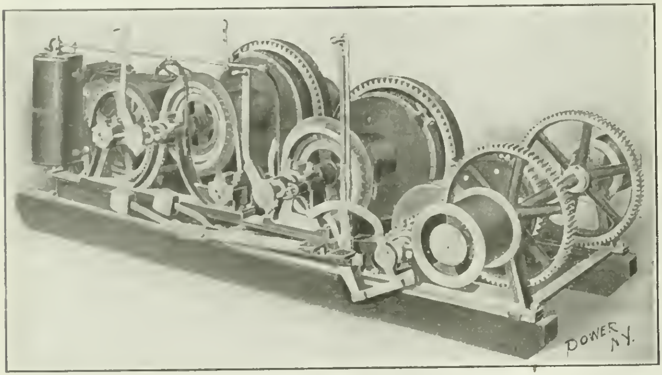


FIG. 15. MOTOR-DRIVEN DOUBLE-DRUM HOIST AND SWINGING GEAR

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It is always safer to have two independent means of feeding a boiler. Then if one means fails, the other is available and may thus prevent disaster.

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# Energy in a Steam Boiler

The explosion of a boiler is not an instantaneous action, but a series of well defined but rapidly succeeding operations. If the break occurs below the water line, it is possible that no explosion will ensue, as the situation of the break is not favorable for the production of water hammer, and the boiler will relieve itself of its pressure by the water issuing out first. But if the break be above or near the water line, the circumstances are favorable to the production of water hammer, and a violent explosion may occur. The method of explosion in most instances seems to be the opening of a small orifice at a point where the resistance offered by the material is less than the stress to which it is subjected, followed by an outrush of steam or water, or both; the extension of the rupture to the adjoining parts when these parts become too weak to sustain the increased stress which the break already made puts upon them, this operation being so sudden that sufficient time is not allowed for the gradual escape of the inclosed fluids; and the boiler is torn violently into fragments and distributed far and wide by the steam generated from the liberated water. An explosion does not ensue if the parts adjacent to the initial rupture possess sufficient strength, and it is probable that explosions do not occur unless the strength of the boiler is quite uniform, but less than that required to sustain the pressure. Local weakness is a safety valve that permits a rupture and insures against a general disrupture. Minor defects surrounded by strong parts merely relieve the pressure, but a long seam weakened by corrosion or "burning" of the lap, a considerable area of plate thinned by corrosion or weakened by overheating, or an extended crack, may be the occasion of a disastrous explosion.

The energy in a cubic foot of highly heated water is equal to the energy in a pound of gunpowder. Most of the ency in a steam boiler under pressure is co- tained in the water and only a relati small amount of the energy in the ste Take, for instance, the case of a h zontal tubular boiler carrying 150 pou pressure and having 160 cubic feet water space and 80 cubic feet of st space. The water weighs

$$160 \times 62.4 = 9984$$

pounds, and the steam weighs

$$80 \times 0.3671 = 29.37$$

pounds. The energy in each pound water at 150 pounds pressure that w be liberated by explosion and expan down to 212 degrees Fahrenheit is 11,8 foot-pounds, and the energy in pound of steam at the same pressur 134,521.2 foot-pounds. The total en in the water is therefore

$$9984 \times 11,823 = 118,040,832$$

foot-pounds, and the total energy in steam is

$$29.37 \times 134.521 = 3,950,882$$

foot-pounds. The energy in the stea consequently less than 4 per cent of in the water. The water is the m dangerous content of the boiler. total energy in the water and steam i

$$118,040,832 + 3,950,882 = 121,991,7$$

foot-pounds. If the boiler weighs, 10,000 pounds, and if all of this en were expended in an explosion in jecting the boiler vertically, then, negl ing the friction of the air, the b would rise to a hight of 12,199 feet, or two miles.—*The Fidelity and Casu Company, of New York.*

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If the commutator of a dynamo motor be made to glaze over, it give much better results and wear rapidly. In electroplating dynamos, i necessary to use copper brushes, and this account it is more difficult to g the commutator than when carbon bru are employed. According to the *B World*, the following composition been found excellent for glazing the c mutators of electroplating dynamos: solve four ounces of caustic potash one pint of water, and then boil and one ounce of flowers of sulphur. until the sulphur is wholly or parti dissolved, making a yellow-colored s tion; then add lard oil and boil unt soap is made. Cool and add a mix of equal parts of flowers of sulphur graphite—very fine, or that known electrotypers' graphite—until a thick p is produced. This is applied to the c mutator, but very little is needed to duce the desired results.

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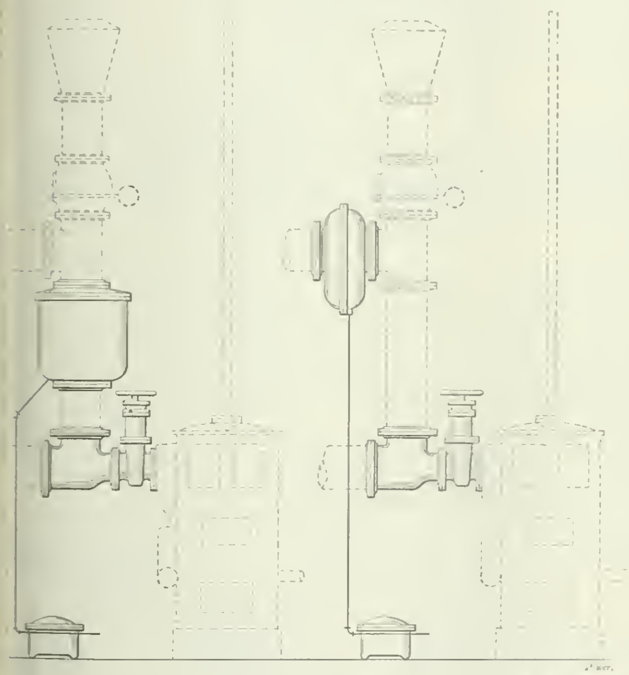
A small leak in a boiler may be tected by a white wedge-shaped mark rivets or plate. In calking, chalk or ot wise mark all the leaks first, as the h mer blows may destroy the faint i cations due to the leak.

# Piping Open Feed Water Heaters

## Old and New Methods of Connecting Exhaust Steam Heating Systems with Suggestions as to How Unnecessary Piping May Be Eliminated

Some engineers believe that steam-en e refinement has reached a point where ther advance is doubtful, other than rovement in minor details. Many are ng their attention to other sources for improved economy in steam plant operation, as the furnace, pipe line construction, condensers and feed water heaters. It is with feed-water heaters that this article has to do.



1. THE OIL SEPARATOR, TEE, VALVE AND TRAP ARE ELIMINATED WITH THE STEAM-STACK OPEN HEATER

Installing a feed water heater is seemingly a simple matter, and yet there are thousands in use which are either too small for the purpose for which they are used, or the design is not what the conditions call for. Again, the piping is wrongly connected, or the heater is placed in a faulty position in relation to the boiler.

A few months ago a Cochrane steam stack and cutoff-valve heater was described and illustrated in POWER, which so simplifies the matter of feed-water heater piping and the space necessary for it that it would seem that a few illustrations regarding its installation, with its advantages over the old type of Cochrane heater, would be pertinent at this time.

In order to obtain satisfactory results with the old type of open heater, an oil separator large enough to treat the whole amount of steam passing through it was necessary, so that it could be used for various purposes if desired. The heater also required a bypass, so that it could be cut out for cleaning without cutting out the feed-water system. With a separate oil separator there would be required a tee and a valve, a trap and a separator, which cost money and take up room. The ordinary arrangement of these features is shown in Fig. 1, and any arrangement that will do away with these features certainly has its advantage, but would have the disadvantage of requiring a large enough heater to be installed to have a separator of sufficient capacity to pass the whole amount of steam, other than that required for heating the feed-water. It would not be possible, however, to cut such a heater out of service

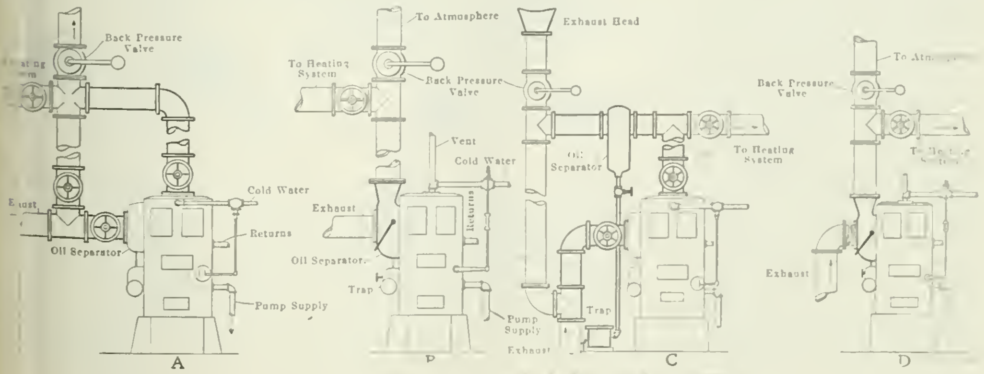


FIG. 2. HOW THE STEAM-STACK HEATER SIMPLIFIES THE PIPING PROBLEM

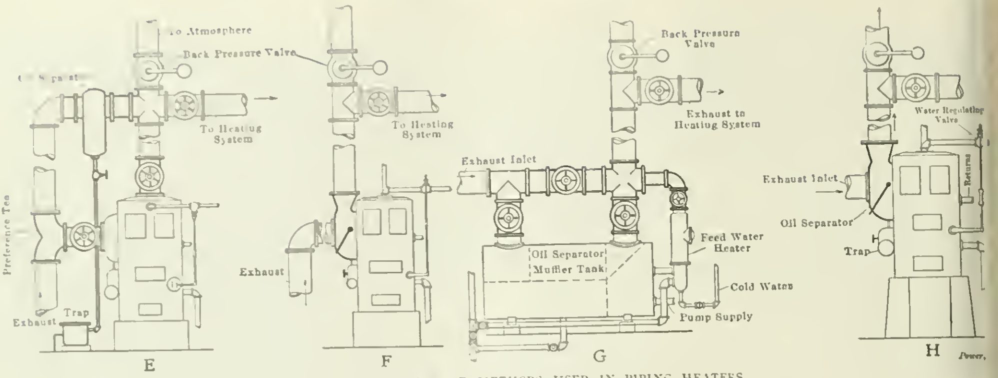


FIG. 3. COMPARISON OF METHODS USED IN PIPING HEATERS

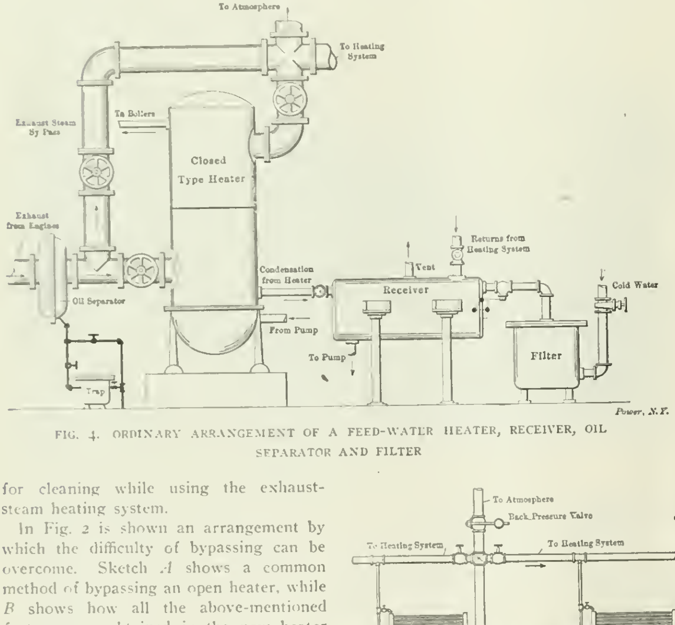


FIG. 4. ORDINARY ARRANGEMENT OF A FEED-WATER HEATER, RECEIVER, OIL SEPARATOR AND FILTER

for cleaning while using the exhaust-steam heating system.

In Fig. 2 is shown an arrangement by which the difficulty of bypassing can be overcome. Sketch *A* shows a common method of bypassing an open heater, while *B* shows how all the above-mentioned features are obtained in the new heater and in a less expensive manner. Sketch *C* shows how the arrangement of *A* may be simplified and improved by the addition of an independent oil separator, to prevent oil getting into the heating system. This will be an additional expense, however, but with a steam-stack and cutout heater, shown at *D*, the expense of installation is decreased and a more presentable piece of work obtained. It does not require much observation to note the reduction of pipes and fittings, as well as the increased ease and convenience of operation.

Sketch *E*, Fig. 3, is an improvement over the method employed at *C*, Fig. 2, but a preference tee is required, in order that the heater may always receive sufficient steam to heat the feed water. In such an installation of bypass arrangement a separator, the latter should hav capacity sufficient to purify the maxin output of steam from the engine, bec: it may be called upon to do so when heater is cut out for cleaning or pairs, or when the returns from the h ing system come back so hot that do not condense any of the exhaust st Diagram *F* shows how the same r can be obtained with the new typ heater.

Taking up the commercial end of u exhaust steam in connection with hea a view of an installation is shown in 4 which is an ordinary arrangen of closed heater, oil separator, recei filters and piping, in all taking up siderable space; in fact, some open-he auxiliaries occupy about as much s as the heater, as shown at *G*, Fig. 3 which is shown a combination of oil arator, muffler, tank and feed-water he as sometimes installed. The piping i

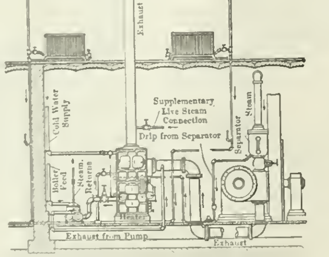


FIG. 5. CONNECTIONS OF SPECIAL HEATER AND RECEIVER TO GRAVITY-RETURN SYSTEM

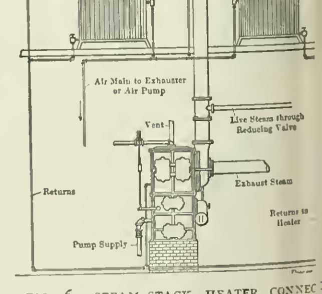


FIG. 6. STEAM-STACK HEATER CONNEC TO A PAUL VACUUM HEATING SYSTEM

aborate piece of work, but such an arrangement does not provide for any separation of oil when the muffler tank is it out. The arrangement shown at *H* ustrates saving of space, cost of piping d convenience of operation.

In Fig. 5 is shown a common method connecting an old type of Cochrane ater, such as is designed to be used th a heating system; the method of ping the heating system, which is in case a gravity-return system, is o shown. It is evident that the exhaust steam from the engine and boiler-d pump, which exhausts into the engine's exhaust pipe, enters the heater in h a manner that some of its heat is imparted to the incoming cold-water supply and that the feed water is taken from the lower portion of the heater and receiver. The returns from the heating system also return to the heater at a point where it is again reheated by the incoming exhaust steam, which after doing its work in the heater passes up the vertical exhaust pipe and part, or all, is diverted to the heating system, or allowed to escape to the atmosphere.

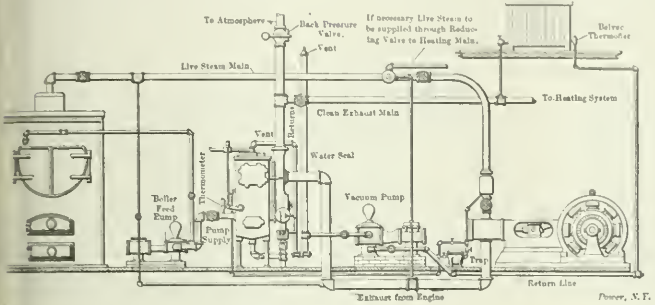
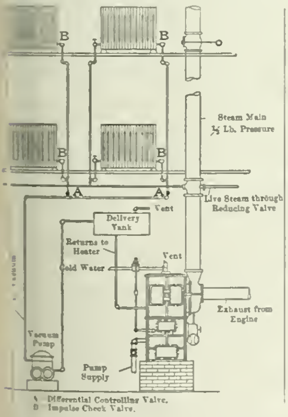


FIG. 7. VAN AUKEN SYSTEM OF STEAM HEATING



G. 8. HEATER PIPED TO A DONNELLY POSITIVE DIFFERENTIAL HEATER SYSTEM

Fig. 6 is illustrated a Paul vacuum system of steam heating, with a Cochrane steam-stack and cutoff-valve heater connected in. This heater performs the functions of feed-water heater, return tank, independent oil separator, trap and raw-water regulator. In this system a pump or ejector is employed to draw the air from the special air valve attached to the radiators. If the exhaust steam of the engine should at any time be too little to maintain all the radiation surface at a temperature of 212 degrees Fahrenheit, the heating system and heater act as a vacuum condenser, thus diminishing the back pressure on the engine, causing it to run under a vacuum down to the pressure at which the pressure-reducing valve admitting live steam from the boiler comes into action. The water of condensation returns by gravity to the heater in the ordinary manner, and the vacuum pump or exhauster is called upon to deal only with such air as may enter in the pipe line or radiators.

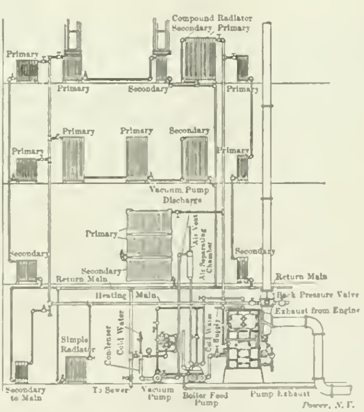


FIG. 9. HEATER PIPED TO A SIMONDS HEATING SYSTEM

In Fig. 7 is illustrated the Van Auken system of steam heating, but the functions of heating the feed water and separating the oil of the trap, return tank, etc., are proformed by a single unit—the steam-stack heater. In this case the vacuum pump handles both the air and return, and in such a system it is usually necessary to add cold water to the return in order to enable the pump to handle the air

Another application of this type of heater is shown in Fig. 8, which illustrates an arrangement of the Donnelly positive differential system, a differential controlling valve or pressure reducing valve being placed at *A* in the suction line of the vacuum pump. With this arrangement it is possible to use a simple valve operated by gravity for controlling the overflow of water and air from the radiators.

Another system, the Simonds, is shown in Fig. 9. The peculiarity about this system is that a primary and secondary set of radiators are used. The primary radiators radiate the heat given off by the steam in condensing, and the hot water then passes through a special controlling valve to the secondary radiators, where the water is cooled from a steam temperature down to some lower temperature at which it can be handled by the vacuum pump without trouble. This does away with the necessity of introducing cold water in the vacuum pump.

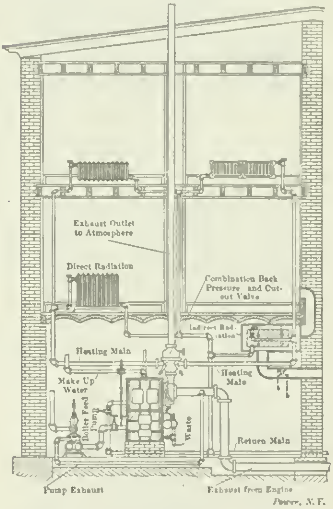


FIG. 10. APPLICATION OF STEAM-STACK HEATER TO A BROMHALL HEATING SYSTEM

The application of the steam-stack heater to a Bromhall heating system is shown in Fig. 10, and illustrates the simplicity of piping to a system which is of the simple gravity-return type, with a manually controlled valve at the inlet of the radiators.

The illustration shown in Fig. 11 is a reproduction of a layout of a Webster system of heating, as illustrated in a paper read before the American Society of Heating and Ventilating Engineers. Fig. 12 shows the same system when a steam-k heater is used. In comparison with other vacuum-heating systems there are no unusual features, both air and return being handled by the same pump.

The application of the steam-stack heater to a hot-air-blast heating and ventilating outfit is shown in Fig. 13. The separator on the heater removes the oil from the exhaust steam used in the hot-blast coils, and the heater serves as a hotwell for the condensed returns.

Much might be said regarding the piping of a feed-water heater and heating system, but the main thing to bear in mind is simplicity of arrangement when possible, which also reduces the first cost and avoids pockets, so that the air and water, which are both heavier than steam, can run to the bottom of the system or heater by gravity, without interruption.

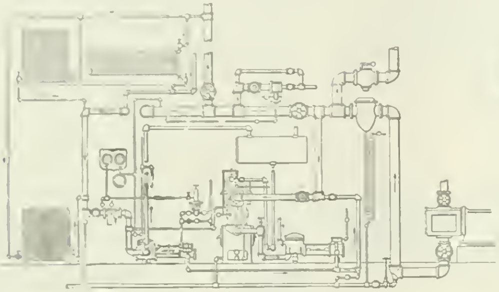


FIG. 11. ORDINARY ARRANGEMENT OF WEBSTER HEATING SYSTEM

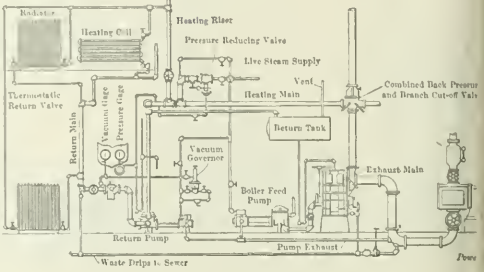


FIG. 12. SAME SYSTEM WITH A STEAM-STACK HEATER

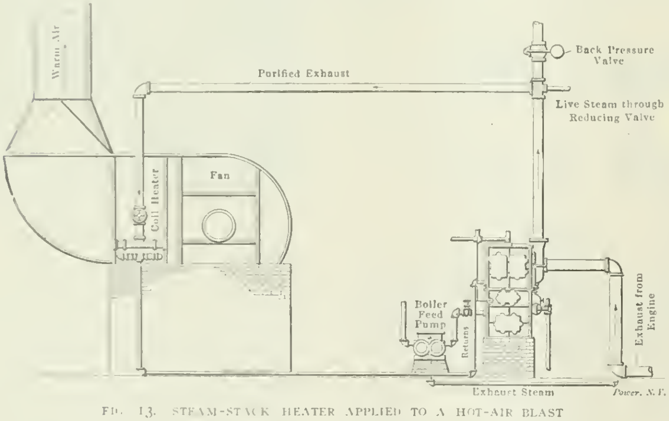


FIG. 13. STEAM-STACK HEATER APPLIED TO A HOT-AIR BLAST

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A horizontal tubular boiler should never be fed at the front and bottom under the tubes, as the sediment in the feed water will settle on the plates over the fire, and burning of the metal may result. Moreover, when the boiler is fed at the front, the sediment will settle down so far from the blowoff pipe that blowing off will not remove it.

## Receiver Pressure

By E. H. Lockwood

That theory and practice do not agree on the subject of the best receiver pressure for compound engines is the belief of many engineers. It has been noticed that a slight variation in the receiver pressure of compound engines results in marked changes in action, and that receiver pressure which appears to be the most economical in practice may be quite different from that which theory requires. Practical engineers ask the reason why and receive an evasive answer oftener than a satisfactory explanation. I propose to examine the matter carefully to determine, if possible, whether theory and practice really disagree. Looking at the subject first from the theoretical point of view, the receiver pressure should be just high enough to produce little drop in the high-pressure cylinder at the end of the stroke, as in this way loss due to unresisted expansion is avoided. In a frictionless engine the drop should be zero; actually there should be some small drop, enough to furnish a driving force at the end of the stroke equal to the frictional resistance of the engine.

The temperature range in each cyli should be approximately equal in o to minimize cylinder condensation. also desirable to develop equal wor each cylinder for mechanical reasons though this point is not to be pressed it does not affect the economy of engine as a steam user. Cylinders usually designed so that all of these ditions are approximately fulfilled at mal load when the receiver pressu properly adjusted. Hence the wor rule that the receiver pressure shoul set to show but little drop, and the guide needed is an indicator dia from the high-pressure cylinder.

This sounds very well but the prac engineer notices something which dist him. He is operating, let us say, a pu ing engine with a steady load and a cutoff in the high-pressure cylinder. discovers that when the receiver sure is carried lower than that fixe the theoretical rule the pump incr in speed. The gage on the delivery shows a greater pressure, hence the p is doing more work in each stroke out any change in the cutoff. Here pears to be an improvement in the omy of the engine, brought about violating theoretical rules regarding ceiver pressure. I will mention one example, that of a cross-compound C engine with a flyball governor which trols the cutoff in the high-pressure inder. The points of release, com sion and admission are fixed in both inders, while the low-pressure cuto adjustable by hand, allowing a vari in the receiver pressure. The ope discovers that when running und steady load with all conditions unif lowering the receiver pressure below required by theory results in a resp by the governor with an earlier cu ff. The logical conclusion seems to be there is a gain in economy since the power is developed by using an ea cutoff in the high-pressure cylinder. illustrations point to the same result the receiver pressure is carried than the theoretical rule, namely, work from a given amount of stea

The steam in the cylinder at cutoff may be divided, for purposes of reasoning, into three parts. First, that which remained in the cylinder when the exhaust valve was closed, sometimes called the cushion steam. Second, the supply of steam taken from the chest, necessary in addition to the foregoing to fill the cylinder with dry steam. Third, the steam which was condensed at entrance and exists as a film of water on the surfaces of the walls and parts. Of these three quantities the first two may be calculated from the known density of dry steam, using pressures and volumes scaled from the indicator diagrams. The third cannot be calculated. It is only known that considerable of the steam used is either condensed on the interior walls or lost by leakage past the valve and piston during the stroke. This loss is sometimes called the "missing quantity," as it represents the difference between the steam actually used and that accounted for by the indicator. The magnitude of the "missing quantity" is from 10 to 50 per cent. of all the steam used, depending on the speed, ratio of expansion, size and lagging of the cylinder.

While definite calculation of the amount of condensed steam is not feasible, its variation with the receiver pressure may be predicted. Lowering the receiver pressure increases the temperature range in the high-pressure cylinder, hence it increases the initial condensation item. The general tendency of lowering the receiver pressure is, therefore, to increase the steam consumption through the increase of cylinder condensation. Moreover, lowering the receiver pressure increases the steam consumption through its effect on the cushion steam, and this item is one capable of more exact calculation.

I will show by an example how the dry steam used by a compound engine can be calculated, and how its amount is affected by change in the receiver pressure: Take the following data:

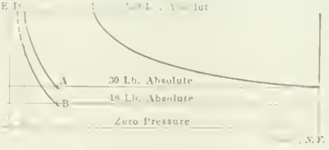
Diameter of high pressure cylinder, 12 inches, stroke of piston, 36 inches; clearance of high pressure cylinder, 5 per cent.; cutoff at one-quarter of stroke; compression begins 6 inches before the end of stroke; steam pressure, 130 pounds absolute; receiver pressure, 30 pounds absolute in the first case; receiver pressure, 18 pounds absolute in the second case.

These dimensions relate to a compound engine where the valves are set for a fixed point of compression, the cutoff being controlled by the governor in the high-pressure cylinder and by hand in the low-pressure cylinder.

For the first case, with the receiver pressure at 30 pounds absolute (15 gage pressure), the density is found from the steam tables to be 0.0735, the volume is found to be 0.512 cubic foot when compression begins and the product is 0.038 pound, which is the weight of dry steam in the clearance, or the cushion steam. At cutoff the density is 0.290, the volume is 0.708 cubic foot, the product is 0.205 pound, which is the total weight of dry steam in the cylinder at this point. Subtracting, the difference is 0.167 pound, which is the weight of dry steam used per stroke as calculated.

For the second case the receiver pressure is 18 pounds absolute (3 pounds gage pressure), for which the density is 0.0455, the volume at compression is 0.512 cubic foot, as in the first case, and the product is 0.023 pound, which is the weight of the cushion steam. Subtracting, the difference is 0.182 pound, which is the dry steam used per stroke with the lower receiver pressure.

A comparison of the two cases on the percentage basis shows that the dry steam used is 9 per cent. greater when the receiver pressure is carried at 3 pounds gage pressure than when carried at 15 pounds. Of course the increased steam consumption will result in more work being done, as is proved by the indicator diagrams. We meet here a fact which is not very well known, namely, that the work done by a compound engine of this type depends on the cutoff in the low-pressure cylinder as well as the cutoff in the high-pressure cylinder. The statement in textbooks on the steam engine is that the high-pressure cutoff determines the power of the engine while the low pressure cutoff determines only the proportion of work done in each cylinder. This statement deserves revision in view of the fact that the steam consumption may vary as much as 10 per cent., solely by change in the low-pressure cutoff.



SHOWING DIFFERENCE IN COMPRESSION CURVES

To exhibit these calculations in another form the accompanying diagram has been drawn. The figure is purposely exaggerated in order to emphasize the difference in the compression curves. The point F represents the steam at cutoff, whose weight as dry steam has been previously calculated to be 0.205 pound. The point A represents the steam at compression at 30 pounds absolute amounting to a weight of 0.037 pound. This steam is compressed to the admission pressure when it occupies the volume EC, which subtracted from the steam at cutoff leaves an amount CF, 0.1675 pound, as the weight of steam used per stroke.

The point B represents the density at the lower receiver pressure, 18 pounds absolute, previously found to weigh 0.023 pound. When this steam is compressed to the admission pressure it occupies the volume ED, which subtracted from the volume at cutoff leaves DF, 0.182 pound, as the amount of steam used under the reduced cutoff. The increase in steam consumption is shown by the distance DC, and this amounts to 9 per cent. of the whole steam used.

The increased steam consumption is brought about wholly by change in the compression curve, not by any change in the cutoff. In other words, the steam consumption is controlled by the receiver pressure as well as by the point of cutoff in a compound engine of this type.

Referring to the phenomena which began this discussion, I have shown that there is nothing contrary to theory in them. Lowering the receiver pressure but making no other change ought to increase the amount of work done, and in this theory and practice agree. But the real question is, does the increase of work compensate for the increase of steam used?

The practical engineer cannot answer this question by any simple observation from his engine. He can recognize an increase in the work done, through the medium of the engine governor, but cannot tell whether the increase of steam used is in a greater ratio or not. Theory says that the gain of work due to lowering the receiver pressure below a certain point is wasteful, for the gain is more than offset by increase in the steam consumption. The final test of the matter, however, will be by experiment. Carefully made trials where the steam consumption is measured, run at various receiver pressures with all other conditions constant, would furnish data to settle the whole matter definitely. Meanwhile it may be safely assumed that in a well designed engine with a moderate load the receiver pressure which gives a small 'drop' is the most economical in use of steam. Any other receiver pressure will give inferior results, but the difference may be very slight.

One fact, yet little known, may be stated in conclusion, namely, that lowering the receiver pressure in a compound engine with fixed points of compression, will increase the total work done by the engine, an increase amounting in some cases to as much as 15 per cent. This fact might find some useful applications, as, for instance, in a Corliss engine loaded up to the limit of cutoff in the high-pressure cylinder. In this condition an increase of 5 or 10 per cent. in the work done brought about by lowering the receiver pressure might be most welcome at a time when power and not economy is the pressing consideration.

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Old paper should never be fed into a boiler as it is injurious to the plates and [illegible] the [illegible] look as good for [illegible] boiler should be used. It will not only save repairs to the boiler but will also save in fuel.

# Cracks in Longitudinal Boiler Seam

## Why Some Seams, Both Lap and Butt, Crack While Others Do Not
## A New Explanation of the Action of Boilers under Pressure

### BY S. F. JETER

It has been open to question, whether the method ascribed to the formation of cracks along the seams in lap joints is correctly understood or not. It is common belief that such defects are produced on account of the lapping of the plates, which causes the tensile strain at right angles to the seam to produce a bending action in the plate with varying boiler pressures which would finally result in rupturing the material, the action being assumed to be the same as is produced in a piece of wire or strip of metal which may be broken by repeatedly bending it back and forth.

Fig. 1 illustrates the deformation that must tend to occur, when a tensile strain is applied to a lap joint, but no investigation seems to have been made as to the extent of the deformation under working loads, or to the movement that would be caused by the usual variations that might be expected in the steam pressure under working conditions. It has been contended by many engineers, that the substitution of the butt form of joint for the lap would be a complete cure for this class of defect, and one State has passed laws prohibiting the use of lap joints for boiler construction except within certain limits.

That the mere lapping of the plates is not the only factor in producing cracks in lap seams, would appear to be amply justified by the thousands upon thousands of seams of this form which have given long years of service without any indications of defects developing, while if the lapping of the plates is the sole cause it must have been present in all. Another indication that the mere lapping of the plates is not entirely responsible, is the fact that butt joints have failed in a similar manner. On page 220 of the January 26 issue of Power, there is a description of the failure of a butt joint given by T. T. Parker, chief inspector of boilers for the Fidedity and Casualty Company, who states that this was the third instance of such a failure to his knowledge, and since this time a fourth has occurred in Torrington, Conn., which was described in the November 30 iss It would seem from this record that abolition of the lap seam would not tirely prevent the further formation such cracks, for it must be remembe that these defects generally require or more years of service to develop, the butt-strapped form of seam has been generally used in boiler construct for a sufficient length of time to definit determine if it is to be as readily s ject to such defects as the lap form not.

The writer has given the subject c siderable thought and would like to p pose a modification of the present the of the formation of these cracks wl will apply equally as well to the l form of joint as to the lap, and will explain the erratic nature of such f ures. To illustrate the idea that I endeavoring to explain. I will make of Fig. 2 in which *A* represents a spring, fastened rigidly between blocks *B* which are nailed to *C* so the spring presses up against *D* whicl

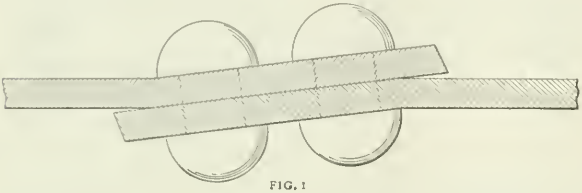

FIG. 1

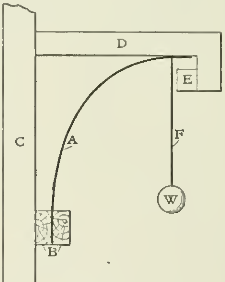

FIG. 2

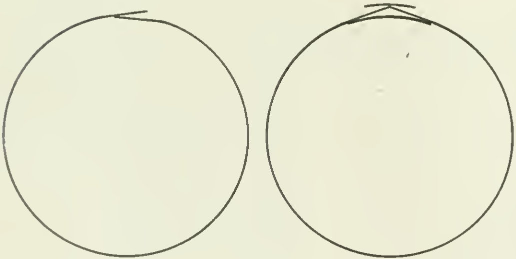

FIG. 3

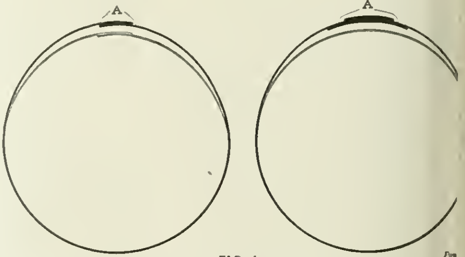

FIG. 4

A SUGGESTED EXPLANATION OF THE FORMATION OF CRACKS IN LONGITUDINAL BOILER JOINTS ilso fastened rigidly to $C$. The end of D is arranged, so that $E$ forms a stop o limit the movement of the end of the pring downward. If a chain $F$ is atached to the outer end of $A$ and a weight $W$ hung on the chain, it will tend to ill the spring downward. It is evident hat no movement of the spring will occur intil the weight applied to $F$ exceeds he force with which the spring is pressg up against $D$; also that when the pull f $W$ is sufficient to cause the spring to me down against the stop $E$, a further crease in the weight on the chain will rduce no further movement in the ring.

If the spring is assumed to be pressg up against $D$ with a force of 20 unds, and a weight of 21 pounds rings it down against $E$, then only anges in the weight $W$ between o and 21 pounds can cause a vement in the spring $A$, and varians in the weight above or below these ints would be without effect. The riter's idea is, that practically these me conditions exist in boiler joints of l kinds which crack or tend to crack, the manner commonly described as lapint cracks.

If the ends of the plate are not formed the curve of the shell before bolting gether, with either form of joint, they ght be as illustrated to an exaggerated le in Fig. 3, and after riveting tother, they would assume a form more less like that illustrated in Fig. 4, the ht lines showing the true cylindrical rm. Riveting together joints as illusted in Fig. 3, produces strains in the ets near points $A$, Fig. 4, correspond to the initial strain in the spring $A$ Fig. 2, and it requires a certain tene strain on the shell to overcome this tial stress in the sheet and produce vement tending toward a true cylinal form After this point is passed other one is reached at a higher prese where the cylindrical form has been ctically obtained, and further pressure the shell does not tend to produce a ange of shape or movement in the et. In the lap form of seam, the effect the movement is concentrated along outer line of rivet heads, on account their being so close together that they hd the sheet rigid up to this line, in the sme manner as the spring $A$ in Fig. 2 is upported rigidly by the blocks $B$ up to tl upper edge of these blocks. In the bt form of joint, the span of the rivets in the outer rows is so long that the l of greatest stress may run inside tl line of the outer edge of the rivet hds.

is the writer's opinion that, in every jot made up as illustrated in Fig. 3, tre are two pressures, more or less clrly defined, between which movement inhe sheet will take place, and when th working pressure happens to lie within this range (and near the lower limit if the range should happen to be wide), all conditions are ripe for the production of a cracked sheet.

Of course this is only a theory and requires practical demonstration, but the commonly accepted ideas regarding the formation of lap cracks are also merely theories, and their truth has not been demonstrated practically to the writer's knowledge. The theory here given, as previously stated, will account for the fickleness apparent in such failures; that is, a boiler may be built of several courses, each containing material of the same quality and all apparently alike as regards construction, and one may fail while the others show no signs of distress.

The theory given can account for this from the fact that two conditions must be fulfilled to produce a crack.

1. The joint must be out of truth due to the method of laying up the seams as illustrated in Fig. 3.

2. The tensile stress produced in the shell by the average working steam pressure, must be sufficient to overcome the initial stress at the points $A$, Fig. 4, tending to keep the shell out of round, and not enough to keep it a true cylinder, as illustrated by the light lines in Fig. 4.

It has been suggested editorially in POWER, that the Government make accurate tests to determine the actual conditions existing in boiler joints under working conditions. It would seem that such tests, properly made, would not only throw considerable light on the subject but would possibly locate definitely the cause of such cracks, so that in the future boilers could be designed and built along lines that would be known to obviate such defects instead of our having to grope in the dark as is now the case.

It would appear to be a measure of prudence for the insurance companies, or others who are responsible for the safety of boilers, to measure the shape of the shells at the joints to determine any variation from true cylindrical form, and possibly to prescribe some limit for such variations beyond which boilers would not be accepted as fulfilling the requirements of good workmanship.

The writer does not wish to have what he has said construed as advocating or defending the lap form of boiler seam, but he does believe that some effort should be made to definitely locate the cause of the so-called lap-joint crack.

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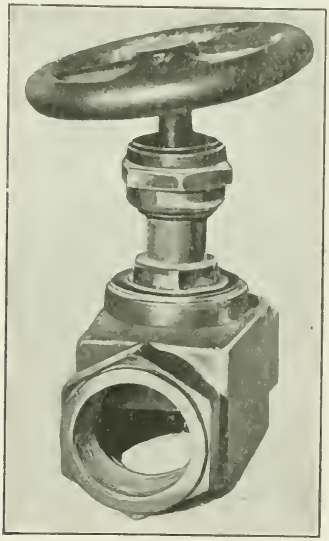
A good feed-water regulator will prolong the life of a boiler by averting the stresses set up by the continual variation of the water level, which almost necessarily occurs in hand feeding. It will also obviate the dangers of high and low water. Such a device, however, should be frequently inspected, and should never become a substitute for care and watchfulness on the part of the attendant.

## Valve Fifty-eight Years in Service

Some valves will remain useful for years, while others will be ruined before steam is turned on, during the process of pipe fitting. The construction and usage of a valve has much to do with its life, therefore a valve, in order to serve its purpose for fifty eight years, must have been made of honest material and by good workmanship, and have been free from abuse while in service.

Such a valve is illustrated in the accompanying illustration made from a photograph of the valve after being removed from the pipe system. The valve was made by Morris Casker & Co., and was in service for fifty-eight years in the boiler room of the Girls' Home of Refuge, Philadelphia, Penn. It was used on the steam-line system under a working pressure of 65 pounds per square inch, and is even now in good condition, save the bent valve stem, as shown. The valve has never been repaired and was only replaced when larger piping, carrying a higher steam pressure, was installed.



VALVE FIFTY-EIGHT YEARS IN SERVICE

We are indebted to Frank Barry, of the Chapman Valve Manufacturing Company, for the data and photograph.

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The portion of the feed pipe in the boiler should be suspended by stout wires from the braces and not be allowed to rest upon or across the tubes. Tubes are sometimes cut through by the continual movement of the feed pipe upon them, due to the pulsations of the feed pump. The pipe should be put together in sections so that it may be removed and cleaned.

# Experiences of a "Trouble Man"

By William Westerfield

Ignorance amazing! If any mortal comes in collision with it in large quantities it is the "trouble man." And in nearly every experience there is the same lesson. Bad judgment on the part of the operative in charge in the choice of a calling, and bad judgment on the part of the employer in the choice of an operative. I was recently sent to square up a compound condensing engine. The engine was a 12 and 24 by 36-inch Corliss of one of the best makes. The condenser was of the jet type, and it was with difficulty that a vacuum of 25 inches could be maintained, though the temperature of the injection water was below 70 degrees Fahrenheit. The trial diagrams were as shown in Fig. 1. It will be noticed that at the point of cutoff the expansion line drops straight downward, showing that at this point the exhaust valve is open, and steam is blowing right through into the receiver. This causes a loss of efficiency in the high-pressure cylinder, and the loss occurs at the most critical period, as the pressure is high, and the crank is approaching its greatest turning moment. This loss in the high-pressure cylinder must be made up in the low-pressure cylinder, and as a result the work it must do is out of proportion to the load. This causes the engine to use more steam in doing a given amount of work, and impose more work on the condenser. The condenser is too small for the engine, if worked at full load, but is amply large for the load the engine is carrying at present. The condenser was being run 90 strokes per minute, with the injection valve two-thirds open.

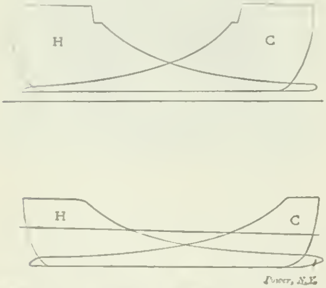

FIG. 1. HIGH- AND LOW-PRESSURE DIAGRAMS BEFORE ADJUSTMENT

No attempt is made to put forward the corrected diagrams as perfect, but after the valves were gone over, and the diagrams shown in Fig. 2 were secured, the vacuum rose in the condenser to 28 inches, and after reducing the speed of the condenser to 72 strokes per minute and the opening of the injection valve to about one-third, the vacuum remained at 26 inches strong. In addition to the better running of the engine, a noticeable change was made in the firing and the quantity of fuel burned, the load on the engine remaining the same.

The engineer (?) is receiving the munificent salary of $45 per month. The "old man" said that he was trying to get a good engineer, and that it was not his fault that he did not have one. He was willing to pay a first-class man $60 per month to run the engine, and do extra expert work in keeping the machinery of the mill in repair. I said nothing, but wondered how long it would take him to find a first-class engineer who would accept the place at the wages offered under the conditions named.

Here is an uptodate plant which it cost a goodly sum of money to install. The engine and auxiliary apparatus should have the attention and care of a first-class engineer. Instead of having a good man in charge at a fair price, the plant is being butchered by an incompetent, pending the discovery of "a first-class engineer" who would be fool enough to accept a position at about half price.

After the work of correcting the valve setting was finished, I was asked to give my attention to repairing a Rochester lubricator, that would not feed. Just what the trouble was or how long the valves had been running dry required an examination to determine. I therefore disconnected the body of the lubricator from the oil pipes, and carried the pump and oil reservoir to the oil tank for the purpose of emptying it, so that it could be cleaned up for examination. As I went to pour out the oil, a lump of dirt as big as one's fist went "plunk" into the tank. That was enough. The oil reservoir had not been cleaned for so long that dirt had accumulated in it until the passages from the reservoir to the pump plungers had become entirely stopped up, and of course no oil could get to the pump. The engineer said that he did not like the kind of lubricator, as there was "so much to them." He preferred the old-style sight-feed lubricator that never gets out of order. I did not venture an opinion as to how any lubricator would perform as an oil feeder when stopped up with dirt, and any of them will if not given a cleaning out occasionally.

I was recently sent for to examine an alternating-current generator in an electric-lighting plant, which for some reason would not pick up. The engineer said that it had been in the habit of picking up slowly, and that he often applied weight to the brushes of the exciter in order to hasten it, but this time the remedy had failed to produce results. I went about and examined all terminals, and all connections that could affect the exciter or the generator, and everything seemed all right except for dirt. I had already noticed that the commutator the exciter was dirty, in fact as black one's hat. I obtained a piece of cle cloth by tearing a piece from a handk chief, and wrapping it about a piece wood trimmed nicely for the purpose, a plied a few drops of good engine oil a applied this to the commutator of t exciter to loosen the dirt, and th cleaned it off with the dry side of t

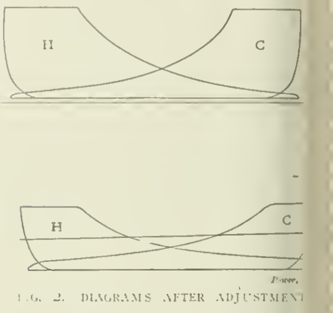

FIG. 2. DIAGRAMS AFTER ADJUSTMEN

cloth. I had hardly got started in t last part of the work when up came lights, and the machine was at work nicely as you please.

I hope to see the day when a pr tical and universal license system will in force, so that it will not act to ham good practical men, but will act an effective bar to those who are untru worthy and incompetent. Such will only protect the incompetent from dangers due to their ignorance, but protect the employer from the danger which his folly often leads him to pose himself and his property, as well innocent and helpless persons who work for him to earn a living.

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In the discussion of a paper at Institution of Mechanical Engineers other evening, W. S. Bryan recalled some years ago Mr. Yarrow had mad large vertical, triple-expansion eng from his designs and had placed alo side it a little engine for a torpedo b working at the same indicated pow Photographs of the two engines w published at the time and showed the markable difference in size of the t types. The little engine was only ab one-tenth the size of the larger one.

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In *The Engineer*, of London, it is e timated that the German Empire has nea 35,000,000 acres of forests, of which per cent. belongs to the State. Gern forestry on scientific lines has resulted raising the average yield of wood acre from 20 cubic feet in 1830 to cubic feet in 1904. During the sa period it has trebled the proportion of sawn timbers secured from the aver cut. In fifty-four years it increased money returns from an average acre forest seven fold, yet today the for are in a better condition than ever bef

# A Transmission and Recording Dynamometer

## Automatically Traces a Record of Torque in Inch-pounds and Number of Revolutions from Which Horsepower Is Easily Computed

BY JAMES W. HUGHES

The various kinds and styles of dynamometers now in existence are so numerous and multifarious, that one would be led to believe, on first thought, that this is a hackneyed subject for a technical magazine. But, after many years' of practical experience with a vast number of various kinds of dynamometers I have come to the conclusion that 98 per cent. of those I have thoroughly tested or calibrated, are not worth the laboratory space they take up. It is safe to say that the result obtained from an average dynamometer is by no means as reliable as a shrewd guess of an experienced engineer.

Under these circumstances, while in the course of experimental work for a former employer, I sorely felt the need of a reliable power-measuring machine or, more correctly, some reliable device that would automatically record the torque produced in a shaft while the shaft was rapidly revolving. At this point I was instructed to produce such a machine for the express purpose of delicately testing various forms of a slip pinion, such as is commonly used to relieve shocks on street-car drives.

The task was successfully accomplished. The first machine built is now in the laboratories of the University of Pennsylvania, where it is known as the "Hughes Dynamometer." This dynamometer having fully come up to all expectations and requirements, I hereby respectfully submit the results to the readers of POWER AND THE ENGINEER.

### FAULT IN BRAKE DYNAMOMETERS

Before taking up the general principles and designs, let us first look into at least one principle common to almost every form of brake dynamometer, which proves to be a serious fault of such a magnitude as to make them utterly unreliable, if not worthless. The following important principle has never been pointed out by any of the authorities (?) or writers on the subject of dynamometers, so far as I have been able to ascertain.

First, let us take the case of an ordinary prony brake dynamometer: On several occasions I have tested various types and obtained results showing anywhere from 105 to 120 per cent. efficiency. The ridiculousness of the results required a solution of the mystery, but the enigma was never solved until one day, while calibrating a certain form of dynamometer, the following paradox was obtained: In Fig. 1 *S* represents a shaft, mounted in two bearings *B B'*, carrying two levers arms *A A*, each exactly 50 inches long from center of shaft to the fulcrums *M M* respectively and firmly keyed to the shaft. At *K* is represented a counterweight which balanced the two lever arms and brought the center of gravity about the center line of the shaft. *T* represents a platform scale and *W* represents a weight which weighed 100 pounds when placed on the scales *T*.

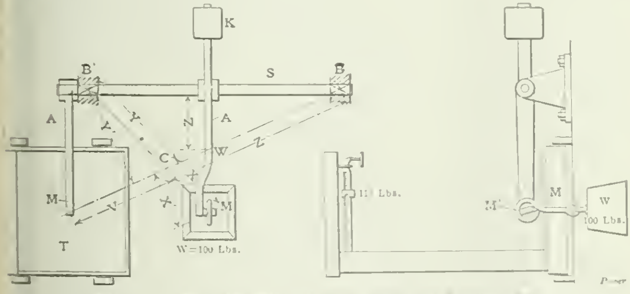

FIG. 1. DIAGRAM OF PRINCIPLE OF A BRAKE DYNAMOMETER

When *W* of 100-pound weight was hung on the fulcrum *M* the scales just balanced at [illegible] pounds.

At first this paradox almost staggered the [illegible], but on closer examination the mystery was easily solved, as follows: Considering *A* and *A'* to be firmly keyed to the shaft *S*, then the two arms and shaft *S* become practically one solid mass. Therefore, when any weight *W* is placed on the fulcrum *M'* of the lever *A'* it would tend to rotate the mass about a line passing through the points of support *M* and *B*, with a moment of *W* times the lever arm *X*. The shaft *S* at the point *B* will be fetched forcibly upwards the top of box or bearing cap of bearing *B'*, which will resist the rotation of the mass about *M B*, with a balancing moment equal to *W X'*, or a reaction on the bearing cap equal to

$$\frac{WX'}{Y} \text{ or } \frac{WX}{Y}.$$

Now, it is evident that the resultant of these two forces is a downward vertical force *C* at the point *C* equal to

$$W + \frac{WX}{Y},$$

which load is distributed between the points of support *B* and *M* inversely proportional to their respective distances from the point *C*. Hence the load on the scales *T* will be represented by

$$\frac{Z}{(Y+Z)C}$$

or

$$\frac{Z}{Y+Z}\left(W + \frac{WX}{Y}\right).$$

Hence a weight of 100 pounds on the fulcrum *M* will produce a load on the scales *T* equal to

$$\frac{Z}{Y+Z}\left(100 + \frac{100\,X}{X}\right)$$

instead of 100 pounds as generally believed.

The above condition obtains, more or less, in the vast majorities of dynamometers and is sometimes so exaggerated as to make the results positively ridiculous. In the case of a motor test let *W* represent the tangential pull on the armature, an equal upward pull on the opposite side of the shaft might tend to balance the error, or it might tend to make it worse, depending upon the position of the other parts in the diagram, but wherever it may fall the results will be most erroneous.

For instance, suppose that *W* happened to fall on the arc *M B* at *W''*, then it is evident that the weight exerted on the scales *T* will be equal to

$$\frac{WZ}{Y+Z}, \text{ instead of } \frac{XW}{L}$$

as generally accepted.

### THE HUGHES DYNAMOMETER

Fig. 2 represents diagrammatically the entire workings of the machine under discussion. At *X*, *Y* and *Z* are different change-gear wheels of different sizes to give different speeds, according to the call of [illegible] cage *U*, which in its turn is delicately balanced on a pair of strong, high-class ball bearings *A A*, *B B*, *C C*. The spring cage *U* carries a spiral spring *V*, one end of which is attached to the spring cage *U* and the other end attached to the cam hub *W*, which is, in its turn, firmly keyed to the shaft. The cam hub *W* carries a cam lever *Q* perfectly balanced on a pivot point of support.

A specially made cord *T*, out of which all the "stretch" has been taken by subjecting it to a stress of about 100 times its working load, is attached at one end of the lever *Q*, passes over the two little sheaves *S S'* through the center of the main shaft and attaches at the other end to the small shaft or drill rod *F*. The other end attaches by means of a swivel to a little crosshead *D'*, which carries a recording pin that works on a roll of paper passing over the master roll of the recording instrument, the description of which will be given further on in this article.

### Action of the Machine

The action of the machine is as follows: In testing a motor or engine the motor or engine is made to drive the spring cage or quill *U* through a silent chain or belt driving on wheels *X*, *Y* or *Z*, according to the speed desired or necessary. The torque produced in *U* is transmitted into the shaft *E E* through the spiral spring *V*, one end of which is "fixed" to *U* and the other end is "fixed" to the cam hub *W*, which is keyed to the shaft *E E*. The shaft *E E* drives by any convenient method any kind of power absorber desired, from an ordinary prony brake to a dynamo. The style of brake on *E E*, or the position of the shaft bearings *F F* play no part whatever on the results. Now, it will be clearly seen that the spring *V* will deflect practically proportional to the torque transmitted through the whole arrangement, and will allow the spring quill *U* to chase around the shaft *E E* on the ball bearings *B B*, and the angle of deflection will be proportional to the torque carried or transmitted.

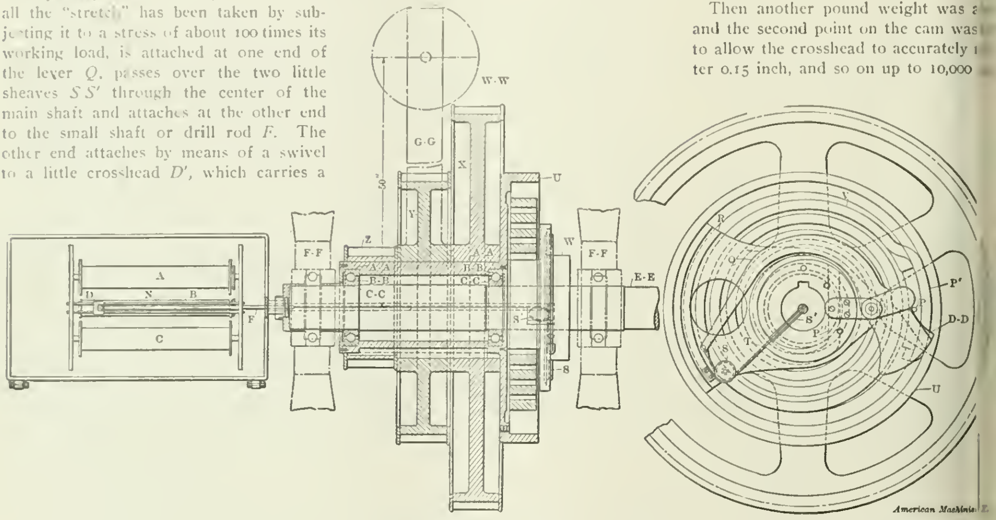

FIG. 2. DIAGRAM OF HUGHES DYNAMOMETER

Now, as *U* is moved with respect to *E E*, the pin *P* (which is carried in the steel casting of the spring cage *U*) presses against the cam *D D* on the cam lever *Q*, which operated the little crosshead *D'* of the recording instrument through the cord *T* and swivel shaft *F*.

The curve *D D* was determined, or rather the machine was calibrated, as follows: On the quill of the spring cage *U* was keyed a lever *G G* (50 inches in length) between the ball bearings *B B*, *B B* in the place of the driving wheel *Y*. Next weights *W W* are hung on the end of the beam *G G*, advancing by one pound per setting. A two-pound weight at the end of *G G* will produce a torque of 100 inch-pounds and advance the pin *P* a new position on the cam *D D*.

Beneath the crosshead *D'* was cla a scale reading in hundredths of an Now, since 1 inch on the record represents 1000 inch-pounds, 1/10 would represent the 100 inch-po hence the cam *D D* was filed unde new position of the pin *P* till the c head *D'* registered exactly 1/10 inc the scale.

Then another pound weight was and the second point on the cam was to allow the crosshead to accurately ter 0.15 inch, and so on up to 10,000 pounds torque. An examination o diagram shown in Fig. 3 will suffi show that no false reaction can b corded.

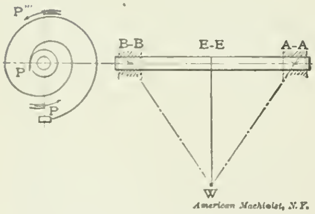

FIG. 3. DIAGRAM OF SPRING AND CALIBRATING WEIGHT OF HUGHES DYNAMOMETER

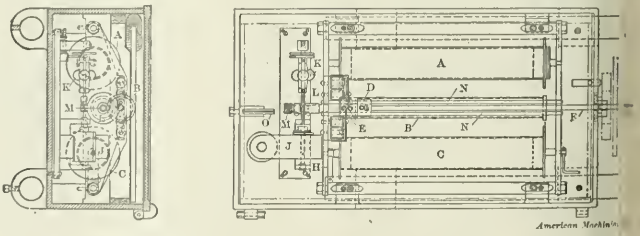

FIG. 4. DIAGRAM OF RECORDING INSTRUMENT OF HUGHES DYNAMOMETER

The load *W* with its counterbalanc shaft *E E* must be supported by th bearings *B B* and *A A*. The spiral s *V* which takes the reaction, being fix both ends *P'* and *P''*, can only pr pure torque, since the reaction upwa *P'* which tends to thrust the shaft upward against the top of the be *B B* is counterbalanced by the equa opposite force at *P''*, acting downwar tending to force the shaft against th tom of the bearing *B B*.

### The Recording Instrument

The recording instrument is show

embled in Fig. 4. The working of the strument is as follows:

At *B* is represented a master roll driven y a small electric or spring motor *J* rough a worm and gear *M* and *L*. At is a roll working under the friction ring *H* and carries a big roll of paper raduated in tenths of an inch. At *A* is e receiving roll on which the paper nds as the record is made.

Roll *A* is driven by means of a small, d. rubber belt which slips as the roll *A* increases in size, thus allowing the er to pass uniformly over the master *B*.

At *K* is a governor, which controls the d of the recording instrument, allow- the paper to pass under the recording at a constant speed of 10 inches per ute.

Pen *D* is a recording pen, made of ass; *E* represents two recording pens

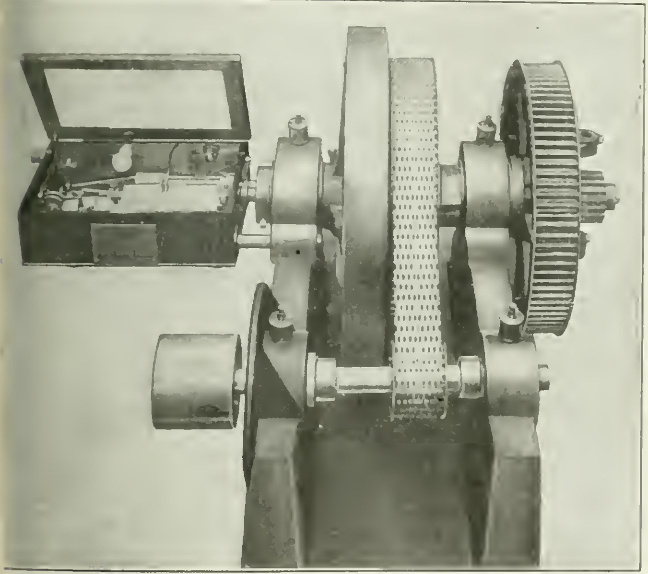

FIG. 5. THE DYNAMOMETER COMPLETE

rated by magnets *E′*, causing a dot kink to be made every revolution of machine, one recording the revolu- s made by the driver, the other re- ding the revolutions made by the ven, thus showing the slip of a belt slip pinion, as desired.

At *C* is a small sheave, inside of which a watch mainspring, and around which nds a chain, one end of which is con- ted with the crosshead *D* and keeps crosshead pulled snugly down with a stant tension on the cord *T*.

As the dynamometer automatically re- ds the inch-pounds torque and the nber of revolutions per minute, the sepower can easily be calculated from the record paper without any further data by the old formula $Horsepower=\frac{TN}{63{,}020}$, where $T$ = torque in inch-pounds and $N$ = number of revolutions per minute.

It must be admitted that the dynamometer above described is somewhat expensive in construction, nevertheless the advantages gained by building such a machine are well worth the excessive cost over the ordinary type of dynamometer. Fig. 5 shows the finished machine.

## Drying Out Small Direct Current Machines

By R. H. Fenkhausen

It frequently happens that a direct-current motor or generator becomes submerged, and is under water for some days before it can be reached. If the machine is of large capacity the employment of expert insulation men is advisable, but if it is a small machine it may be successfully dried out by the engineer or anyone else of intelligence.

The best method known for drying out electrical machinery of any kind is by passing the current through the windings, but care must be used when this method is employed, or permanent breakdowns may be caused in the insulation, necessitating the rewinding of the machine. If the following instructions are carried out, satisfactory drying will result and the machine will be none the worse for the submarine experience:

The machine should not be completely dismembered mechanically. All parts should be thoroughly cleaned and painted and the contact surfaces between the magnet poles and the frame scraped free from all rust. The brush rigging, lugs and other contact surfaces should be cleaned with sandpaper and new brushes fitted. The bearings and oil wells must be freed from all sand and grit.

Attention should now be given to the armature. Test for a ground between the shaft and commutator, using a bell and batteries for the purpose, or a magneto if one be available. Dynamo current should not be used for this purpose under any circumstances, even in series with lamps, while the armature is wet; permanent breakdowns in the insulation are liable to result. The armature should be prepared for drying out by binding several turns of heavy twine around the commutator and removing the locknut and outer cone from the commutator shell. This will permit the escape of any water

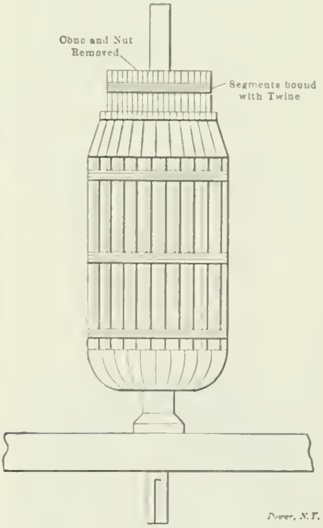

FIG. 1

that has found its way into the commutator shell and will also give the mica insulation a chance to dry out.

The armature should be placed on end, inserting the shaft in a hole bored in the bench. This will allow any moisture expelled during the baking process to escape by running out of the slots instead of working down between the laminations of the armature core. See Fig. 1.

The full-load current of the machine should be determined by an inspection of the name plate, and a lamp bank or rheostat rigged up, capable of passing twice the full-load current of the machine when in series with the armature; the resistance of which may be neglected owing to its low [illegible]. Fig. 2 shows the connections required for passing the current [illegible] [illegible] [illegible] or for a [illegible] armature, the ends being

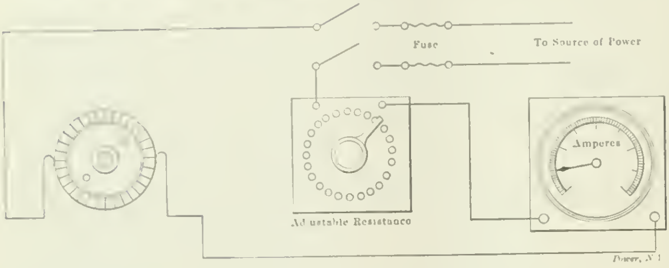

FIG. 2

connected to opposite bars of the commutator. If the armature winding is of the multipolar-drum type, the connections shown in Fig. 2 might result in the current passing through only a part of the coils, therefore the method illustrated in Fig. 3 should be employed with all lap-wound drum armatures for four poles or more. When the armature is wave-wound or lap wound with a cross-connected commutator, only two brushes situated 90 degrees apart are required, and the connections to the bars may be made as shown by the full lines, Fig. 3. An inspection of the brush rigging and connections of the machine to be tried out will show the connections required to cause the same current to flow through all the coils.

When trying out coils by the method shown in Fig. 2, the voltage drop across the armature is very small, therefore the chance of injury to the insulation is very remote.

The current flow through the armature should be gradually increased by screwing in lamps or by cutting out resistance until double the full-load current is indicated on the ammeter. The current should be held at this point until the entire armature is just hot enough to handle without discomfort. The current should then be reduced to the full-load value which will hold the temperature constant, and kept at this value until a ten thousand-ohm testing magneto will not ring between the shaft and commutator. This will probably take about ten hours' baking, but the baking must be carried on even longer if necessary. When the magneto no longer rings between the shaft and winding, procure some good armature varnish and thin it well. Then shut off the current and with a brush apply the varnish liberally to the entire armature, allowing it to run down between the coils and soak into all end connections. The armature should be laid horizontally while applying varnish, and after sufficient has been applied, the current should be turned on again and the varnish baked by the application of the full load current to the winding. The armature should be turned through one-fourth of a revolution every few minutes while baking, which will prevent the surplus varnish from running to one side and dripping off.

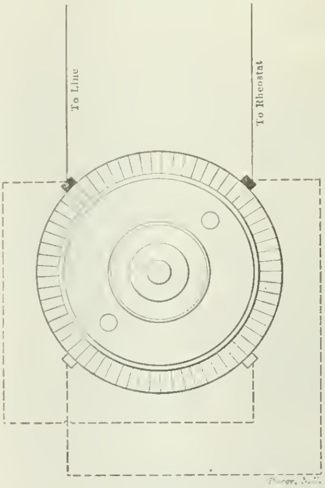

FIG. 3

After the armature is perfectly dry the commutator cone and locknut may be screwed home and the commutator trued-up if necessary. A bar-to bar test of the winding may now be made with the testing set described in a former article,* and if it tests clear, the armature is rea for use.

Before attempting to bake out the fie magnet coils, all external taping sho be removed to allow the moisture escape. The coils should then be bak in an oven first, if possible, because high resistance of the shunt wind makes the application of current dang ous while the coils are very wet, ow to the liability of breakdown betw layers, due to the voltage at the termin of the coil. If no oven is available, the coils lie in the sun as long as p sible before applying current. Wl partly dry the coils may be connected series with a resistance and baked like the armature. The current streng however, should be kept very low at fi so that most of the voltage drop be across the dead resistance, and gr ually increased as the coils dry

Many makers place no insulation tween successive layers of their field wi ings, and it therefore frequently happ that a turn of one of the upper lay is forced down through the winding u it comes in contact with the turns of lower layers. When the winding is the cotton covering may hold out, after a wetting, a breakdown is alm certain to occur, resulting in a par short-circuit of the coil. This makes necessary to unwind the coil down to damaged wire, and even then it is h to detect the fault. Fig. 4 shows scheme which I have often used w success and which indicates the inst the faulty turn is removed from the c A wooden block is fitted to the cer of the field-magnet coil and an iron r with the end bent to form a crank. driven through a hole in the center. magnet-wire spool to receive the wire it is unwound from the field coil

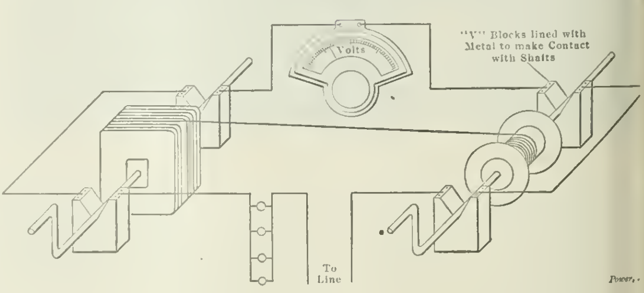

FIG. 4

mounted on a shaft similar to the first

Two form bearings for the rods, shafts. V-shaped notches, cut in woo blocks, and a strip of thin copper is in each notch, as shown, to make c nection with the shaft. The inside t minal of the field coil is grounded to shaft and the free end is grounded the shaft of the empty spool. The t copper strips under the shafts are c nected in series with a resistance across the line and a voltmeter is bridged across the two shafts, thus registering the drop cross the field-magnet coil. The resist- ice in series with the winding should adjusted so that the voltmeter reading will be relatively small. If the wire be und onto the empty spool the voltmeter ill give a continuous record of the drop, nd any change in the resistance of the il will be indicated. When the short- ircuited turn is wound off the coil, the neter reading will rise instantly and unwinding may be stopped, the wire ated and the unwound portion wound k on the coil. The voltmeter will of rse indicate any short-circuit occurring g the operation of rewinding and also give notice of a broken wire.

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*Page 833, issue of May 11, 1909.

he field-magnet coils may now be re- ed and the machine assembled. The larity of the shunt coils may be deter- ned with a compass and if the machine compound wound, it should be run as generator at part load, and the voltage nd with the series field-winding short- cuited. The series field winding should so connected that the voltage falls en its terminals are short-circuited.

## Catecism of Electricity

1106 *How does a [illegible] engine-driven alternating-current generator [illegible]?*

Fig. 341 shows a General Electric 105-kilowatt, three phase alternator designed to run at 257 revolutions per minute and give 2300 volts. Its low speed in comparison with the belt-driven alternators previously considered necessitates a comparatively large number of poles; 28 are used. This machine is provided with a direct-connected exciter.

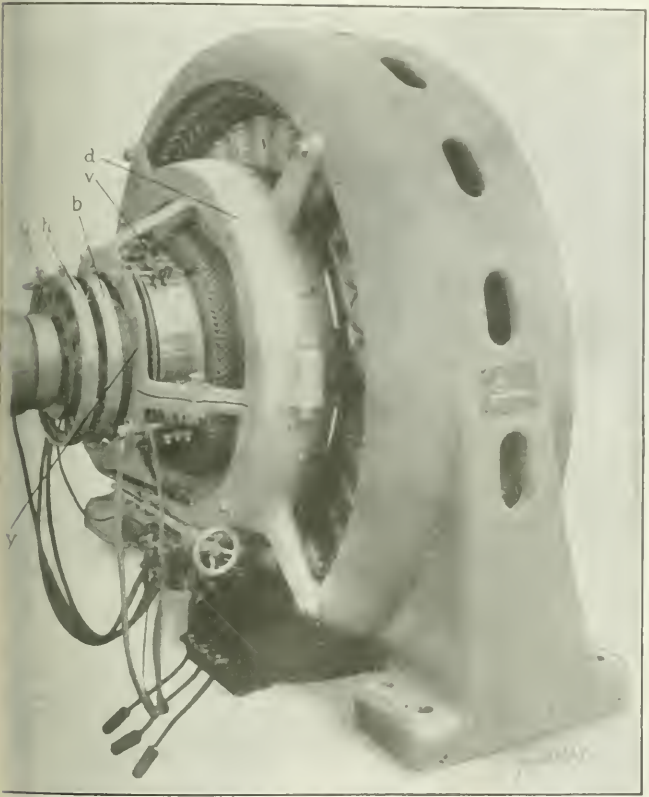


FIG. 341. ENGINE-DRIVEN ALTERNATOR WITH EXCITER ON SHAFT

1107 *Describe the principal parts of the alternator shown in Fig. 341.*

The armature coils can be plainly seen at c, in Fig. 342, which shows the alternator frame separately. The teeth of the armature punchings are firmly supported by steel fingers to prevent vibration. The armature coils are protected by an extended spider frame, which is made broad for this purpose. Provision is made for sliding the armature to one side to clear the revolving field magnet, thereby exposing the field and armature windings and giving good access to them for inspection or repair. The field magnet spider [illegible] Fig. [illegible] is cast in one piece with the rim *r*. The low speed permits the poles *n*, *s*, etc., to be bolted to the spider instead of dovetailed into slots.

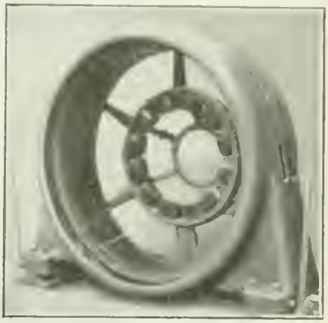


FIG. 342. STATOR OF ALTERNATOR SHOWN IN FIG. 341

The collector rings *h* and *b*, Fig 341, are made of cast iron, split in two pieces, and are supported by insulated pins mounted on a small cast iron shell on the shaft. This construction affords ventilation and allows the rings to be easily removed from the shaft.

The exciter is mounted on the shaft, close to the revolving field magnet, as shown in Fig. 341. Its magnet yoke *d* is bolted to the generator armature frame, being split into two pieces so that it can be easily removed. The brush holders *v* for the exciter and the brush holders *u* for the alternator are supported by a brush-holder yoke *y* which is part of the exciter.

The designs for these machines are adapted to three-phase or two-phase windings without change except in the coils and armature punchings, the exciter and all accessories being the same for both.

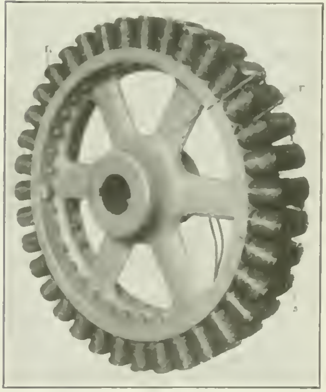


FIG. 343 ROTOR OF ALTERNATOR SHOWN IN FIG. 341

# A Common Type of Electric Elevator Machi

## Construction and Operation of One of the Early Otis Designs, with Details of the Stop-motion Mechanism and Magnetic Safety Attachment

### BY WILLIAM BAXTER, JR.

The controller used with the elevator machine in Fig. 61 is shown in Fig. 69, which is a photographic view taken with the front removed and the right side swung open. This controller is not easily shown so as to clearly reveal its operation, which is not complicated, because the various parts are so compactly arranged that only a few of them are visible from one direction. Looking first at Fig. 69, the ring *A* which is secured concentric to the main operating shaft, carries four brush holders the brushes of which rest upon the drum shown within the ring, and in connection with this drum they form the reversing switch. At *S S* is located a switch that is used to close the motor circuit to start and to open it to stop.

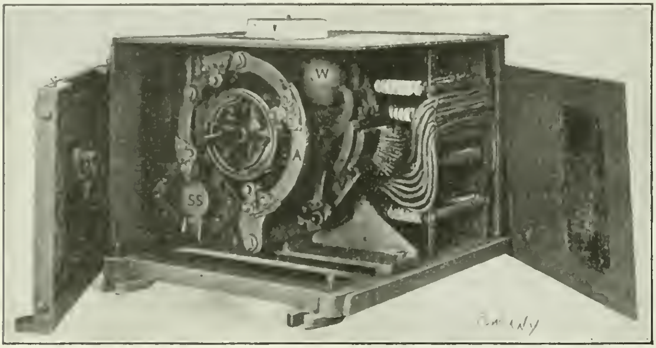


FIG. 69. MOTOR CONTROLLER

The weight *W* is mounted upon the upper end of a frame that carries at its lower end a number of brushes which travel over the part that looks like a section of a motor commutator. This last named part consists of contacts to which the sections of the starting resistance are connected, and when the weight *W* swings counterclosswise, the brushes are carried upward over the contacts, gradually cutting out the starting resistance. The shaft that is central with the ring *A* is the main operating shaft, and its end projects through the hub in the front of the controller box, marked *S*. On the end of this shaft is fixed a crank which is linked to the operating bar *A*, Fig. 61, so that the movement of the bar turns the shaft and actuates the controller. The drum within the ring *A* is mounted on the erating shaft and turns with it. W it is turned in one direction the m circuits are properly closed for the ward movement of the elevator car, when turned in the opposite direction connections are properly made for downward movement of the car.

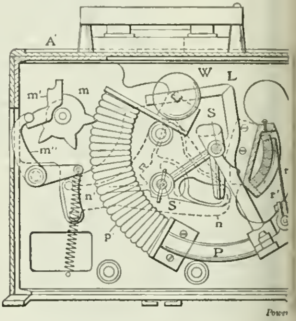


FIG. 70. SOME DETAILS OF FIG. 69

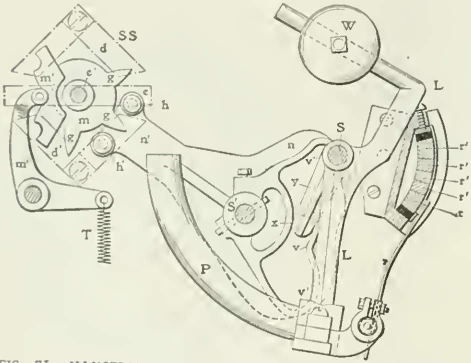


FIG. 71. ILLUSTRATING THE OPERATION OF THE CONTROLLER

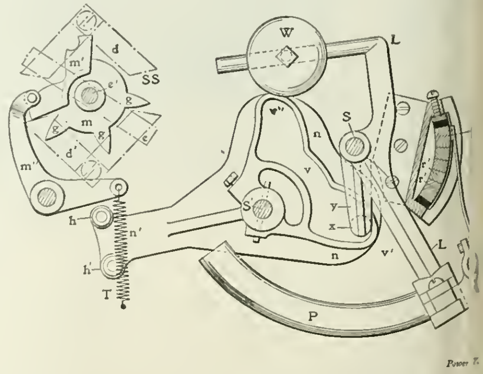


FIG. 72

Now refer to Figs. 70, 71 and 7 follow the operation of the contr Figs. 70 and 72 show the parts in t position when the motor is running, Fig. 71 shows their position when motor is stopped. It will be noticed at the frame *L* carries at its lower e a curved bar *P*, which forms the core a solenoid magnet. It also carries a ible finger *r* to the end of which is tached a carbon contact that sweeps the contacts *r'* of the starting resist The frame *n* is mounted upon the erating shaft back of the reversing d e shaft being shown at $S'$. When the ame $n$ is in the position shown in Fig. , the switch $S S$ is open, and the start- resistance is all in the armature cir- . When the parts are in this posi- n the weight of the core $P$ tends to ing the frame $L$ around to the posi- n shown in Fig. 72 but cannot do so a se the arm $y$, which is made fast to is held by the roller $x$ in the narrow ening $v$ of the frame $n$. When the it $S'$ is rotated so as to swing $n$ into position shown in Fig. 72, $y$ is left e to move, and if not restrained it d do so because it would be carried nd by the weight of the core $P$. It l be noticed that the effect of the ght of the core $P$ decreases as it ves toward the position shown in Fig. but it will also be evident that the ect of the weight $W$ increases as this on is approached, so that by prop- adjusting the position of the weight it can be made to balance the weight the core $P$ in practically all positions the mechanism.

he solenoid $P'$ tends to draw the core nto it, when it is energized, and the rent that passes through the armature he motor also passes through the coil $l$. Consequently, when the armature is c into circuit, the solenoid tries to pull t core into it. The parts are so made, ever, that as long as the armature rent is not excessive the core $P$ will ve out of the coil slowly when re- l ed mechanically. If $P$ moves too fast, t brush $r$ will cut out so much of the ting resistance that the armature cur- t will increase to a point where the mag- pull of the coil $p'$, Fig. 70, will be suffi- to hold the core $P$ from advancing her, and not until the motor speeds u enough to cut the current down to proper strength will there be any her outward movement of $P$. From foregoing explanation it will be seen gravity tends to move the brush $r$ ward to cut out the starting resistance, that the strength of the current pass- through the motor armature acts ugh the solenoid coil to retard the ement, so that all that is necessary to re the proper velocity of the brush $r$ have the parts properly adjusted.

he switch $S S$ is of the type known as nap switch," because the switch moves he open position with a sudden snap. T operation of the switch is as fol- l . When the frame $n$ is moved back position shown in Fig. 72 to that in Fi 71, the upper roller $h$ strikes the r tooth $g$ of the wheel $m$. This wheel tegral with the cam $m'$ and the switch e $e$. The first movement of the wheel ts to lift the roller on the end of the fr e $m''$ out of the depression in which it sts, and carries it over the high point on the part that slopes down toward the central point. As soon as the roller ad nces far enough, the tension of the sp g $T$ forces it down into the central depression and thus swings the wheel $m$, and the switch blade $e$, rapidly into the open position. The object of all this is to break the spark that is formed on separating the switch parts as quickly as possible so as to reduce its destructive effect upon the switch contacts.

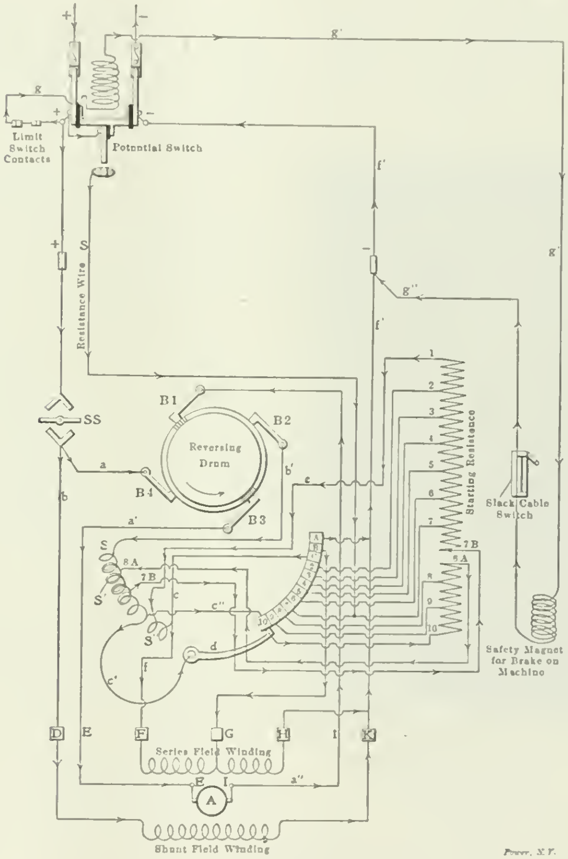


FIG. 73. WIRING DIAGRAM OF CONTROLLER

The way in which the controller operates can be made clear by the aid of the wiring diagram, Fig. 73, in which the direction of the current in each wire is indicated by arrow heads. The potential switch shown in this diagram is the main-line hand switch referred to in the explanation of the safety brake. It is a two-pole knife switch so constructed that it will open by the action of gravity if not held in the closed position, and provided with a magnet that holds it closed as long as current passes through the magnet coil. This operates exactly like the no-voltage release magnet used in connection with the starting box of a stationary motor. When this potential switch is closed, the current starting from the left side flows through the two limit switches to the retaining coil of the switch, thence to wire $g'$, through the magnet of the safety brake on the machine, through the slack-cable switch to the wire $g''$ and then through the wire $f'$ to the other side of the main line. It will be plain that as long as there is a current flowing in the main line the magnet of the switch, as well as that of the safety brake, will remain energized and the only thing that can deenergize them is the opening of the slack-cable stop switch.

When an electric slack-cable stop is used with this type of elevator machine, if it goes into action it stops the motor by opening the main-line hand switch and at the same time applying the safety brake. When the controller-operating shaft is turned to set the motor in motion it closes the snap switch $S S$ and at the same time rotates the reversing drum so as to connect the brushes bearing on it in the proper order. Suppose the drum is rotated in the direction of the arrow, then the brushes $B_1$ and $B_2$

[illegible] other, and in [illegible] the brushes $B_1$ and $B_2$ will be connected. Then the main current coming from S S through the wire a will pass through the lever to the wire a' and thence [illegible] through the armature [illegible] brush [illegible] and again through the reversing drum to the wire c; through the solenoid S to the wires C' and C'', by means of both of which it reaches the lower resistance segment 10 and thence through the starting resistance as indicated by the arrow heads, to the point 8A. From here it passes out to another coil of the solenoid marked S' in dotted lines, back to the point 7B and through the balance of the starting resistance to the wire c, which leads through another coil of the solenoid marked S''. From this point the current flows into the wire f and passes through the series-field winding of the motor to the wire f' and to the opposite side of the line. The wire b carries the current from the switch S S to the shunt-field winding of the motor, and from the latter it passes to the wire f' where it joins the current coming from the series-field winding. The solenoid coil S' acts to increase the pull on the core; therefore, by varying the points 8A and 7B on the starting resistance to which the coil is attached, the time during which the strength of the solenoid is kept up to the highest point can be varied so as to give the desired action of the apparatus. When the arm D has moved far enough forward to bring the brush onto the segment [illegible], the current will pass through the wire C'' directly to the wire f and thus cut out the coil S''. This is done so as to make sure that the arm will move far enough to carry the brush over the contacts B and 1 and surely cut out the series-field winding of the motor.

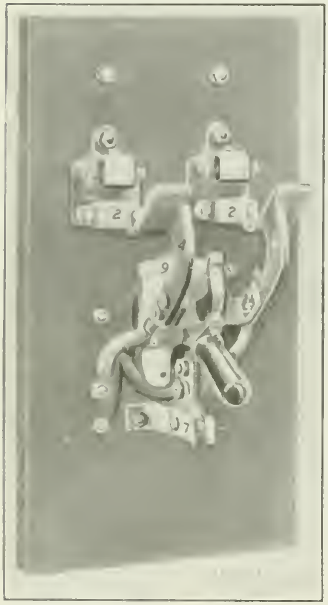


FIG. 74. POTENTIAL SWITCH

In the diagram the reversing drum is shown in such a position that the brushes $B_1$ and $B_2$ rest upon the insulating sections that separate the two halves of the drum from each other. In stopping the elevator the snap switch *S S* is opened first, so that when the reversing drum is rotated back to the stop position there is no current flowing through it; therefore, there is no sparking between the brushes and the drum.

The limit switches shown to the left of the potential switch are additional stopping devices placed in the elevator well to be actuated by the car as it approaches the ends of its travel, and are intended to act if for any reason the stop motion on the machine should fail. If while the elevator is running the current in the main line should die out from any cause, the retaining magnet of the potential switch would become deënergized and the switch would open and break the connections between the motor and the line. At the same time the lower blade of the switch would drop into the contact below it and close a circuit of low resistance into which the motor could generate a current. If the potential switch should open under these conditions, the switch *S S* would be closed and the reversing drum would be in one of the running positions, so that the circuit of the motor armature would be closed through the wire marked "resistance wire," as can be clearly seen by starting from, say, the right side of the armature, and following up through brushes $B_1$ and $B_2$ to and through the solenoid to the resistance contact 7 and thence to the potential switch and through the lower blade of the latter to the switch *S S*, and through wire *a* to the left side of the armature. The shunt-field current of the motor would start from *S S* and run down to and through the shunt winding, to and through the series-field winding in the reverse of normal direction and thence to the wire *f* and through the coil *S''* to the upper end of the starting resistance, through the resistance to the contact *10* and through the wire *c''* to and through the solenoid coil *S*; thence to and through the drum brushes $B_2$ and $B_1$ to the right side of the armature.

The potential switch is shown in Fig. 74. The lever *9* of the magnet is provided with a hook that engages with the hook just above the handle, between the switch blades, and as long as a current flows through the magnet the switch is held closed.

## Don't Be a "Back Number'

By George F. Wright

One of the most important duties f an engineer is to keep his engines r ning smoothly—at least with as l noise, and as few "knocks" as is poss under the particular and special con tions to which his engine is subjec Of course it is much easier to "keep engine up" running under a light l than it is one which is pulling her capacity, or perhaps laboring under overload; let the case be as it may, ev engineer will have a clearer conscie and lighter heart if he applies him diligently to his duties—and besides will have the confidence and good of his employers.

The next thing, and one of vital port, is a neat and tidy engine ro No one can imagine a dirty engineer be an efficient man, nor can you bel him to be a man who takes an inte in his work. If every engineer w only come to the realization of his p tion, and the application thereof, a ter impression would be made as to dignity of the profession.

If an engineer expects to advance, must advance because of his merits, his merits are in proportion to his sire for knowledge—the stronger his sire for knowledge, the more he read and study. These are days progress, and no man can expect to cl to the top rung of his profession w out study. A man may perhaps be s in acquiring the desired proficiency become discouraged, and finally se down into a rut, which allows him "plug along" (satisfied with his pre position) until by and by he will lose interest in the work—and when that st is reached, he soon becomes affiliated w failure, and is therefore entitled to the privileges and benefits of the "l number club."

Don't be a "back number"—brush and take an interest in your work you will soon see the smile of appr on the face of your employer—but if smile does not materialize, you must continue to live and "do things" for y own sake.

---

The Columbia river, with its many la tributaries from Montana, Idaho British Columbia, draining an area of 2 000 square miles, and drawing its su from the snow fields of great moun ranges, affords large possibilities power developments. The annual m mum flow above Kettle falls is repo as ranging from 19,000 to 30,000 cubic per second. This is a runoff from drainage area of 63,160 square miles which 10,000 to 12,000 square miles is surface. At Kettle falls the drop is 5 feet over a dike of rock.

# Some Useful Points on Piping

## Plain Instructions as to the Best Location of Pipes and Fittings to Insure Efficient Results; Several Correct and Incorrect Practices Compared

### BY W. H. WAKEMAN

The full lines in Fig. 1 illustrate the m pipe of a small engine used for ving one of the auxiliaries in a large wer house. The vertical pipe is fitted h a tee having a reduced outlet, to h the lubricator is attached, and this llowed by a short nipple, on which re is an ell, followed by another nipple t is thus brought into a horizontal posi- n in connection with the throttle valve. s arrangement of fittings requires four wed joints at this point in the main e, together with a tee, but this tee two of the joints are superfluous, as arrangement shown in dotted lines minates them, and at the same time kes a better job. A tee is used instead an ell and this carries the lubricator by ns f a bushing as shown. Into the er part of this bushing a ½-inch nipple is screwed which carries the oil to the center of the horizontal pipe. A small drip pipe is tapped into the lower part of the tee, and the pipe from it may be carried to the sewer in the most convenient way. Such a drip pipe is provided for the purpose of drawing off all water that has collected in the main pipe before starting the engine, after which it should be closed, but in some plants it is frequently forgotten and left open for hours. In many cases this pipe is attached to the main pipe so that it takes much of the cylinder oil, in addition to the steam wasted, but the design shown in dotted lines in Fig. 1 cannot divert any of the oil from its proper course. The design in full lines shows four joints in the main pipe between the lubricator and the throttle valve, through which much cylinder oil will be forced by the action of steam, provided the threads do not form a perfect contact at all points, but with the design in dotted lines the number is reduced to one at the throttle valve which is another advantage There is one at the ell but the small internal pipe carries the oil beyond it before discharging the same into the swiftly moving steam.

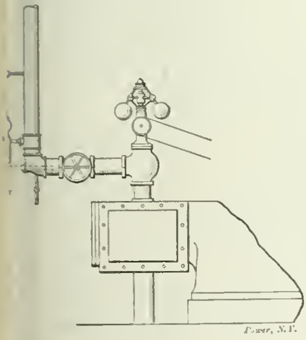
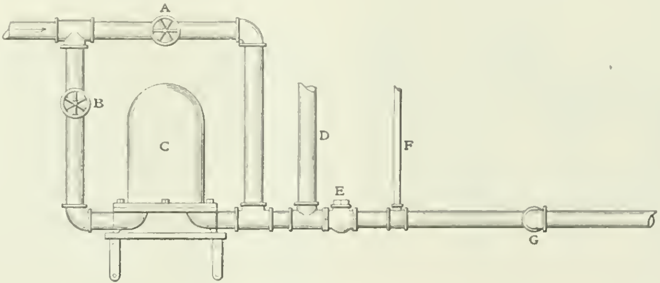

Power, N.Y.

FIG. 1

Fig. 2 illustrates a section of the drip pipes as originally installed in a plant, which contain two bad features. Steam mixed with hot water enters as shown by the arrow, and as the bypass valve *A* is usually closed the mixture passes down through *B* into the trap *C*, where separation takes place and only water is allowed to pass into the sewer through the long horizontal pipe. Another drip pipe is connected at *D*, but it is seldom used. The check valve *E* prevents water from being forced back into the trap when water and steam are discharged under high pressure through *F*. The check valve is on a level with the bottom of the trap and as it requires a light pressure to open it, water must stand higher in the trap than it otherwise would, especially if *F* is in use, because it strikes the main drip pipe at right angles, and so forms an obstruction to the free escape of water

The check valve *E* is connected to the tee by means of a close nipple, which was shorter than it ought to be, hence the check valve touched the tee before a good joint was made; consequently, there was always a leak at this point Close nipples should never be used, if they can be avoided, on account of the possibility of leakage, also because they form a weak spot in the line as the threads meet and leave only a thin ring to stand the strain. Even if there is only 1/2 inch of space between the threads it makes contact of the fittings impossible, and is much stronger than a close nipple.



Power, N.Y.

FIG. 2

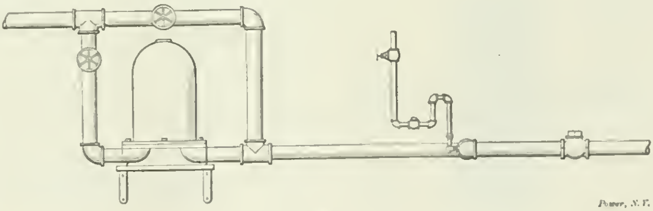

Power, N.Y.

FIG. 3

Fig. 3 illustrates the same piping after it was remodeled, and it will be noted that close nipples are not used. Consequently, it is impossible for the above-mentioned defect to cause trouble, and ample strength of the pipe is secured in a workmanlike manner. When steam and hot water are discharged at high pressure through the small drip pipe, no resistance to the free escape of hot water through the larger pipe is offered, because the discharge is not at right angles to the main pipe. The ell shown at *C*, Fig. 2, was removed and a reducing tee used instead, a plan of which is shown in the plan view, Fig. 4. Care was taken to place the check valve beyond this point, therefore it is forced open when the small drip pipe is used, and an ejector is thus provided which draws water from the trap and connecting pipes.

Fig. 3 shows a loop in the small drip pipe, including a check valve at this point, which is used in order to prevent hot water from backing up into this pipe when it is not in use. The drip valve is left open to afford free drainage when steam is turned into the machine for which this provides an outlet. A check valve is less liable to leak when under a water seal than when it is omitted.

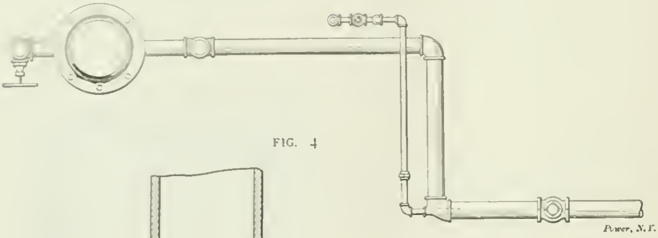


FIG. 4

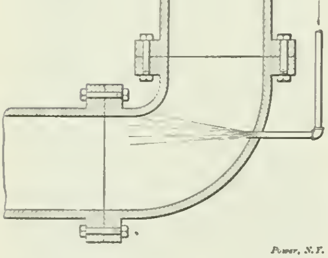


FIG. 5

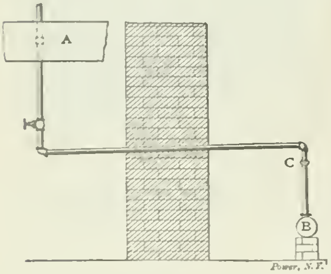


FIG. 6

Fig. 5 shows a ¾-inch pipe discharging steam into a main 12 inches in diameter. When steam at high pressure is discharged directly against the side of a pipe, it will make a hole in due course of time, and it may cost several dollars to repair the pipe, but the device shown here prevents steam from striking directly against the iron. If the steam jet entered the center of the larger pipe it would be more satisfactory, but the curve in the large ell prevented boring and tapping the hole at a lower point. This action of steam is taken into consideration whenever I find it necessary to make such a connection in my plant, or elsewhere.

Fig. 6 illustrates two defects in a drip pipe forming part of a low pressure heating system, both of which were eliminated by making one change. The vertical pipe passes through a galvanized-iron ventilating duct, as shown at *A* and a coupling was used at this point, which proves that the steamfitter who planned and executed the job did not intend to operate it afterward, for in that case there would not have been a joint where it was inaccessible, or at least very inconvenient to reach after the plant was finished.

The pipe, which is located in a nearly horizontal position, should have pitched toward the right hand in order to drain properly, but it really pitched in the opposite direction; therefore, water was forced "up hill" before it could run into the main return pipe *B*. As a general rule water will stand in the vertical pipe in such a case about as high as the valve shown, and the weight of this short column will force the liquid up the incline into the short vertical pipe at t right hand, but this case seemed to an exception to the general rule, becau water leaked out at the coupling *A*, a though it was about 2 feet above t valve, proving a great nuisance in t duct and on the floor below it. It d not leak every day, nor according to a schedule, as far as I could discover. addition to this nuisance there was clicking in the pipe which was very a noying, as it was in a building where noi cannot be tolerated. It was not hea continuously, as it would disappear f days and then return when least e pected and not wanted.

The above-mentioned leak could be se by everybody who came into that pa of the building, and the clicking w plainly heard; consequently, both were r ported several times before there was chance to make the necessary repair but the real cause of trouble was n suspected by casual observers. I cut piece out of the vertical pipe, put in union at *C* which caused the long pi to pitch toward the right hand, and th disposed of both the leaky joint and t disagreeable clicking.

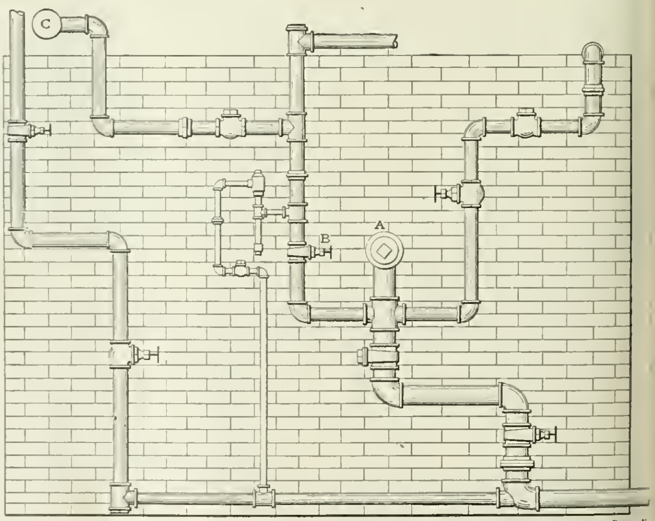


FIG. 7

Fig. 7 illustrates a section of piping the rear of one boiler in my plant. Th blowoff pipe extends through the wall an there is a tee on the end of it as show at *A*. Below this tee there is a cros into the right-hand inlet of which a dr pipe from the main header is screwe while the left-hand inlet receives a pi for filling the boiler with cold water. T gate valve *B* controls the supply whic is received from the main water pipe When a new fireman is sent to cut in th boiler after it has been laid off, he ought to open the drip valve *D* after opening the main stop valve, which is not included in the illustration, but he will sometimes open *B* instead, and thus blow hot water into the cold-water system. To prevent this the check valve *E* was installed, and it worked well, but its perfect operation caused more trouble as follows: When cold water was received through *B* the temperature of the pipes was reduced, causing the iron to contract, then after water ceased to circulate, the pipes became hot again as the whole section is located in a very warm place. Heat caused the water to expand and as there was no outlet, a high pressure resulted (although there was no gage to indicate it), which caused some of the joints to "weep."

Another point to be considered in this connection is that the supply pipe *C* is larger and longer, and as it is exposed o the same extremes of temperature the xpansion is greater, accordingly, when

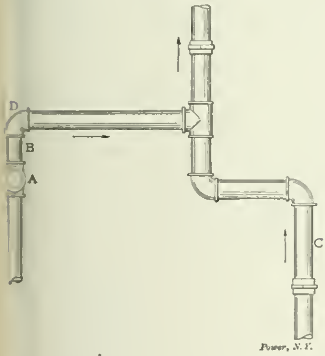


FIG. 8

ılves on both ends of it are shut. In der to provide an outlet that would event high pressure on the pipes, a tee as put in just above the gate valve *B* nd by means of two nipples and a small e a water relief valve *F* was connected, nd set to open at a higher pressure than realized in *C* under working conditions. discharges through three ells and a eck valve into the blowoff pipe near e floor. The check valve is provided this case to prevent water from backing into the relief valve *F* when any one of e five boilers located in this plant is own down, as all of them discharge into e same pipe.

After this relief valve had been in use short time it leaked badly. It was disnnected and a piece of scale from the side of a pipe was found on its seat, us preventing it from closing. Previous this an ell was used just below it, but was then removed and a tee used inead. A nipple was screwed into the lwer opening of this tee, with a coupling d a plug on the other end of it, thus forming a pocket into which foreign matter that is heavier than water falls, and this protects the valve. The pipe at the extreme left hand is used to let water go into the blowoff pipe and thence into the sewer, when it returns from the heating system faster than it is wanted in the boilers. The upper valve leaked badly, hence the lower one was added to prevent the loss of water. In such a case the lower one ought to be opened first, then water will rush through the upper when it is only partly open. If this wears the seat it does no special damage because the small amount which passes here will be held by the lower valve without the excessive friction due to water passing rapidly through a small opening, hence the lower valve will last indefinitely.

Fig. 8 illustrates a section of piping that lies flat on a brick floor. It forms part of a system which carries water from two batteries of boiler to the sewer in the direction indicated by the arrows. A vertical pipe discharges into the tee at *A* beyond which there is a short nipple *B* that was badly corroded by water constantly standing in it through a long term of service. It was removed and a new one substituted as follows: The two unions shown were disconnected and this part was raised from the floor, swinging it on the nipple *B* as it was necessary to remove the pipe *C*. The remainder was then unscrewed out of the ell *D* like a carpenter's huge auger coming out of a hole. The corroded nipple *B* was then removed and a new one put in, after which it was an easy matter to replace the ell *D* and screw the long pipe carrying one tee, three nipples, two ells and one-half of a union, back into place. The pipe *C* was returned to its place, then the whole of this end was carried downward until the two unions were ready to be connected, then the screwing on of the two nuts completed the job. By following this plan it was necessary to break but two pipe joints (in addition to the nipple that failed), which saved much labor that would have been required by any other plan, as old pipe joints do not unscrew easily as a rule.

The demand for competent teachers of industrial arts has led teachers college, Columbia university, to plan a series of night courses, by which young men who have a first-rate technical ability in the trades such as woodworking or machine-shop work can prepare themselves for the profession of teaching. These courses are being offered at night in the school of industrial arts of teachers college, covering mathematics, drafting, design, woodworking, machine-shop work, industrial chemistry, industrial history, methods of teaching industrial arts. A three-years' course of night work, it is claimed, will enable an expert mechanic, otherwise qualified, to gain a diploma as a teacher of industrial arts.

## Patches on Boiler Plate

If for any reason it becomes necessary to put a patch on a boiler, the patch should be put on the inside, not on the outside. By putting it on the inside, a pocket in which scale or grease may accumulate is avoided. The patch may be gotten inside the boiler ordinarily if made of an oblong shape, its short width being less than the long diameter of the manhole.

In putting on patches, it should be borne in mind that in cylindrical shells, the longitudinal stress per unit of section is only half as great as the peripheral stress per unit of section, and the patch should be designed accordingly. Thus a patch with longitudinal edges having an average inclination of 45 degrees to the circular seams, even though single-riveted, may be equally strong as a patch with its longitudinal edges perpendicular to the circular seams, even though the longitudinal edges are double riveted. The patch shown in Fig. 2 is equally strong as the patch shown in Fig. 1, provided rivets of the proper diameter, properly spaced, are used.—*The Fidelity and Casualty Company, of New York.*

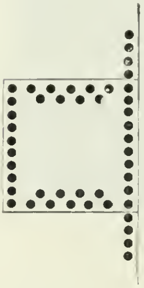


FIG. 1. SQUARE PATCH

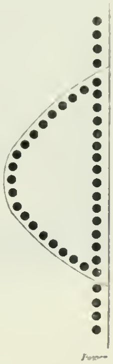


FIG. 2. DIAGONAL PATCH

The United States Civil Service Commission announces an examination on January 5, 1910, to fill a vacancy in the position of engineer, $1600 per annum, in the National Museum, Washington, D. C. The subjects and weights are as follows: Letter writing (a letter of not less than 150 words on some mechanical and electrical-engineering subject), 10; practical questions in mechanical and electrical engineering, comprising the construction and operation of the heating plant and electric lighting and elevator machinery in first-class public buildings, 65; education and experience in mechanical and electrical-engineering work, 25. The application form is No. 4.

# Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think,
Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

## A Condenser Question

Herewith is a sketch of our injector condenser of Knowles type and a photograph of the tail pipe. I have been anxious to know for a long time why the condenser could not be run with the tail pipe discharging above the surface of the water in the tail race. A few weeks ago I tried it and found it worked all right, as shown in Fig. 2. I have asked several well posted engineers about it, and I am still at a loss to know why the tail pipe has to be in the water. I hope to hear from readers of POWER.

JOSEPH S. LABONNE.

Jewett City, Conn.

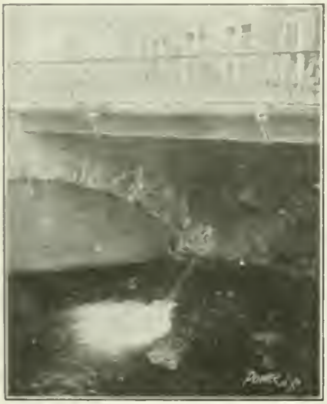


FIG. 2. TAIL PIPE DISCHARGING ABOVE SURFACE OF WATER

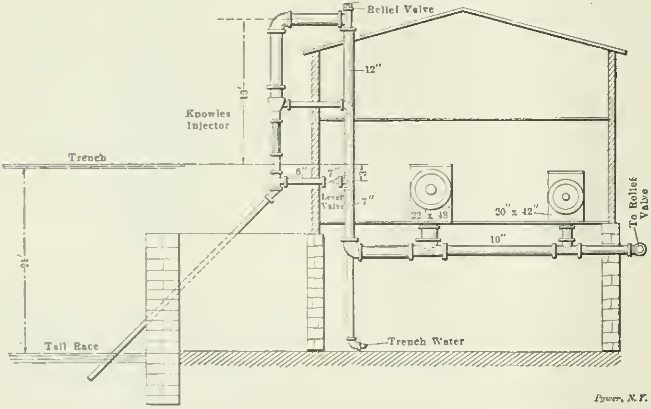


FIG. 1. ARRANGEMENT OF CONDENSER AND TAIL PIPE

## A New Cure for Priming

That story in a recent issue of POWER of the man whose hair turned white in a short space of time owing to his having been shut up in a boiler, reminds me of the way I acquired the white hairs sprinkled here and there among my luxuriant brown locks.

Years ago I was at sea in the engine room. The first ship I sailed in was a little English tramp with compound engines and a single boiler carrying 45 pounds of steam. It was an easy job which never gave any trouble, and after three months' experience I was no better equipped to take care of a hard job than before I went to sea.

The next job was one of the (at that time) new triple-expansion jobs with 150 pounds of steam. One evening, a few days after we had put to sea on the way to Bombay, the chief entertained us at supper with a harrowing account of disasters which had been caused by priming boilers. I had had no experience with priming and I swallowed whole what the chief said, not knowing that he was "stringing" me. As my watch was from 12 to 4 a.m., I turned in shortly after supper. For a long time I could no sleep, but rolled restlessly from one sid to the other worrying over these prim ing yarns. Eventually I fell into troubled sleep and dreamed of priming boilers and a series of terrible disaster all attributable to priming. When th watch called me at a quarter to twelve got up and dressed and went below. Th terrible dreams had had their effect, how ever, and I went my rounds with m nerves on edge and an oppressive sensa tion that something was going to happe

Suddenly there was a loud bang, th blood froze in my veins, here it is a last, this is that terrible priming whic the chief had spoken about. What was to do? I had had no experience, so wa at a loss. The noise, however, did n recur immediately and I was beginnin to think that I had been mistaken, whe suddenly again came that sharp bang. made a dive for the stokehold and calle the fireman.

"Smith, you were donkeyman in you last ship, weren't you?"

"Yes, sir."

"Will you come into the engine roo with me a minute?"

So Smith and I went into the engin room and the moment we entered the came another bang, if anything loud than the previous ones.

"What was that?" I inquired, my voic shaking with terror.

"She's primin', sir."

"What's the best thing to do?"

"Link her up a bit, sir, and I'll put u the ashpit dampers; that ought to fix it

So I linked her up and Smith went int the stokehold and put the ashpit dampe on, but it didn't seem to do much goo At intervals the terrible bangs recurr and seemed to be getting worse, if an thing. At last I could stand it no long and, calling Smith to stand by, I we up the engine-room ladder to tell t chief. His room was just opposite t engine-room door. He was awake a immediately called "come in" in respon to my knock.

"Well, what's the matter?" said he.

"She's priming terribly."

"How do you know?"

"Good God, man, every once in awhi she's making the most awful bangs ever heard."

"What have you done?"

"I've linked her up and put the ashp doors on, but it don't seem to have ma any difference. Can you suggest anything else?"

"If I were you," he replied while a smile played about his lips, "I would shut and hook back the engine-room door."

And, as though to emphasize his words, the ship rolled heavily and the iron door of the engine room swung with a loud bang against its iron frame.

E. A. DIXIE.

New York, N. Y.

## The Melville-Macalpine 6000-Horsepower Reduction Gear

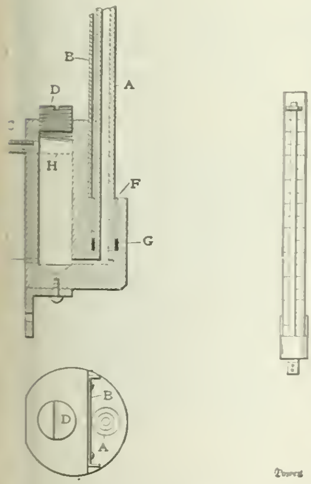
I was much interested in the account of the turbine reduction gear, which appeared in a recent issue of POWER, also in *London Engineering*, and I should like to have an expression from POWER readers as to the probability of being able to transmit continuously and satisfactorily this amount of power on a gear with teeth pitched at 1¼ inches and making [illegible] revolutions per minute. If a tooth should fail, there would be a fine smash-up. Of course, I understand it is in an experimental stage only.

E. FOLEY.

New York, N. Y.

## An Easily Constructed Air Gage

The accompanying sketch shows an air gage which I made and mounted on the gage board in the engine room. This gage was connected to the main air duct of a forced-draft system with which the plant was equipped, and would indicate all pressure in inches of water.



DETAIL OF AIR GAGE

The body of the gage is of brass, about 1½ inches in diameter, cut out on one side as shown in the drawing. The bent tube from the air duct is connected at C. The hole H is drilled and tapped to a short distance with an ⅛-inch pipe tap and fitted with the plug D. A is a glass tube about ¼ inch outside diameter and about 10 or 12 inches long, the length depending on the pressure of the air. This tube is fitted as shown. G is a rubber gasket, the space above G being filled with plaster of paris. B is the scale fastened with screws and graduated in inches.

The instrument is fastened to the gage board by a screw through the angle piece at the bottom. The small hole under the glass is drilled from the point F and is plugged at E. The hole H is filled with water, colored red, which the pressure of the air forces upward in the glass tube.

R. L. MOSSMAN.

Tampa, Fla.

## Overworked Boilers

An operating engineer can hardly secure a position where a knowledge of firing and conditions essential to economy and efficiency in the boiler room will not be invaluable.

I know an engineer who took charge of a lighting, power and heating plant. The boiler room contained four 275-horsepower Heine water-tube and four 72-inch by 18-foot return-tubular boilers. In the engine room were three engines, one 30x54 Corliss, 75 revolutions per minute; one 34x48 Corliss, 80 revolutions per minute, and one 28x42 Corliss, 120 revolutions per minute. The engines were overloaded, and the average cutoff on the peak loads would be about one third stroke, and the back pressure carried from 5 to 8 pounds. The economy under these conditions was about such as one might expect from a plain slide-valve throttling engine.

Now, the capacity of the boilers was 1700 horsepower, and the engines carrying the peak load had an output of approximately 600 horsepower each, or a total of 1800 horsepower. Now, under the conditions the engines could not have required less than 35 pounds of steam per horsepower-hour, so that allowing nothing for the auxiliaries, the boilers, assuming that all of them were hot, were grossly overloaded. The four Heine boilers were set two in a single setting, in order to lower the cost of stoker installation, only one stoker being used for both boilers. In order to repair one 275-horsepower boiler, it was necessary to cut out 550 horsepower.

It was next to an impossibility to give these boilers the attention they should have had, especially during the winter. It was absolutely impossible to pull the load with one battery of 550 horsepower cut out.

When the engineer went to this plant he found that the return-tubular boilers were hand fired. The Heine boilers were stoker fired, and owing to good draft and were doing all the work, the hand-fired boilers being run for a bluff.

The boiler room was in charge of a fireman, whose knowledge of the politics of "booze" exceeded his knowledge of boiler-room practice; therefore he discarded him. The men who had been firing the tubular boilers were in the habit of keeping a mound of coal next to the fire doors, leaving the back of the grates, near the bridgewall, bare. This was easy on the fireman, and besides he burned less coal than if he had spread coal properly over the grates. As a result the Heine boilers were crowded so that tubes were being constantly burned out, and it was costing $150 per month to keep up repairs on these boilers for this item alone.

The new engineer first endeavored to secure better handling of the fires under the hand-fire boilers, and those who were willing to learn he instructed, and those who would not, were discharged, and other firemen secured in their places. In this way he relieved the Heine boilers, and saved over $125 per month on the repair bills.

It will be readily admitted that without a thorough knowledge of boiler room work this engineer could not have coped with the situation.

WILLIAM WESTERFIELD.

Lincoln, Neb.

## A Christmas Bill of Fare

The following would be a rather appropriate "spread" for the power station operator who is on duty on Christmas day.

ELECTRIC COMPANY.
Christmas Dinner.
December 25, 1909. Operating Gallery.
Pumps.
Condensers. Feed Water.
Rotary (Hunter).
Dynamos (stuffed with amperes).
Motors (assorted). Alternators.
Repair Work. Electric Shock.
Turbines (à la Curtis). Boilers (steamed).
Frequency. Power Factor.
Split-pole Converters.
Amperes. Currents. Volts.
Watts. Energy.
Short-Circuit. Ground. Shutdown.
D. C. Juice. Operation. A. C. Juice.
Cycles. Speed.
K. W. Peak Load. B. T. U.
K. V. A. Mhos.
From 7 a.m. to 6 p.m. Meters.

HARRY J. BARTON.

Schenectady, N. Y.

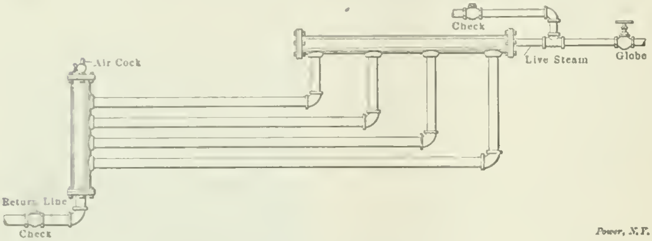
## Preventing Water Hammer in Radiators

The accompanying drawing illustrates how to remove the danger of bursting pipe fittings and prevent water hammer in radiators and at the same time assist proper circulation. A check valve on the steam line to the radiator is the secret of the whole thing.

The check valve is so arranged that when steam is turned on the radiator, it closes. As the steam flows to the cold radiator, it condenses and creates a vacuum, but as it begins to create the vacuum, the check valve opens up and allows air to rush in. This prevents the sound which is heard in nearly all radiators when the steam is first turned on. The check will work automatically and requires no attention

E. H. Marzoef.

Youngstown, O.



CHECK VALVE TO PREVENT WATER HAMMER

## Linings for Steel Chimneys

It is well known that small unlined steel chimneys are very severely damaged by corrosion, particularly where the coal used contains iron pyrites or "brasses" ($FeS_2$), as is often the case with bituminous coals. In burning such coals one of the products of combustion is sulphurous acid gas ($SO_2$), and a portion of this gas is apparently absorbed by the light flocculent coating of soot which gathers on the inside of the chimney. The joints of small stacks are very rarely tight, and at every rain storm more or less water is driven into the stack through the badly made joints. The water comes in intimate contact with the sulphurous-acid gas in the soot, and the result is sulphuric acid ($H_2SO_4$) which attacks the metal. The white or rusty-white deposit found in many steel chimneys beneath the soot is sulphate of iron.

It is often considered that small stacks cannot be lined, but it is possible to put a lining in any stack in which a man can be slung on a "bosun's" chair. Such a lining will, to a large extent, prevent corrosion, and in most cases will improve the draft, and the available stack area will not of necessity be greatly reduced; the following sizes of brick being available for linings less than 4 inches in thickness:

| | |
|---|---|
| No. 1 split............ | 1¼x4½x9 inches. |
| No. 2 split............ | 2 x4½x9 inches. |
| Straight nine inches.. .. | 2½x4½x9 inches. |
| Small nine inches ....... | 2½x3½x9 inches. |
| Soap .. .. ........... | 2½x2¼x9 inches. |
| Checker ............... | 2¾x2¾x9 inches. |

| How Set | Thickness. |
|---|---|
| Set on end. | Lining 1¼ inches. |
| Set on end | Lining 2 inches. |
| Set on end. | Lining 2½ inches. |
| Set on end. | Lining 3½ inches. |
| Set on end. | Lining 2¼ inches. |
| Set on end. | Lining 2¾ inches. |

In order to avoid, as far as possible, cutting brick, the lining can be put in in a spiral having a pitch equal to one brick in the circumference of the chimney, or they can be set in rings, as may be desired. The edges of the brick must be rubbed so that they will key in. This is particularly necessary at the lower portion of the chimney where the heat is greatest, and it is advantageous to have the radial joints slightly open on the inside of the chimney. In putting in a lining of this kind it is a good plan to leave a slight air space between the brick and the metal at the lower part, but in the upper portion of the chimney the lining can be placed against the metal.

In some cases it is a good plan to put in a shelf of angle iron to support the lining at intervals, but it is not necessary to use a complete ring, as one ca be made in several pieces, and the gap can be bridged by a piece of flat iron.

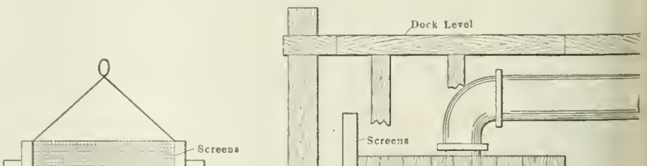
The mortar for laying up firebric should be very thin, about the consistenc of pea soup, and the brick should b dipped and rubbed firmly into place. Th addition of lime or sand to firecla mortar spoils it, and a trowel should n be permitted on such work, the only to required by the bricklayer being h "skutch." The mortar should consist a mixture of raw and calcined firecla ground fine, about 25 to 40 per cent. ra clay and 75 to 60 per cent. calcined cl or old firebrick. The clay should b of the same quality as the brick it used with and preferably should com from the same pit; from 300 to 4 pounds are sufficient to lay 1000 bricks.

A. E. Dixon.

Cleveland, O.

## Keeping Seaweed from Pumps

I have two 20 and 12 by 12-inch dupl steam-driven pumps taking water fro Jamaica bay. The end of the suctio pipe is inclosed in a wooden box and provided with a foot valve. The box made as shown in the drawing. Thre inch planks are given a coat of copp paint, sharpened on one end and driv down into the sand as far as they will g They are then spiked onto the frame the box, which had been previously mad and sawed off on top. The three sid of the box are made in this way, t planks being tongue and groove a minus holes. The top is planked tig also, and the side facing the bay is l open, but is provided with two removal screens, three to the inch.



SCREEN PROTECTION FOR SUCTION PIPE

When these screens get blocked w grass, one can be raised, cleaned, lown and the other one done in the same way without stopping the pump. All the water that goes to the pumps has to go hrough these screens. I find this is a very good way to keep grass out of the pump, specially as one of the pumps is running all times.

JOHN MORLOCK.

Barren Island, N. Y.

## Where is the Leak?

Within a short time two of the ladies the cottages in this place have reived severe electric shocks in attemptg to draw water from faucets while ding on a floor that was wet from rubbing, and a boy received a bad shock attempting to turn on water while ting in a bath tub. We experience uble also with the telephones when re is much trouble with the power s, which at times swing into the telene lines.

The power house is at least 500 feet m the hotel and cottages, and each l phone is connected to ground through rbons, the grounded line being ground on the pipe line to the power house.

Can anyone explain why we are subct to these shocks from water pipes and ephones?

WELDY S. GEAGER.

Colgate, Cal.

## Receiver Pressure

Nothing pleases me better than to start e "old man," as we call our chief, talkg on the "practical," and when I read L. Johnson's article under the title of om Sawyer on Receiver Pressure," I w I had something to draw him out. h the issue of November 16 opened at proper page I went into the office, l as I anticipated soon got him going. er some preliminary theorizing he red some of his own experiences bearg on the subject, as follows:

S me years ago I was hired to run day shift in an electric light station h included among its equipment a and 28 by 30 tandem-compound en- When I first took charge of the it, I found the receiver gage register- 2 inches vacuum, and after verifying i accuracy by indicator cards, I prompt raised it to two pounds pressure I called t superintendent's notice to the superior ds obtained, and he ordered that the ht engineer maintain that receiver ssure, during the night shift, when t heaviest and lightest loads prevailed, hin the compass of two pounds minim and 10 pounds maximum.

The night man was rather jealous of t new man, and held to the firm conion that he was obtaining the best results on the heaviest loads by limiting the receiver pressure to five pounds maximum. The receiver pressure, by the way, was regulated by fitting a link block close to the eccentric, and really forming a part of the eccentric rod. After some friendly argument the night man offered to convince me by undeniable proof that he was right in his contention. I had no idea of how he proposed to do this, as the engine was a shaft governed machine, belted to a dynamo, which, by the way, belonged to that loud-noised humming family.

"I accepted his invitation, and that night appeared when there was a fairly good, steady load on the engine. The receiver pressure stood at 10 pounds, and I noticed the engine was not running as smoothly as I expected to find it. The engineer proceeded to apply his test by decreasing the receiver pressure, and with his hand on the handwheel, said: 'Now listen to the hum of that dynamo.' I did, and undeniably the hum of that machine changed as the pressure fell, and, undoubtedly, that hum proclaimed the engine going faster; there was no mistaking it.

"Here, apparently, was one of my pet theories knocked on the head by actual observation. I acknowledged the inevitable, but it was a bitter pill to swallow, as I knew that it would be all over town how the local man put a kink in the imported, and more expensive man. What sleep I got that night was after forming a plan of action for the morrow, or rather that day, for it was near daylight. With the indicator ready, I experimented with the receiver pressure, and was surprised to note that with every turn of the handwheel the distribution of the steam changed, so that actually, at 10 pounds pressure, all the low-pressure work was done at one end of the cylinder, with a consequent loss of vacuum, while at two pounds, the point at which I had left it the previous day, the distribution was ideal. As I knew that the superintendent had been invited to see for himself the engine performance that night, I worked diligently during the noon hour—when I was alone, and at last attained results that showed the cutoff was equal at 10 pounds receiver pressure and very much off at five pounds, and from tests, I knew I had changed the conditions of things so that the hum of that dynamo plainly proclaimed that 10 pounds receiver pressure was what it needed. Well, the order of two pounds minimum, 10 pounds maximum remained on the order books, and there was a highly discomfited night engineer the next day.

"This is a particular case, but might not 'Tom' Sawyer's case be also a particular one? Might not the piston or exhaust valve of his machine be inclined to let some steam by them; these members, you know, will leak much more steam at 15 pounds than at five pounds.

"I once had charge of a Corliss engine, that was running under a heavy load, and also running under a hardly perceptible compression. The engine ran well, and though I believe in compression, I had no reason whatever for applying it to that engine. However, having nothing else to do one day, while overhauling minor details it occurred to me that, as it ran good with little compression, it might run still better with the 'regulation' amount, and on that theory I changed the point of closure of the exhaust valves. I was immensely surprised, however, to find that now, the engine, three strokes out of ten, took steam the full stroke. Why? I have never been able to duplicate the action of this engine with another, nor have I been able to satisfactorily explain it on this engine, unless a possible solution of it is the fact that the steam was superheated, and by applying compression I was causing the engine to compress saturated steam, when we had installed a costly apparatus for filling the clearance with superheated steam from the boilers. Cards from the engine, however, showed no marked condensation of the compression.

"It is surprising how many engineers test the effect of compression on their engine by noting the change of hight of the governor link collar, and how many come to a hasty, and wrong conclusion from the fact that the cutoff remained practically the same or probably was a trifle later. The fact that the governor remained at the same hight is a strong point in favor of compression. To illustrate, suppose an engine was doing 100 horsepower

$$100\ horsepower = \frac{P \times L \times A \times N}{33{,}000}.$$

If any one of the factors on the top line be decreased, some other factor must be increased. Now, suppose we had an indicator card with an absolutely square corner where compression should show, it is very evident that by drawing a curved line representing compression, we cut off a slice from the area of the card, and as we know that we are doing 100 horsepower of work, then some of the other factors must increase, and naturally enough it will be N, unless the point of cutoff happens later, thus again giving us the same area of card. But the fact that the cutoff happens later by compressing, say, up to initial pressure, as compared with running with no compression, does not, by any means, prove that the engine is using more steam per horsepower, for though the steam valve is opened a longer period, steam does not flow into the cylinder the whole time it is open, as it meets steam of equal pressure filling the clearance. But," concluded the chief, "the whole thing affects [illegible] r than a that's weight on a [illegible] the market weight, and that [illegible] has been able to prove that compression is either economical or uneconomical 'in terms of pounds of water per horsepower hour.'"

H. Hughes.

Roxbury, Mass.

## Cylinder Lubrication

The faulty lubrication of a cylinder may be the result of using an oil of too low fire test or of poor methods of applying the oil to surfaces requiring lubrication; then it may be due to an improper fit between surfaces which allows the oil to be forced away from the place where it should do its work. The makers of any engine will gladly advise what oil should be used with their engine, and it is always a good policy to follow this advice up to a certain point. If you think you are not getting the results which your experience tells you you should, find out for yourself where the trouble lies and correct it. If the oil is too thin, it does not protect the walls of the cylinder and valves properly, or does not make a good packing nor assist as it should in helping the piston rings to hold the pressure. It may be of too low fire test, in which case it would burn away in a blue smoke, leaving the surfaces dry and harsh, which allows them to become cut and grooved.

To get satisfactory lubrication the oil must work under the right conditions.

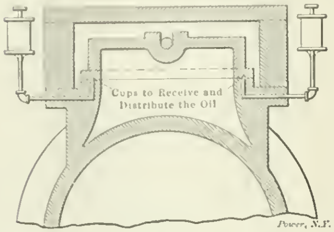


FIG. 3.

It is not the quantity but the quality and how it is introduced into the cylinder that give the results. You may have the best engine built and also the best lubricator or pump and use the best oil on the market, but if these do not work in harmony, you would be foolish to expect results. The lubricator should be above the throttle valve just as far as conditions permit, as this insures more perfect atomization. That is the key to the whole situation. Completely atomize a good oil and the question will not be, how much, but how little, oil must be used, and the results will show up on the right side of the ledger. And e if you don't get a glimpse between covers of that volume, when you le into the engine the satisfaction of see the silky luster of the cylinder is su cient. I have used one large lubrica on a header to lubricate six engines w the best success.

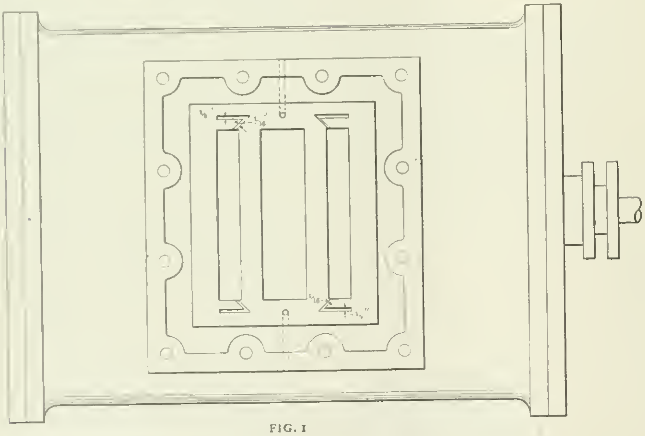


FIG. 1

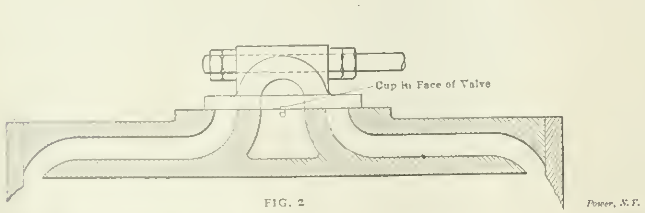


FIG. 2

Power, N.Y.

The accompanying sketches may pr interesting to those concerned in lul cation problems. This system may put on any cylinder with very li trouble and expense. Referring to Fig a ¼-inch pipe tap hole is drilled i the cylinder on both sides as far as center of the valve seat, thence up to face. With the valve in position, shown in Fig. 2, a cup is drilled in face. This cup picks the oil up and af lubricating the valve seat is deposi into the oil grooves. On the return str the steam entering the ⅛-inch gro forces the oil through the 1/16-i groove into the cylinder. Fig. 3 sh the arrangement of the oil cup gravity feed. This is a very effici method of lubrication and it gives gr fying results on the Corliss valve as v as the plain slide valve.

H. M. Nicholl

Chicago, Ill.

Our engine is of the automatic pist valve type, 14x14-inch, running 223 r olutions per minute. The valve is v heavy and is controlled by a Rites ine governor, which is very sensitive soon begins to "hunt" if the valve d not receive proper lubrication. I h tried various grades and kinds of oil find that I get the best service from engine when using a high-grade, he oil, of which 1½ pints for a 12-hours' is sufficient.

E. H. Cavanaugh

Altamont, Ill.

## Condenser Wanted Cleaning

The absorption refrigerating system our plant was not working as well a should last summer The absorber condenser got very hot, and the cool water did not seem to have very m effect on them, and we came to the c clusion that the coils were dirty.

We connected a 1-inch steam line the manifold at the top of the conden and absorber, and took the plug out the bottom manifold. After drawing charge over into the generator, we ope the steam valve and blew the coils with steam and it would be hard imagine the dirt we blew out of the co After they were cleaned, the syst worked better than it had worked years, so we made a permanent fixt of the steam connection, so as to k the coils clean.

Walter C. Edge

Philadelphia, Penn.

# Annual Meeting of Mechanical Engineers

## A Number of Good Papers Presented. George Westinghouse Elected President. 187 Members Added to Roll. Spring Meeting at Atlantic City

The annual meeting of the American Society of Mechanical Engineers was inaugurated by the gathering of the members and guests of the society in the auditorium of the Engineering Societies' building on Tuesday evening, December 7, to listen to the address of the retiring president, Jesse M. Smith.

### President's Address

The presidential address dealt with the Profession of Engineering. History tells us of the emperors and kings under whom the great engineering feats of the past were accomplished, but one looks in vain for a mention of the men who planned and carried out the work.

The first organization of engineers was the Smeatonian Society, organized in 1771 by Smeaton and his contemporaries. All of the great national societies were founded during the nineteenth century.

| | |
|---|---|
| Institution of Civil Engineers of Great Britain | 1818 |
| Institution of Mechanical Engineers.... | 1847 |
| La Société des Ingénieurs Civils de France | 1848 |
| Der Verein Deutscher Ingenieure...... | 1856 |
| American Society of Civil Engineers... | 1852 |
| American Institute of Mining Engineers | 1871 |
| American Society of Mechanical Engineers | 1880 |
| American Institute of Electrical Engineers | 1884 |

The four greatest national societies have an aggregate membership of over [illegible]000. Twelve national societies of engineering specialists comprise more than [illegible]00 members. Twenty-three local engineering societies in different cities of the United States count 8600 in their membership.

The address refers in detail to the interchange of visits and courtesies between the great international societies; to the acceptance in 1889 of an invitation tendered by the Institution of Civil Engineers of Great Britain and of the Société des Ingénieurs Civils by the four American national societies; of the visit of the Mechanical Engineers to the Institution of Civil and Mechanical Engineers and the French society in 1900; to the joint meeting of the Institution of Mechanical Engineers and the American Society of Mechanical Engineers at Chicago in 1904, and to the intended visit of the American Society of Mechanical Engineers to the Institution of Mechanical Engineers in Great Britain during the coming summer.

Alluding to the Engineering Societies building in New York, Mr. Smith said: "Under the same roof are grouped together, besides the American Society of Mechanical Engineers, the American Institute of Mining Engineers and the American Institute of Electrical Engineers, fifteen other societies of engineering and allied arts. Twenty-five thousand engineers practising in all the specialties of engineering may call this building their professional home."

In the Institution of Civil Engineers, as well as in the Institution of Mechanical Engineers of Great Britain, no person is admitted into the lower grade of membership except he can pass a satisfactory examination as to the fundamental principles of engineering by an examining board of the Institution. If the technical schools in Great Britain maintain an equally high standard in granting their degrees in engineering, then the degree may be accepted in lieu of an examination.

In other words, the engineering institutions in Great Britain establish the standard for the degrees granted by the technical schools. In the American Society of Mechanical Engineers a person may enter the society as a junior upon the presentation of a degree in engineering from a technical school, but the society has not established a standard by which to measure that degree. Promotion to higher grades of membership in our society is made only upon a showing of engineering experience satisfactory to the membership committee, which is maintaining a high standard of membership.

If we are to have a profession of engineering as distinguished from the trade of engineers, we must have a broad education befitting that of a learned profession, as distinguished from a narrower education sufficient for men of a trade. President Lowell, of Harvard, in his recent remarkable inaugural address gave this as his conclusion: "The best type of liberal education in our complex modern world aims at producing men who know a little of everything and something well." The engineer capable of being at the head of the larger engineering works must know something of many things, several things well and one profoundly, and is still one-sided if all this knowledge is confined strictly to his profession.

The American Society of Mechanical Engineers has before it a future of usefulness to its members and influence in the profession which is unlimited. It requires only that we stand by our tradition of increasing the membership with men of high quality as engineers, that the members maintain enthusiastic devotion to good professional work, that they cooperate with each other in the broadest and most friendly spirit to produce that solidarity of membership and devotion to high ideals which will compel the world to class the profession of engineering with the other learned professions.

### Officers Elected

The presentation of the president's address was followed by the announcement of the results of the election of officers for the ensuing year: President, George Westinghouse; vice presidents, Charles Whiting Baker, W. F. M. Goss, E. D. Meier; managers, J. Sellers Bancroft, James Hartness, H. G. Reist.

After the new president had been introduced to the audience, the meeting adjourned to the headquarters of the society in the same building, where the president and president-elect with their ladies received the membership and their friends.

### Wednesday

The Wednesday morning session was devoted to the reception of reports of the council, tellers of election and various committees, and to the consideration of proposed amendments to the constitution. One hundred and eighty-seven members were added to the roll, and it was announced that the spring meeting would be held at Atlantic City. The several amendments relating to the qualifications of candidates for the grades of associate and junior membership, as well as providing for a Committee on Public Relations, were referred to the membership by letter ballot. Reports from the Standardization and Plant Installation Committees of the Gas Engine Section were received and abstracts will be found in our treatment of the meeting of that section.

On Wednesday afternoon, through the courtesy of George Gibbs, chief engineer of the Pennsylvania Tunnel and Terminal Railroad Company, and a member of the society, the members and guests of the society were afforded an opportunity to inspect the new passenger station and terminal and service plant. This was the only excursion of the society *en masse*, but various opportunities were offered for visits to local stations and industrial establishments.

### Thursday

Thursday afternoon, December 9, was devoted to the presentation of the five papers: Tanbark as a Boiler Fuel, by Frank Moffat Myers; Cooling Towers for Steam and Gas Power Plants, by J. R. Bibbins, Governing Rolling Mill Engines, by W. P. Caine, An Experience with Leaky Vertical Fire tube Boilers, by F. W. Dean, and a second paper by the same author on The Best Form of Longitudinal Joint for Boilers. The paper first named, was published in Power November 30. Albert A. Cary said that the chief trouble with tanbark furnaces is the rapid deterioration of the firebrick around the stokehole openings. This defect is obviated by the insertion of a cast-iron lining into the stokehole, with a shoulder on top to hold it and a second shoulder at the bottom turning inward to support a second cylinder of such length as to bring the top of the tanbark cone, as it is fed onto the grate, some distance from the corner of the stokehole opening.

A second part subject to rapid deterioration is the side of the furnace near the grate. Around the base of the cone of tanbark on the grate, there exists only a thin layer of fuel which allows the air to pass through readily and causes combustion so intense as to destroy the furnace walls in the immediate vicinity in a comparatively short time. This difficulty is overcome by building the furnace wall with an offset of several inches sloping down to the grate so that the cone of fuel will have a base of larger diameter than the width of the grate, and the extra thickness of fuel thus obtained at the edges of the grate prevents too rapid infiltration of air and produces more uniform combustion. Mr. Cary's experience with tan presses was that the moisture content of the tan could be reduced considerably more than had been indicated in the paper, and that preheated air should by all means be introduced into the ash-pit.

The paper on cooling towers was freely criticized and discussed at such length that it will be necessary to publish both the original and discussion when more space is available.

W. P. Caine's paper on Governing Rolling Mill Engines was given a limited hearing and the discussion turned to Mr. Dean's first paper on vertical boilers. In a written discussion, A. Bement, of Chicago, suggested that leaking tube ends were caused by local heating due to restricted passages. One case was cited where the trouble was cured by passing the hot gases over a nest of water tubes on their way to the fire tubes of the main cylinder. In another instance the lower tube sheet of a vertical boiler was covered with asbestos.

R. P. Bolton thought that the design invited what followed and that the tubes were too large and too long, the last 5 feet doing no good at all. The tube sheet should be at least 7 feet above the grate. The detached furnace, or dutch oven, was recommended to prevent clinkers, etc., from entering the tubes, adhering to the surfaces and stopping the flow of gases.

William Kent commended the moral courage of any man who made a failure public, and spoke of his unfortunate experience with the Edgar boiler some years ago. In a humorous vein he said that he had often advised Mr. Dean to desist from designing boilers, as he could easily buy a much better boiler than he could make.

John C. Parker characterized the chain grate as being too inelastic for the varying demands of everyday service. It was O. C. Woolson's opinion that to obtain the best results, combustion must be completed before the gases enter the tubes. The dutch oven was becoming popular because it was correct in principle, and if Mr. Dean had used it, he would have had no leaking tube ends.

Albert A. Cary had remedied similar troubles by lowering the grates, and in one instance had introduced a checker brick wall between the fire and the tube sheet. Incomplete combustion, he said, conduced to zone combustion or an alternation of zones of intense heat and comparative coolness, producing the strains due to unequal expansion and contraction of tube sheet and tube ends.

The chairman, L. P. Breckenridge, requested Mr. Dean to experiment with one of his boilers by burning all of the fuel possible on the grates with all of the draft he could get. Then, after noting results, stop one-half or more of the tubes, and while burning the same amount of fuel on the same grate area also note results. It was his opinion that we have a few pieces of laboratory apparatus, but very few boilers, and of the proper relation of grate area to heating surface, but little was really known.

E. D. Meier, who organized the syndicate to put the water-tube boilers into the boiler house at the Columbian exposition, said that in the burning of oil it was necessary to direct the flame so that no unburned oil could strike the tubes. Small particles upon striking the tubes would stick and spread out, producing local heating and finally resulting in a leaky tube. To prevent this, the oil should be directed downward and away from the tubes. He had always believed in the utility of larger combustion chambers.

R. P. Bolton was given the first chance to discuss Mr. Dean's second paper on boiler joints, which appeared in the October 26 number of Power and has been discussed editorially. He said that the joint advocated by Mr. Dean had been tried as long ago as 1858 and was used in the British merchant marine, where it gave satisfaction, while the unequal length of strap was used in the navy with more or less unsatisfactory results.

E. D. Meier thought that for marine boilers, from 12 to 15 feet in diameter, it was a most excellent joint, as it to care of the buckling of the plates whi was caused by the breathing action d to changes of pressure. But he believ that on the smaller drums of water-tu boilers, from 36 to 48 inches in diamet a long inside strap was better, but shou be made thin and be shaped to the cu vature of the shell by being rolled wi it at a red heat.

Mr. Greene enumerated the United Stat cruisers "New York," "Columbia" a "Minnesota" as being fitted with boil having this type of joint. S. F. Je said that laboratory tests showed t weakest point of a joint to be along t line of rivet holes, while rupture usua took place at some other point. It w evident that some factors besides th entering into the laboratory test shou be considered.

On Thursday evening a reception w tendered by the membership of N York and vicinity to the officers and me bers of the society, their ladies guests, at the hotel Astor.

## GAS-POWER SECTION

At the session of the Gas Power S tion, held separately from the main s sion on Thursday afternoon, there w presented two important committee ports and two very interesting pap The reports were those of the Plant eration and of the Standardization Co mittees.

The report of the Plant Operat Committee contained a set of well plan blank forms for use in recording reg plant performance. These included Producer Log, an Engine Log, a L Curve Form, a Monthly Data Sheet, which to summarize the other reco and a Monthly Cost Sheet, covering purely operating costs. A supplement report by a member of the commi presented substitute forms for recor monthly costs in which the cost producer operation is separated from of engine and generator operation. other member presented another mino report covering forms for blast-fur gas-power plants.

The Standardization Committee, Charles E. Lucke, chairman, presente preliminary report which contained following recommendations and dis sions:

### Coal

It is recommended

*A.* That coal quality be defined by ultimate analysis of samples dried at degrees Fahrenheit; (*b*) proximate an sis of samples dried at 210 degrees renheit; (*c*) calorimeter test by a sp fied calorimeter, such as Parr, Mal Atwater.

*B.* That this definition of quality considered as a mark of identity some coal successfully gasified by oducer in question, and not in itself measure of the satisfactory nature of e coal specified.

C. That a variation from values given *a* and *b*, not exceeding 5 per cent any one of its terms, and 2 per cent, *c*, be considered as compliance.

D That producer builders adopt a n used with success in Germany, of intaining their own test plant, which be used to operate their own fac- ies, that they make preliminary trials a coal, the use of which is contem- ted by a purchaser after a provisional , the results, if satisfactory, to be rporated in the final contract, the coal g defined by its trade name, mine or , and size. For example, "This pro r, when continuously supplied with — pounds of Pocahontas coal per r," will do something, with some re- ts to be named.

### Producer Operation

t is recommended that the weight of l [gasified] be determined from the ght of coal fired with these precau- s:

l Regular intervals of feeding and rm amounts.

Regular removal of ash, preferably roportion to the coal fired, as indi- d by the proximate analysis.

Constantly maintained level, deter- ed by a bar with a flat plate on the at right angles and as large as will s through top holes after leveling re. The use of a bar or stick, with- a bearing plate extending over con- rable bed surface, may lead to error.

. No measurement to begin until the bed is at least eight hours old under r ximately the load to be used for run.

The length of run to be such that total coal regularly fired will be at equal to ten times the weight of the mal producer content, which is about alent to the acceptable 12-hour run boiler test; in which case if an error al equivalent to one-fourth of the content were made, the error in coal umed would be only about $2\frac{1}{2}$ per

is recommended that the calorific er of coal, multiplied by the weight ned, each modified by consideration he difficulties pointed out, be ac- l as giving the heat equivalent of coal consumed, of calorific power rtionate to the weight; with the erstanding that this may not be tly true.

ncerning the "high" and "low" heat es of producer gas, the report de- es that the "low" value is a very nite one, of doubtful value in com- ial operation, and with a possible e only in scientific investigations of liberation in engine cycles. It has e into practice partly because it sures most nearly the heat actually liberated in the gas-engine cylinder and, therefore, that which is effective in preparing for the doing of work at the expense of heat. It has also come into practice because it permits gas-engine guarantees of efficiencies to look better than when made in terms of the high value. Because of its uncertain meaning, however, it has been a source of controversy.

It is recommended that quality of gas be defined by

*a.* Volumetric analysis near the engine by a specified standard apparatus, and by calorific value (B.t.u. per cubic foot) by a specified instrument, taken when the three temperatures, air, gas and flue, differ by not more than 10 degrees Fahrenheit between any two. The calorimeter results are to be accepted without correction.

*b.* That the use of low value and the distinction between high and low value be avoided in commercial work.

*c.* That the volumetric analysis be considered as an indication of the working of the producer, and a guide to its adjustment and manipulation, rather than as a measure of the good quality of the gas, except as noted in the case of hydrogen under adaptability.

*d.* Compliance with any definition of quality or volumetric analysis be considered satisfactory when within 5 per cent. of the value of any numerical quantity given.

### Quantity of Gas Produced

When the quantity of gas is great in large plants and the calorific power is low, as any but natural gas always is, the problem of its measurement is quite beyond the range of any commercial meter, by reason of the disproportionate cost of meter installation to the value of the information. This fact has led to the proportionate-meter design, the application of pitot and venturi tubes, and the holder-drop method.

Correct gas measurement is so difficult or costly, especially when the quantity is large, that its determination should be avoided in commercial relations whenever possible. When one party is responsible for a complete installation, no division should be made and the performance guarantee should include only the performance from producer input to engine output.

Recommendations:

*a.* When necessary, large gas measurements may be best made by venturi tubes checked by pitot tubes in the throat, but not too wide a range of flows should be attempted on one throat. Steps should be taken to reduce flow fluctuations to a negligible amount.

*b.* No dial reading of a manufactured meter can be assumed to be correct, unless proved before and after the run under the same pressure, temperature and flow conditions.

*c.* As a matter of contracting agreement, any meter reading or gas quantity determination may be mutually accepted whether correct or not. This is especially convenient when a meter is part of a permanent installation.

*d.* Holder drop tests may be used with fair results where holders contain not less than 15 minutes supply, if proper precautions are used and care taken to avoid serious positive and negative acceleration of gas flow through the producers.

*e.* A quantity of gas determined by the best method available for any case may be considered as in compliance with the guarantee when not more than 5 per cent. above or below guarantee.

The heat equivalent of a given quantity of gas of defined quality may be taken as the product of the heat units per cubic foot and the number of the cubic feet determination. When either is a variable its average for a given time is to be taken by the method of mean ordinates, by plotting each reading vertically to a horizontal time base, joining points by straight lines and integrating areas in the usual way.

### Performance of Engines

The engine output is generally the prime variable in the series of quantities fixing the general performance of the plant, inasmuch as all other quantities are usually specified and guaranteed, the quantities being fixed for a given horsepower output or load, or a given change of load. Considerable confusion has resulted from the possibility of various interpretations of engine horsepower and engine load, especially with respect to full load, normal load, overload, maximum load, and no load; the time an engine must run under given load to prove its ability to carry that load and its right to a rating at that load; and from uncertainty of the relations among indicated, brake, effective and friction horsepower, one being specified or guaranteed which is not directly measurable, but which is to be determined from another that is measurable.

It may be reasonably assumed that a gas engine, after attaining a steady state under the specified load, as indicated by jacket and exhaust temperatures, is able to carry that load indefinitely, if it can do so for twelve hours. The time to reach the steady state for large engines may be taken as not less than three hours from starting, and in small engines not less than half an hour.

Statement of horsepower should always be in terms of brake horsepower whether it can be directly measured or not, but when not, all assumptions made in its evaluation and the methods of indirect determination should be specified to eliminate the personal peculiarities and preferences of different test experts.

The speed to be used in all horsepower

determinations is best taken as the total number of revolutions by mechanical counter for the entire length of test, divided by the time in minutes. This may be checked by instantaneous readings or intermittent countings taken at regular intervals and numerically averaged.

Brake horsepower should always be directly measured when the conditions permit. It is so important that it is worth considerable trouble to obtain.

Indicated-horsepower determinations of gas engines are very unreliable, cases being known of the indicated values determined by high-class experimenters being less than the directly measured brake values—quite sufficient proof of their uncertainty. It is not desirable here to enter into the causes; but in order to eliminate uncertainty and controversy there should be an agreement:

*a* Precisely how many cards are to be taken, when and how often.

*b* What make of indicator.

*c* Proof of calibration of spring.

*d* What type of reducing motion, and how connected, preferably by drawing.

*e* How the cards shall be integrated.

*f* How the speed to be used shall be found.

Engine speed measurements are data in

*a* Horsepower calculations in which for indicated horsepower there is needed the number of similar cycles executed in one minute rather than the actual speed at any one time; and for brake-horsepower direct measurements the average speed of overcoming the resistance, or the total distance that would be traversed by the point of resistance in one minute, if free; this also does not involve the real speed at any minute.

*b* Proof of speed regulation or ability of the engine to maintain a given value for any time period

When engines are to drive alternators in parallel, the rate of change of speed in extremely small time intervals, down to hundredths of a second, is important. As any part of a complete revolution, divided by the time in minutes, is just as properly the engine speed in revolutions per minute as the revolutions completed in a whole hour divided by sixty, and as these two may be very different in amount and constancy, even with constant load, and doubly so for sudden load changes, it is evident that speed definition in terms of revolutions per minute leads to endless controversy.

It seems further desirable, in accordance with the recommendations concerning the substitution of brake-horsepower figures for fractional or normal loads, to stop the use of per cent. variations in speed and substitute two limiting speeds. For example, instead of stating that at a constant load of 100 horsepower the engine speed will be 200 revolutions per minute, or not more than 2 per cent. above or below, the matter can be put in the form

| | | | |
|---|---|---|---|
| Constant Engine Brake Horsepower. | 100 | 50 | 00 |
| Engine speed limits over 15 min., by mechanical counter attached to cam shaft, maximum . . . | 102 | 105 | 109 |
| Minimum. . . . . . | 98 | 99 | 101 |

Great care must be exercised after a load change to indicate not only the mode of speed measurement but also when the measurement should begin and end. The instrument should be specified, and the maker's name and the size should be given, and if important, subject to maker's calibration before and after test.

### Important Physical or Chemical Conditions of Gas Not Included in Quality

Certain physical and chemical properties characterize gas in its relation to the engine—properties yet undefinable because in an early stage of development, yet quite essential in practical operation. Some of these gas characteristics are:

*a* Presence of gritty solids tending to grind out bearing or rubbing surfaces.

*b* Presence of solids, whether gritty or not, tending to fill up openings and collect in the combustion chamber in nonconducting layers, easily becoming red hot and causing pre-ignitions.

*c* Presence and amount of lampblack, which, besides the tendencies under *a* and *b*, may, with oil or water, form a gum on the bearing surfaces, especially the regulating valves.

*d* Presence and amount of tar in vapor, liquid or mist form, and possibility of picking up from coating on piping and other parts. Tar is one of the most serious causes of disturbance of valve movement, especially sliding regulating valves, besides caking hard on the combustion chamber, where it causes pre-ignition.

*e* Amount of hydrogen or illuminants, or relation of the amounts to other substances, significant in the sense that certain relative quantities may have low ignition temperatures and cause pre-ignition, the tendency toward which is different in practically every engine.

*f* Temperature of the gas. This affects the weight of charge to which the power of the engine is in direct proportion; so that both charge and gas must be as cool as possible.

*g* Pressure and fluctuations.

This may affect both power and efficiency of the engine, as the gas flow to the engine is proportional approximately to the square root of sum of gas pressure above atmosphere and cylinder vacuum caused by suction, while the air flow is similarly dependent on cylinder vacuum alone. Any setting of the mixing valve for correct mixture must be made for some gas pressure, and any change of pressure, however momentary, will admit more or less than the original quantity of gas, decreasing the power in both cases, and where excess enters wasting it with decreased efficiency. The importance f this fact even during one suction sho be more widely recognized.

### Papers Presented

The first paper presented at the s Power session was one on "Testing a Suction Producer with a Körting Eject by C. M. Garland and A. B. Kratz, of University of Illinois. In their paper authors described a method of using ejector instead of a gas engine for testi a suction producer, and presented complete forms for recording the res of such tests. Of course, the metho testing is exactly the same as that follo when an engine is used, except as to control of the load. The paper also sented the results obtained by the aut in a test of an Otto producer made at University. A very complete abstract the paper, excepting the blank forms recording tests, will be published in early issue.

The other paper was by J. R. Bib and presented some of the results obta with the new Westinghouse double-z bituminous gas producer at the West house Machine Company's shops, in course of a series of trials extending a period of nearly two years. Almost classes of low-grade fuels were tried, f meadow peat and lignites up to P hontas coal. The results presented in Bibbins' paper were especially encou ing. An abstract of the paper will printed in next week's issue.

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The collision between a Pennsylv eastbound passenger train and an en engine just outside Jersey City on morning of November 8, resulted in c paratively few injuries to the passeng due to the fact that the strong fra of the passenger cars resisted crush The damage to engines and cars, h ever, was considerable. One of the s passenger coaches jumped the track turned over on its side, denting in steel plates about 18 inches. In the li ing equipment of this car were nine eral Electric tungsten lamps. It is teresting to note that, after the wr when all the lamps were taken out tested, the tungstens were found to in perfect condition—a further proof the rather remarkable strength and ability of the tungsten filament w specially adapted for train-lighting serv

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The power in the Spokane river has ready been developed in several pla namely, Post falls, the city pumping tion at the series of rapids and falls Spokane, and at a point nine miles be Spokane, and at a point opposite Rear In all 100,000 horsepower has been veloped. Some of this acts directly on turbines of the city pumping plants of flour, feed and sawmills. The grea part, however, is converted into electri at high voltage and transmitted long tances for light and power.

## Tests of Steam Turbine Nozzles

At the December meeting of the American Society of Mechanical Engineers, Prof Frederick H. Sibley, of the University of Alabama, and T S. Kemble, experimental engineer for the Chase Machine Company, of Cleveland, O., presented an account of a series of tests made by them at the Case School of Applied Science, to determine the proper proportions and efficiencies of steam-turbine nozzles for given steam conditions. Three methods of testing a nozzle presented themselves

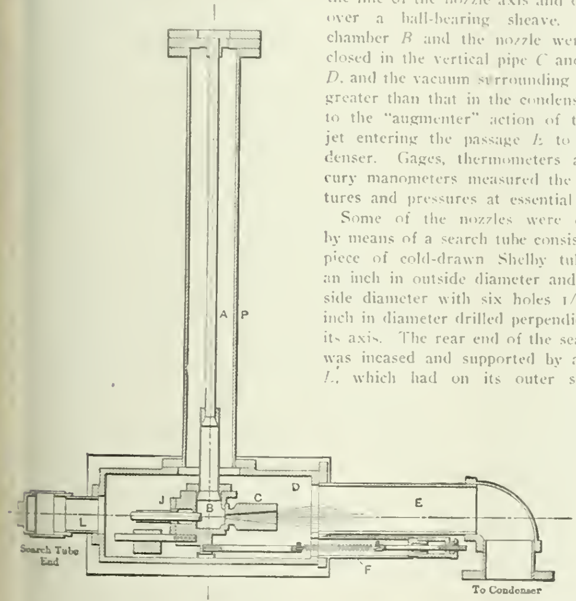
First, by measuring the force of a jet when allowed to impinge on an external surface

Second, by investigating the character of the jet with a search tube inserted axially in the nozzle.

Third, by measuring the reaction of the nozzle when a jet of steam is flowing through it.

The first method involves complications which tend to cast doubt upon the results obtained. The force upon the external surface may be modified by the character of the surface by the effect of steam friction and by the distance traveled by the jet after leaving the nozzle and before it reaches the surface. When the surface used is a flat plate perpendicular to the axis of the jet, the force may even vary from a maximum to a negative value, according to the relative location of the plate and nozzle.

The search-tube method was tried unsuccessfully, and the method adopted for the experiments was that of measuring the reaction of a nozzle suspended at the end of a flexible tube as shown in the engraving. Entering through an elbow needle valve, which allows the flow to be regulated with accuracy, the steam passes downward through the tube A to the chamber B, hence to the nozzle C, into the box D and on to the passage E to the condenser The movement of the chamber B under the reaction of the nozzle is restrained only by the stiffness of the tube and the spring F, and indicated by a needle which multiplied the motion about 10 to 1 The spring F is operated by a micrometer nut and screw and was calibrated in place by known weights hanging on a flexible wire cable which extended from the back of the chamber in the line of the nozzle axis and downward over a ball-bearing sheave. Tube A, chamber B and the nozzle were all inclosed in the vertical pipe C and the box D, and the vacuum surrounding them was greater than that in the condenser owing to the "augmenter" action of the steam jet entering the passage E to the condenser. Gages, thermometers and mercury manometers measured the tempera tures and pressures at essential points.



MEASURING THE REACTION OF A NOZZLE

Some of the nozzles were examined by means of a search tube consisting of a piece of cold-drawn Shelby tube ¼ of an inch in outside diameter and 3/16 inside diameter with six holes 1/32 of an inch in diameter drilled perpendicularly to its axis. The rear end of the search tube was incased and supported by a tube at L, which had on its outer surface a thread fitted with a micrometer nut and passed through the distance piece holding the search tube in the axis of the nozzle. By exploring with the tube along the axis of the nozzle the pressures existing therein at different portions of its length were determined. The nozzles were also drilled near their muzzles and connections made from this perforation to a manometer gage. The paper gives the contour and dimensions of a number of nozzles tested, and gives plots and tables of the results obtained, the efficiencies running between 88.47 and 97.9 per cent. They also say that the values 91.5 for Nos. 9 and 11 and 95 per cent. for Nos. 13 and 14 are probably within 2 per cent. of the true efficiency Since no appreciable difference in efficiency is shown either with a variation in cone angles from 0 to 20 degrees or with a variation in contour from a circular entry to a rectangular muzzle, smoothness of walls would appear to be a much more important feature than contour

## Gas vs. Steam Marine Engines

The cost per horsepower of a marine gasolene engine is somewhat greater than the cost per horsepower of a steam engine

A great advantage in favor of the gas-propelled boat is that the boat is in condition to start at a moment's notice, whereas in a steam propelled boat something like an hour's time is required to get steam up before a start can be made.

When a gas engine is stopped the fuel consumption is stopped also, while in the steam plant the fire that is on the grate of the boiler goes to waste. The absolute evenness and efficiency of gasolene feed is in sharp contrast to the variation in steaming ability of a boiler installation, as the firemen become exhausted toward the end of a day's run. These causes have led to motor boats superseding and replacing the steam yachts of about 100 feet and under.

It is believed that in cruising motor boats having more than 100 horsepower, producer gas will take the place of gasolene. The largest marine producer installation at the present time is in the magnetic-survey yacht "Carnegie," where an auxiliary plant of 125 horsepower has been installed and has proved a success in every respect. The results obtained are so satisfactory that a motor boat has been designed for 1910 which will be fitted with a plant of this type to develop 500 horsepower.

It is too early to predict what will be the ultimate possibilities of the marine gas producer, but there is every reason to believe that vessels will be built in which an installation of several thousand horsepower will be operated successfully. —*Gas Review.*

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For many years Illinois has occupied second place among the coal-producing States, and the rapid development of the iron industry about Chicago and around the southern end of Lake Michigan has already placed the State well up among the iron- and steel-producing States.

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Chimneys, as some believe, are to become less both in number and in dimensions in the near future. On the one hand, Diesel engines are making a bold bid for driving the smaller stations; on the other, where gas producers and large units are laid down, the steam boilers are to become a mere auxiliary. Of course, boilers are still being sold this year to some extent.—*The Electrical Times* (London).

# Some Useful Lessons of Limewate

## The Examination of Lubricating Oils; What Specific Gravity and Flash Point Mean; a Simple Method of Testing for the Former

BY CHARLES S. PALMER

The next subject which we will consider is the examination of oils, and the word "oil" about an engine room or machine shop, ninety nine times in a hundred, means some kind of a lubricating oil. This general subject opens up a field which is undoubtedly the most difficult and complicated in all practical analytical chemistry. In the first place the word "oil" includes hundreds and thousands of substances, many of which are by no means simple substances, but rather exceedingly complicated mixtures of many substances. The methods of separating these substances is an exceedingly complicated subject, and one which in a certain sense has barely begun to come within the limits of exact science. No book nor any set of books has ever been written which really begins to do more than nibble here and there at the great subject of oils. All this does not mean that nothing is known about oils, neither does it mean that there are not many practical tests for oils, some of which we will consider later. But it does mean distinctly that in oil analysis you have got to remember your principles of chemistry, and you have got to support this by levelheaded commonsense backed up by all the experience possible. But the best way to show what I mean is to illustrate these subjects by the examination of a common engine or machine oil.

In the first place the oil usually comes in tanks, barrels, drums or cans, which are closed and opaque; and although it is perfectly easy and natural to draw off a tumbler of the oil and examine it carefully, yet this simple preliminary examination is frequently omitted. Thus, you can note the color, the clearness, the appearance of a peculiar sort of double-internal reflection which is called the "bloom" of the oil and which is due to fluorescence. This means that something in the oil has the property of absorbing light and then emitting it again, so that the interior of the liquid seems as though it were shining with a soft sidelight of its own, which is usually of a yellowish-green cast, although sometimes it may be pinkish or purplish, and sometimes distinctly bluish, as in common kerosene. You want to get in the habit of educating your eye for the colors of oils and especially for this "bloom," for it may show a great deal, after the character and the uniformity of the oil have been compared with some sample which you keep as a standard. One also wants to get in the habit of smelling these oils carefully; for the nose is a most delicate instrument, capable of much greater education and use than is commonly given to it.

### Most Good Lubricating Oils Come from Petroleum

It goes without saying that most of the good lubricating oils are obtained from mineral oil or petroleum. The immense system of companies which controls the American oil supply and part of the foreign market, with all of its faults, has worked out remarkable results and gives us many varieties and brands of lubricating oil of remarkable uniformity and efficiency. No one sample of any particular brand or grade of lubricating oil consists of any one chemical substance, but rather of a mixture of closely related substances, which are often either of a paraffin series of hydrocarbons or of the paraffin series mixed with more or less of another series called the naphthenes, and sometimes with a little of the benzene (benzol) or aromatic hydrocarbons. If you turn back to the chemistry of carbon in an earlier lesson, you will find some of the simpler members of the paraffin series given; it was noted there that they all consisted of carbon and hydrogen with the constant difference, $CH_2$.

The ordinary lubricating oil, as made from petroleum and consisting largely of these paraffins, does not show any particular open chemical character. Suppose you take common kerosene; you can treat this with the strongest acids or the strongest alkalies, with the strongest oxidizers or reducers, with the strongest corrosive dehydrators, and you would get very little result. All this is true even if you give your reagents considerable time to act on kerosene. It would simply laugh at both red litmus and blue litmus; and about the only thing that you could do with it would be to burn it, collecting the products of combustion, when you would find (from the carbon dioxide, as tested by limewater, and from the water given off), that the kerosene must consist mainly of carbon and hydrogen. Thus one would be puzzled at first to know what to say about the paraffin hydrocarbons and about other related hydrocarbons; for they plainly are not active acids, neither are they active bases; nor do they act like salts.

But one can clear his judgment in a moment by remembering that the par hydrocarbons stand as the reduced treme of the carbon-oxidation ta Moreover these paraffin hydrocarbons more reduced chemically than their oxidation stage, the alcohols. The alco are latent bases, latent or sluggish ba In the terms of the new theory of s tion, they do not dissociate or break readily into their ions in water solut which is the solvent for most acids bases. Hence, as the hydrocarbons more reduced than the alcohols (w are bases), they must be of a kind stuff from which bases are made oxidation; and that means that the pa fin hydrocarbons are a set of compou chemically related to the metals, but latent and sluggish in their behavior show any decided character with ordi reagents.

To be sure one can act upon them chlorine or bromine, but that is r only another form of oxidation or b ing. All this is simply to show the pecu nature of the questions coming up in chemical and physical analyses of for this is a case where the chemist ha depend largely on the physical test the physical properties.

Hence, we come to the study of specific gravity of oils; their flas point; their burning point; their bo point; their viscosity, including a sp study of what the books call cohe (that is, their internal stickiness) their adhesion (that is, their ext stickiness, or their quality of being sm and slippery); also, certain special t as the paper tests, etc. In addition all this there are many special tests solubility; many beautiful and charac istic color reactions; and also many ticular chemical tests which are valu in the case of special oils or in detec adulteration.

### Specific Gravity and Flash Poi

The specific gravity of course r to the relative weight of the oil as c pared with water as a standard; the fl ing point refers to the temperatur at which the oil, when heated, begins to e off a volatile gas which will take fir in the air on being approached with a S ing splinter. These two tests, for spe ic gravity and flash point, will tell you re than any other two tests as to the na re and evenness of the oil, and whether is a comparatively simple substance te our sample oil, or whether it is a mix ure of mixtures, that is, an intentional xture of two or more lubricating oils. r instance, suppose that you have a avy machine oil having a specific gravity say, 22 degrees Baume (0.9210 absospecific gravity), and having a flash point of, say, 200 degrees Centigrade, 392 legrees Fahrenheit. Now suppose u should get a new sample of oil having it the same specific gravity, but showa flashing point much lower than that your standard, say 325 or 350 degrees renheit. You can see that this might n that the new sample is made up of xture of a much heavier oil having gher flashing point mixed with a much er oil having a much lower flashing nt. In this way it might be possible to a mixture (of a heavy and a light which would have an average specific vity much like that of the standard; the lower flashing point of the mixe would show that a lighter oil had used in the mixture to reduce the ific gravity of the heavier oil by the t amount.

he principle on which this judgment s is that as one goes up the paraffin es (or indeed any other series of rocarbons), the oils which are heavier hemical composition, containing more ms of carbon and hydrogen to the ecule, are also heavier in specific ity; and they have a higher boiling nt, which means of course a higher perature at which they give off a tile gas which will flash in the air a flame. Hence it is easy to see h all sorts of mixtures could be made light and heavy oils which could h any standard oil in specific gravity; a yet this mixture, as tested by the ing point, could not conceal the fact it contains a lighter oil having a r boiling point; for, in general, it is r that any oil will boil off at approximely its own boiling point, whether it is ne by itself or whether it is mixed other oils. There are certain exceptis to this rule which you will come acs, but in those cases you will untedly find some other means of deteng the mixture; and as such exceptis are comparatively rare, one need ne worry about them.

### Testing Specific Gravity

most all the common oils are lighter th water. Of course, so-called "oil of vit l" or concentrated sulphuric acid is mu heavier than water, but that is not an il proper. The only oil which I remeber at present to have met with recety, having a specific gravity higher th that of water, is the so-called turkeyreoil (this is a sulphuric acid derivative of stor oil, used by dyers and colorists). Spific gravities of oils are most easily tesd by a set of little spindles, such as thashown in Fig. 1. These consist of a gla bulb weighted with mercury or shot at the bottom and carrying a scale marked on the inside of an upright stem as shown. The lighter the liquid the farther the spindle or hydrometer sinks in the liquid. In reading this scale you will notice that the liquid rises around the stem in a "meniscus," and the real level of the liquid is a fraction of an inch below the top of this curved "meniscus," as shown in Fig. 2.

One can easily procure these specific gravity spindles or hydrocarbons "for liquids lighter than water," with both Baume degrees and the absolute scale marked opposite each other on the same spindle; they usually go in sets of three, one reading from 0.700 to 0.800, one from 0.800 to 0.900 and one from 0.900 to 1.000. Also, one or two little upright cylinder jars (an inch or an inch and a quarter across, and five or six inches tall) are furnished with these hydrometers.

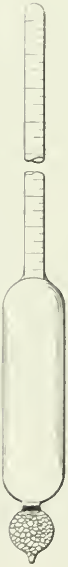

FIG. 1

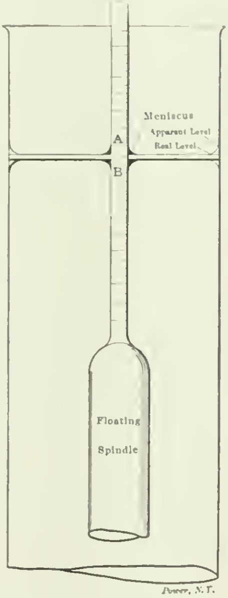

FIG. 2

In estimating the specific gravity of an ordinary machine or engine oil, you will usually use the third spindle or that reading from 0.900 to 1.000; in the cases of light machine oil you will run into the second spindle reading from 0.800 to 0.900; and in the very light oils, such as the kerosenes, benzines and gasolenes, you will have to use the first spindle.

In reading the specific gravity of an oil, the standard usually calls for a temperature of 60 degrees Fahrenheit, which you can get by setting your oil cylinder into a can of water in which in hot weather you will put small pieces of ice until the water is cooled to 60 degrees Fahrenheit. Or you can make a correction roughly of about 1 degree Baume for every 10 degrees Fahrenheit. Thus if the specific gravity of an oil on a hot summer day shows a specific gravity of say 25 degrees Baume, at 90 degrees Fahrenheit, the correct reading would be approximately 22 degrees Baume at 60 degrees Fahrenheit. As you study the comparison of the Baume scale with the absolute scale, do not get confused over the fact that the Baume figures increase as the specific gravity decreases. Also, in reading the specific gravity of a heavy oil, give the spindle plenty of time to come to its true level. In ordinary thin oils the spindle will sink to its proper depth in a few moments, but it is always well to wait ten or fifteen minutes before taking the reading; and in the case of heavy engine oils and cylinder oils you will have to let the spindle stand in the oil overnight to be sure that it has sunk to its proper level, so thick and viscous is the oil. We will go on with the flashing-point tests in the next lesson.

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The construction of the Pennsylvania railroad tunnels from Bergen Hill, N. J., to Long Island City, was practically completed December 3, 1909, when the final section of concrete was placed in line "D," the fourth and last of the tunnels under the East river to Sunnyside yard in Long Island City. The only construction work remaining to be done has to do with some minor features of the Long Island City shafts. These will be completed in a very short time. With all of the construction work on the tunnels finished, it will be possible to go ahead rapidly with the electrification, signal installation, lighting and track laying.

---

On his way to dinner Casey stepped into the door of his friend O'Brien's engine room, and found that worthy member sitting on the tool chest, eating his lunch.

"O'Brien," says he, "whaat's th' diffarance betwane yer ingin an' a lazy hobo breakin' sthone?"

"Oy giv' it up, Casey, whaat is it?"

"Whoy," says Casey, "th' hobo pounds part av th' toime, an' yer ingin pounds awl av th' toime."

And Casey got out just in time to miss connecting with a hard-boiled egg which O'Brien threw at him.—S. Kirlin.

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The low heating value of completely denatured alcohol will average 10,500 B.t.u. per pound, or 71,900 B.t.u. per gallon. The low heating value of 0.71 to 0.73 specific gravity gasolene will average 19,200 B.t.u. per pound, or 115,800 B.t.u. per gallon. The low heating value of a pound of alcohol is thus approximately six-tenths of the low heating value of a pound of gasolene.

POWER
AND THE ENGINEER

DEVOTED TO THE GENERATION AND TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

John A. Hill, Pres. and Treas. Robert McKean, Sec'y.

505 Pearl Street, New York.
355 Dearborn Street, Chicago.
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of Power solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $1 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "Powpub," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During 1908 we printed and circulated 1,836,000 copies of* Power.

*Our circulation for November, 1909, was (weekly and monthly)* 162,000.

*December* 7............ 40,000
*December* 14............ 30,000
*December* 21............ 30,000

*This paper reaches 40,000 separate readers each month and 30,000 each week.*

*None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.*

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## Something for Nothing

When James Watt said to George III, "I have what every subject of your Majesty desires—power," he might have added, "and what every subject desires to get for nothing." The craving to get more than one pays for is very common, and has been in the world for a long time; nevertheless, the would-be-rich knows that there is an element of dishonesty in his schemes and expects condign punishment if he is found out.

No such conscientious scruples trouble the hungry inventor who tries to cheat nature of her dues and to obtain unlimited lease of power without paying any rent. Furthermore, he often seems oblivious to the fact that he is working a fraudulent scheme; he really believes what he says, and thinks he has discovered some other way into the sheepfold, without passing through the strait gate where two and two make four.

He argues that the reason why you do not understand his device is because you have not penetrated as far into the mystery of mysteries as he has, and, therefore, do not understand the newly discovered principles which enable him to make water run up hill.

Probably the fact that there is an almost inexhaustible store of natural energy in its various forms has sent many an inventor off on the wrong tack. The heat of the sun, natural fuels, the tides, waterfalls, static electricity, and last but not least, radio-activity—all appeal to him as reservoirs which only need tapping to flow on forever. In a sense this is true, but the tapping and the piping of the reservoir always cost just about so much, let us say, fifteen or twenty dollars per horsepower per year.

Friction is another quite evident fact that the inventor tries to eliminate—a toll or commission which nature exacts in all power transmission.

You may oil, you may grease gear
  or shaft as you will,
Coefficient of friction will hang
  'round it still.

There is a story going the rounds of the technical press that one genius was pressed hard by an unsympathetic questioner, who asked him what he was going to do with gravity. "Gravity," said he, "t'ell with gravity. I'll use plenty of grease."

Gravity and friction once eliminated, the path is clear. It may be thought by some that these fantasies are a thing of the past along with astrology and witchcraft. Every consulting engineer knows better, and that inventors today are trying to outwit nature and to cash worthless checks at her bank.

Not so very long ago, an otherwise intelligent and responsible engineer of a power plant conceived the idea that the reciprocating forces of the horizontal engine were not being utilized as they sho be, and that here was a mine of ene all undeveloped. He accordingly propo to mount his engine on wheels and to the inertia forces of heavy reciprocat parts for propelling it along the tra drawing in its wake trains of loaded c We found that it was no use to ar with him; he had the mathematics the problem well worked out and poi with convincing finger to the formula,

$$E = \frac{W v^2}{2 g},$$

emphasizing with heavy finger the ca $W$. We accordingly proposed to him following experiment:

That he select a straight, smooth pl and mount it on rollers upon an horizontal floor; that he then stand the plank, and by moving his body lently to and fro, exert reciproca forces of one-man power as long as wind held out; that he measure care the net distance traversed and by a si calculation determine how much of one-man power had been utilized. have never seen him since nor heard outcome of this preliminary test.

We have a pathetic letter from a who is old and in feeble health, but has discovered a "new and original pr ple" in heat engines. By it he is en to use the same compressed air or l tension steam over and over in a s of rotary wheels, the developed en being limited only by the room avail He does show a glimpse of reaso acknowledging a gradual loss of p from friction and leakage. And what one say to him? He is too old to school, and incredulity on your part spells ignorance to him.

And now, most wonderful of all, c a man, not old and feeble, but young vigorous, not ignorant but educate ingenious and versatile engineer, shows us drawings for an elaborate draulic machine with wheels and l and pipes, which will pump water c uously from a lower to a higher level will use as a motive power but a fr of the energy thus created. And thi vice is patented by our beneficent Go ment and is thereby certified to b only novel but *practicable!*

As further evidence of its utility have only to examine a *bona fide* co between the company which manufa it and certain trustees in a western whereby the party of the first part tracts to manufacture motors which generate within themselves a power out the use of coal, gas or electrici any other auxiliary power"—"Said tor and equipment shall be capable of livering all the water taken . . . an not use in so doing to exceed an equi of twenty-five per cent. of the pow delivered from the water taken prim. No investment and seventy-five per dividends—what could one ask

"Said plant shall be continuously operated for a period of at least eight years, except when interrupted by the act of God, a state of rebellion or war, strikes, serious business depression, or some other substantial cause beyond the control of the first party."

In the same State as the above a local paper publishes an account of a similar invention not yet patented. "He has perfected that which has confused expert mechanical engineers for a hundred years. At great labor and expense he has constructed a machine where operating cost is reduced to nothing; where fuel and the cost of handling do not enter."

This is a phase of human nature which needs the attention of our educators. Whether the education should be in mechanics or morals is an open question.

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## Repairing Bagged Boilers

A common defect to which the return-tubular boiler is subject where the feed water contains large quantities of scale-forming matter or oil, is the bagging of the shell plates over the fire.

When such defects occur the repairs should be made by driving up the affected portion of the sheet to its former position if possible. If a bag is only slightly depressed so that the material of the shell is thinned very little, no boilermaker or inspector who knows his business will hesitate to recommend that the bag be driven up, to properly remedy the defect; however, when a bag is down to a rather sharp point, reducing the thickness of the shell appreciably, there is often a hesitancy on the part of the boilermaker to attempt such a method of repair and the inspector often demands that the bag be cut out, when it is frequently the case, that driving it up would make a safer and more satisfactory repair.

In the first place, bags are generally located in a portion of the shell which is subjected to the most intense heat of the furnace; and placing a patch requiring the lapping of the sheets in such a location is inviting trouble. Doubtless fifty per cent. of the repairs made in this manner result in further trouble; and unless it is absolutely necessary to cut out a bag it should never be done.

Almost invariably a bag extending over a small area but which has come down to a rather sharp point, and possibly cracked open at the apex, is cut out, the excuse being that the metal has been thinned so that the boiler might rupture. Often such bags as this could be drilled in the center and forced up and a rivet driven in the hole but the inspector advises that the thinning down of the metal weakens the shell; although he would no doubt, readily permit a handhole of the same or larger proportions than the bag to be cut bodily out of the sheet without giving the slightest thought to any possible weakness produced by such an opening. Small bags of not over seven or eight inches lengthwise the shell make practically no difference as regards the strength of the sheet as a whole, whether the metal is considerably thinned or not for the total cross-section of metal is practically the same after the bag is driven up as it was before it was formed, and even with the amount considerably reduced over a small area it would still be stronger than the riveted joint, and if the metal can possibly be coaxed back to its former position, even if slightly wrinkled, it is far better to rely on such repairs, that to trust a riveted patch, which will weaken the shell more than the thinned portion of the sheet and also invite continuous trouble from leaking and cracking. It is a wise plan for boiler owners who have bagged boilers, to see that they have the best advice regarding the correct method of making repairs and the services of the most skilful repair men to do the work, even if the price is considerably above that required for a lower grade of workmanship. Many good boilers have found their way to the scrap pile on account of poor judgment or lack of skill in making such repairs.

---

## Firemen and Mechanical Stokers

The merits of mechanical stokers have been discussed since the time of their inception; the good and bad points have been pointed out, together with the cost of their installation and operation, as compared to hand firing, but little has been said regarding the humanitarian side of their use in the boiler room.

In some boiler rooms where hand firing is employed, and the boilers are worked hard, the fireman experiences a continual round of the hardest kind of labor to which human beings can be exposed. This not only applies to the stokehole of an ocean liner, but to many stationary boiler rooms found on land.

There are cases where a fireman has six furnace doors to tend, and at a given signal from the chief fireman each man must begin to replenish the fuel in his particular furnaces. Then, as soon as this has been done, he is due to start over again and push the fuel from the front to the rear of each furnace in succession, and when this operation has been completed the fires require slicing. This almost endless grueling continues hour after hour, day after day, only interrupted by the arduous work of cleaning fires, sometimes as often as twice in a day's run of ten hours' duration. The conditions of the men are such as to arouse the sympathy of an observer, other perhaps than the man who is responsible for the existing conditions.

There are laws prohibiting labor being engaged where the surroundings are unsanitary, but nothing has or is being done to prevent men from sapping their strength in such fire rooms and becoming bent, broken-down men at an early age. If there were no known remedy, the situation would be different. In the steel mill a near approach to such conditions is perhaps the "puddler" who must stir the molten mass of metal in order to get it in a proper condition to form into a convenient shape to handle. This is hard, hot work, though the men have fresh air, but there has been no device constructed to improve the method now pursued. In the case of the fire room, however, there is no reason for retaining the old method of hand firing. In moderately large plants the mechanical stoker is generally cheaper, and usually produces better results. In the small plants, hand firing is doubtless the cheaper, but here the human factor does not figure so prominently, as the conditions are such that the fireman has a comparatively easy time.

The continued use of hand-firing methods can be accounted for perhaps for two reasons. It is cheaper to put in and the conveying system usually installed with mechanical stokers is avoided.

It would doubtless be something new for the designer of a steam plant to recommend mechanical stokers from the humanitarian point of view, eliminating the fact that they are under most conditions a cheaper method of firing the boilers than by hand.

There can be no just comparison between the two methods of firing from the standpoint of the fireman's condition. With one method he often becomes but little better than a slave doing the hardest kind of labor; with mechanical stoker he becomes an operator, and by judicious manipulation of adjustments of various kinds the feeding of the fuel to the furnace is controlled to meet the existing load.

The shaking and dumping grate has been of much benefit both to the man who pays the coal bill and to the fireman. It enables him to keep the fires in a better condition with a great deal less labor than would be necessary with the old stationary grate, and owing to the ease with which the fireman can keep the fires clean the amount of cold air rushing into the furnace is greatly reduced.

There is quite a difference between merely shaking a lever up and down and struggling with a slice bar and a furnace at white heat, but while the shaking grate is suitable for the smaller steam plants, the mechanical stoker is the proper equipment where the boilers are of large horsepower and consume large quantities of coal.

---

A pound of gasoline requires approximately twice the weight of air for complete combustion as a pound of alcohol

# Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

## "Pahlow" Patent Hose Coupling, and Valves

The accompanying illustrations show features of the "Pahlow" patent hose coupling and valves, which are manufactured by the George N. Newhall Engineering Company, 136 South Fourth street, Philadelphia, Penn.

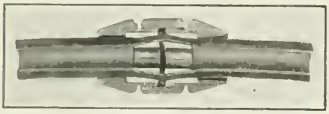


FIG. 1. SECTIONAL VIEW OF "PAHLOW" COUPLING

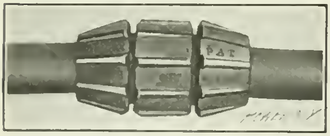


FIG. 2. HOSE-COUPLING CONNECTION

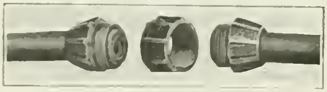


FIG. 3. COUPLING UNCOUPLED

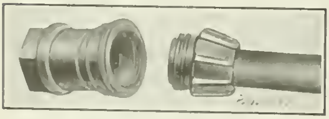


FIG. 4. AIR-HOSE VALVE

These couplings are so designed that they do not obstruct the hose, the opening in the coupling being exactly the same size as the diameter of the hose. This permits of reduction in the size of hose used to carry a given quantity of air or water, thus reducing the cost of hose necessary to handle a given amount of either.

Owing to the design of the coupling, no leakage of air or water is said to be possible, thus increasing the efficiency of pneumatic and hydraulic plants, by allowing a lower pressure to be carried at the central station.

Fig. 1 is a sectional view of a coupling, which illustrates its construction. The tapered ring is slipped over the end of the hose and a tapered thimble inserted on the inside, the two being forced together with the hose projecting slightly beyond. The tapered ring fits inside the recess of the coupling nut, allowing it to turn freely. These two coupling nuts are connected by means of a third sleeve. The coupling nuts are free to move on the hose and, by turning them, the projecting ends of the hose are drawn together, making a tight joint. This eliminates gaskets and other devices in connecting the hose coupling. In Fig. 2 a coupling is shown coupled together; Fig. 3 shows an uncoupled coupling.

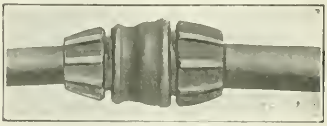


FIG. 5. SEALED JOINT

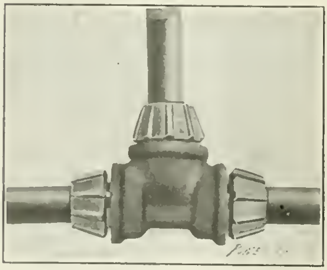


FIG. 6. TEE COUPLING USED AS COUPLING

A valve operated by the valve nut is shown in Fig. 4, which when screwed up unseats the valve, admitting air to the hose and sealing the joint by means of the projecting end of the hose; this is shown in Fig. 5. As the valve nut and the coupling nut are exact duplicates, the may be used either for opening or operating the valve, or for forming th coupling. If the valve nut is slacked o the valve becomes seated and closes th air supply. The valve body contains release hole which allows the air escape from the hose after the valve seated.

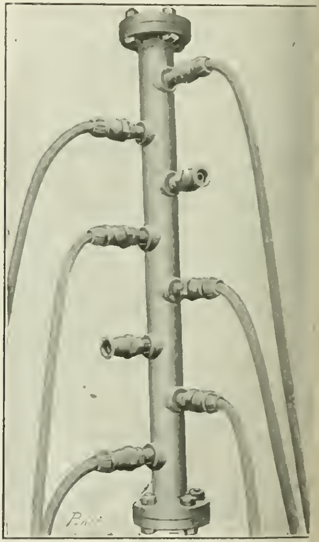


FIG. 7. MANIFOLD WITH HOSE CONNECTION

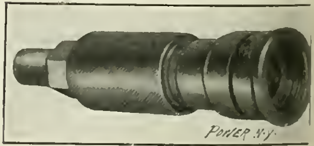


FIG. 8. THROTTLE HANDLE

Another feature of this coupling is th fact that it comprises a reducing coupli for the connection together of differe sizes of hose, as shown in Fig. 6. Fi 7 represents a manifold with several ho connections fitted thereto, and Fig. shows the throttle handle.

# Slick Air Tub Blowing Engine

The essential features of the Slick type air tubs for blowing engines, shown by Fig. 1, are as follows:

The inlet ports are located in the barrel of the tub, which is supported on independent slides and may be reciprocated, while the heads are stationary. The barrel, therefore, serves as an inlet valve and the action is the same as would take place with an ordinary piston valve, provided the valve were held stationary and the valve seat reciprocated.

This construction gives enormous inlet area for very small motion of the barrel, as the ports are of large size and extend around its entire circumference, Fig. 2. As this construction leaves the entire area of the heads available for discharge valves, it is possible to secure correspondingly great discharge area, with the result that in practice the tub fills completely at the piston and rotative speeds usual in ordinary Corliss engine practice.

The Slick inlet admits air to the tub on the suction stroke with no measurable loss of pressure. By reference to the indicator diagram, it will be noted that there is a slight drop of the suction line below the atmospheric line, at the beginning of the suction stroke, due to the fact that the valve travel is slower this point. As the piston advances, the valve, opening quickly, gives sufficient inlet area to admit air to the cylinder with no measurable drop in pressure; and the diagram shows that, when compression begins, the cylinder is completely filled at atmospheric pressure. The discharge line rises but a fraction of a pound above the receiver line, and this overpressure is found only in the middle of the stroke where the piston travel is highest. Toward the end of the stroke there is no overpressure noticeable on the diagram. The tub from which this diagram was taken was fitted with automatic discharge valves.

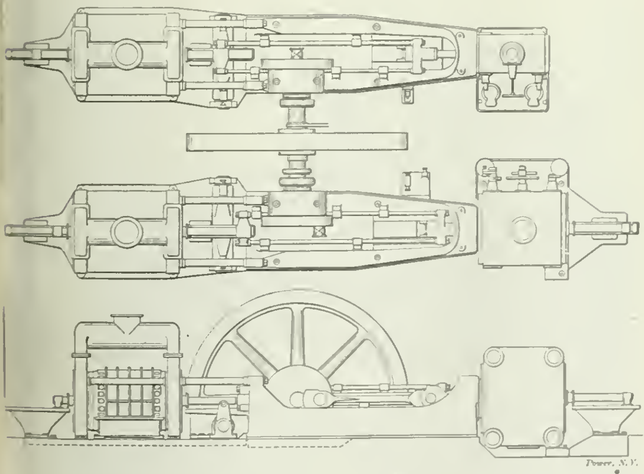


FIG. 1. SLICK AIR TUB BLOWING ENGINE

The inlet ports are circular, 5 to 6 inches in diameter, and an electric light dropped through the port makes it possible to thoroughly inspect the condition of the cylinder wall and to test the discharge valves or the piston-packing rings for leakage.

The piston packing ring and the packing rings on the heads are exact duplicates. With the engine on the dead center, by disconnecting one pin in the valve gear it is possible to slide the barrel back far enough to uncover not only the packing ring on the head, but also to uncover the piston-packing ring, for inspection and cleaning or renewal of these rings without in any way disturbing the valve setting.

The entire air end is mounted on and maintained in alinement by a cast-iron foundation plate, which is carried forward and bolted to the engine frame. The working stresses are taken care of by cast-iron struts and tie bolts extending between the front air head and engine frame. Rigid struts and ties also extend between the two air heads, maintaining them accurately and rigidly in alinement, independently of the cylinder barrel.

The air tub heads are iron castings, made with a broad foot, which rests on the foundation plate. The heads are designed with unusual depth to provide a drum extension over which the end of the barrel may lap the amount required in the valve travel. Each head is fitted with a cast-iron packing ring to prevent leakage between the heads and moving barrel.

The barrel floats independently of the cylinder heads, the only point of contact being the packing ring with which each head is fitted. A bracket or foot is cast on each side of the barrel extending along nearly the full length of the barrel. These brackets fit supporting slides, which are anchored to the foundation plate, thus forcing the barrel to travel in perfect alinement and with a minimum of friction. The barrel is driven by two connecting rods, one on each side, which insures an even drive.

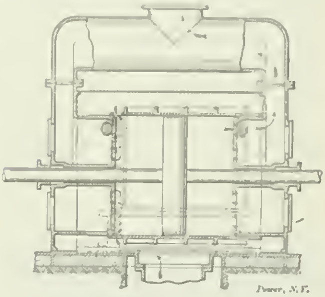


FIG. 2. CROSS-SECTION OF BARREL

The standard equipment for these blowing tubs provides light, automatic, steel-cup, poppet valves located in the heads and so arranged that the valves will seat against the inner wall of the head and give a minimum of clearance. These valves are arranged in groups with a handhole giving convenient access to each group. One spider serves to clamp all of the apparatus of each group, enabling the examination of valves to be easily and quickly made.

The tubs are also equipped, when desired, with mechanically closed steel-cup, poppet-discharge valves. These valves are of familiar proportions and controlled by a simple valve gear.

The heads of the tub are provided at the top with large, rectangular, flanged discharge openings. A cast-iron wind box makes a common connection to these discharge openings of the two heads and conducts the blast to a common flanged discharge at the center and top of the wind box.

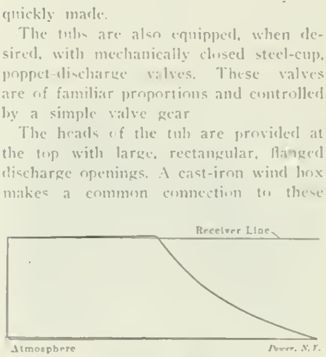


FIG. 3. DIAGRAM FROM AIR TUB

The standard type of blowers is designed to operate economically on a blast pressure of from 16 to 18 pounds normal with a steam pressure up to 150 pounds gage and will easily blow against 20 pounds of maximum blast pressure.

[illegible] built either cross-compound [illegible] or [illegible]ndensing; [illegible] single-cylinder high-[illegible] which can be operated, if desired, as disconnected compounds.

There are two standard sizes of air tub, one having a normal capacity of 20,000 cubic feet per tub and the other having a normal capacity of 15,000 cubic feet per tub.

This blowing engine is made by the Allis-Chalmers Company, Milwaukee, Wis.

# An Improved Oil Burner System

By S. Rice

The increasing production and relatively low cost of crude petroleum throughout the United States, particularly on the Pacific coast, has led to a number of inventions for utilizing it as fuel under boilers, and in the accompanying illustrations there is shown a system which is now being used with very satisfactory results. The essential features of the system are the burner and the compressor equipment.

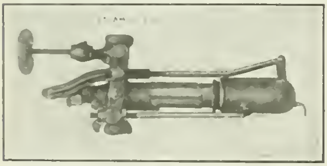


FIG. 2. BURNER FOR LOW-PRESSURE STEAM PLANT

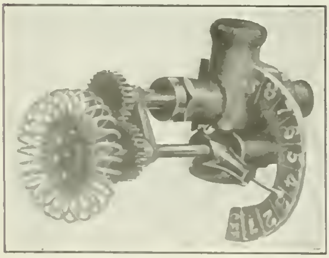


FIG. 3. SEGMENT AND INDICATOR TO [illegible]

Fig. 1 is a diagrammatic sketch giving a sectional view of the standard burner, which consists of the following parts: *A*, main jet body to which the air or steam and the oil supplies are connected; *B*, nozzle or oil-regulating cap; *C*, cap gland; *D*, steam-valve stuffing box; *E*, steam packing gland; *F*, steam-valve stem; *G*, steam-valve stem gear; *H*, steam-valve operating gear; *I*, shaft hangers; *J*, drive shaft; *K*, stock and indicator; *L*, indicating segment; *M*, nozzle operating gear.

By the escape of the steam or air, which is supplied at 25 to 30 pounds pressure, from the nozzle of the main jet body *A* through the cap *B*, there is created a suction. This draws the oil supply as regulated by the cap *B*, which is threaded to screw on and off of the nozzle by means of the handle *N*, shaft *J* and gear *M*. It is only necessary to loosen the adjusting screw in gear *H* and slide it out of mesh of the steam valve gear *G* and thus per- mit the regulation of the two elements independently, after determining their proper proportion, complete combustion being thereby obtained. The gear *H* may be replaced in mesh with the steam-valve gear *G* and locked in place on the drivin shaft *J*. After determining the maximu volume of fuel required, the stop or indicator *K* may be clamped on the drivin shaft *J* against the main jet *A* so as t prevent overfiring.

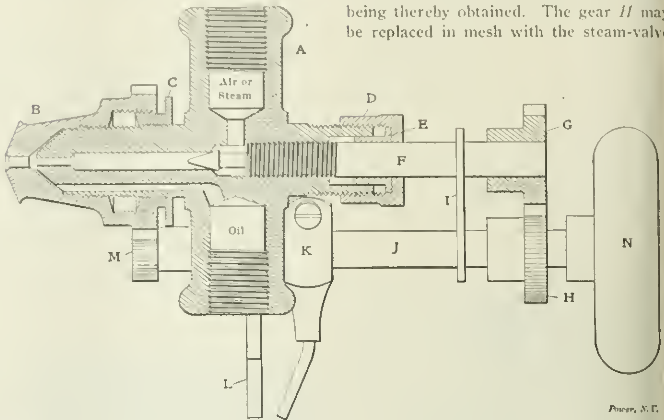


FIG. 1. SECTIONAL VIEW OF STANDARD BURNER

The stop or indicator *K* is also use

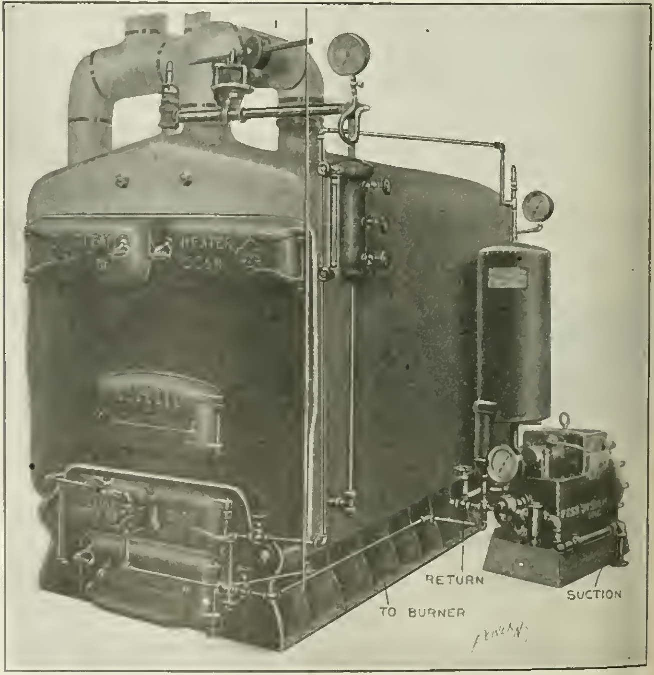


FIG. 4. SYSTEM APPLIED TO LOW-PRESSURE STEAM BOILER

in conjunction with the spaced segment, as illustrated here and in Fig 3. With proper adjustment the fire may be increased or diminished by the operation of the handwheel *N*, which will control the two elements in sufficient proportion to adequately maintain combustion. The supplies of steam or air and oil are properly provided with independent valves, as it is not intended to shut off the supply of the element by the burner when it is not in use.

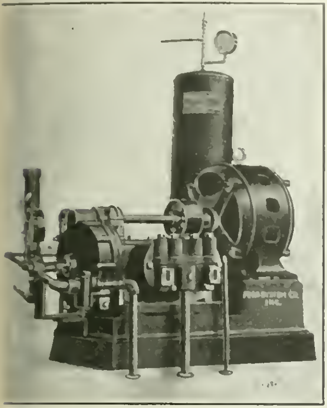


FIG. 5. ALTERNATING-CURRENT MOTOR OUTFIT

Fig. 2 gives an exterior view of a burner designed for use in small low-pressure steam plants. It is so constructed that, by the operation of a single handwheel, the supply of oil and air, together with the opening of the nozzle, are increased or diminished proportionately, thereby maintaining combustion at any capacity from 1 to 40 horsepower. The degree of atomization necessary for good combustion could not be maintained under varying demands with a fixed opening in the nozzle. It was thus essential to have an adjustable opening in the nozzle automatically regulated in proportion to the quantity of oil to be atomized. The manufacturers of this apparatus guarantee an absolutely smokeless operation from a minimum to a maximum load. Fig. 3 shows a segment and indicator by which the firing is regulated as stated above.

Not the least important feature of the system is the compressor equipment by means of which air is supplied for atomizing the oil in the fire boxes. Fig. 4 illustrates the system applied to a low-pressure steam boiler, equipped with automatic fire controller, which is so regulated as to maintain any desired pressure automatically. The air compressor is driven by a direct-current motor of the series type so constructed that the armature and fields can be removed, whenever necessary, without disturbing any other part of the machine. There are two cylinders for the compressor, each of which is fitted with a single-acting piston, and a steel crank shaft operates the connecting rods.

The top of the compressor is formed by the base of the motor, and the herring bone gear, which is keyed on the crank shaft, is inclosed in a cast iron casing. The working parts of the compressor are inclosed. Thorough lubrication of the moving parts is effected from an oil reservoir in the base, supplied through an oil-filling elbow. The latter also gages the proper hight of the oil in the casing. The reservoir communicates with the gear case, carrying oil up to the pinion on the armature shaft

In the cylinder heads the suction and discharge valves work independently of each other. They are seated by gravity and can be changed about, at need, provided the seats have worn equally. The cylinder head, valves, pinion or gear may be removed without disturbing the other parts.

A speed controller is furnished with each equipment with which the speed of the motor may be regulated to best suit the requirements. The air, as fast as compressed, passes into a suitable receiver where its volume is kept within proper limit by means of a pressure gage and blowoff valve. As shown in the illustration, the pump supplying oil to the burner is of the rotary-gear type, requiring no valves, mounted on the compressor case and directly connected to the compressor shaft. The strainer on the suction line is of the basket type, provided with a cock at which any accumulation of water in the oil may be drained off. The pump discharge is provided with an air chamber, pressure gage and pressure-regulating valve by which the pressure of the oil fed to the burner may be regulated to suit the requirements of the installation.

Fig. 5 shows an arrangement with an alternating-current motor similar to that illustrated by Fig 4, except for the fact that the motor is mounted on a separate base and that in Fig 4 this base forms the top of the compressor, making a little more compact unit The apparatus shown in Fig 5 may be applied to any type of furnace designed for burning oil It is manufactured by the Fess System Company, Inc., of San Francisco

## Sight Feed Oil Pump Model "C"

A practical oil pump for small engines, pumps, compressors, auxiliaries, etc., is known as the Sight Feed Oil Pump, model "C," which is manufactured by the Sight Feed Oil Pump Company, Milwaukee, Wis.

The accompanying illustrations show an outside and sectional view of the pump, which is semi-automatic in action. There is nothing radically new in its general appearance, but in construction details a decided difference is found, when compared with the older types of oil-feed pumps. It is built with one or two feeds and with glass tanks of several capacities.

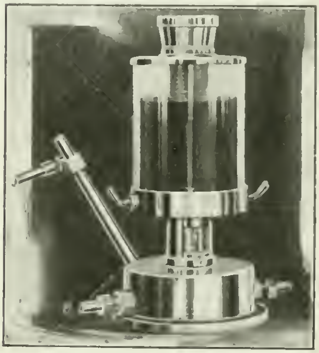


FIG. 1. MODEL "C"

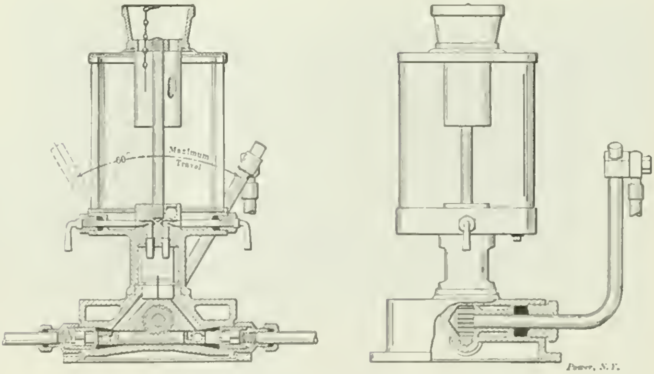


FIG. 2. DETAILS OF MODEL "C" OIL PUMP

At the top is a large opening for filling, which is equipped with a good strainer; a [illegible] cover, so fastened that it cannot be [illegible] or lost, is also provided. The [illegible] valves, which are on the side of the pump near the bottom, are convenient to get at and in plain view, as shown. The valve seats are also so arranged that dirt will not lodge in them, and an opening in the bottom is provided so that the tank can be easily drained.

To compensate for wear, hard-babbitt cones which form the working chamber can be compressed to renew the fit by forcing them in with the screw-valve cases, and to insure perfect tightness, valve cases with steel valves and beveled seats, that can be quickly reground, have been incorporated.

The oil drops through an air-tight glass-inclosed chamber, in which the rate of feed is clearly visible. When the oil pump stops, a small amount of oil will continue to fall, thus forming the necessary excess for starting. The pump, as shown in Fig. 2, works on a long or short stroke, fast or slow, and is made that the delivery is positive.

## "Bunsen" Smokeless Furnace

The "Bunsen" smokeless furnace, manufactured by the Bunsen Smokeless Furnace Company of America, Hudson Terminal building, 50 Church street, New York City, is described and illustrated herewith. This furnace is of firebrick construction, and produces perfect combustion, it is said, without mechanical appliances, is adaptable to all types of boiler and its installation does not mutilate the boiler or boiler setting.

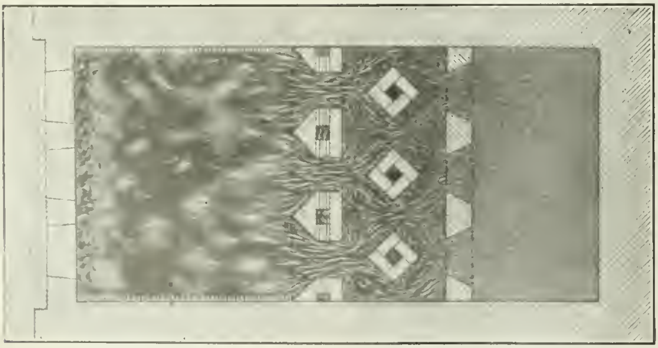


FIG. 1. GASES PASSING THROUGH FIREBRICK CONSTRUCTION OF THE "BUNSEN" FURNACE

The distilled gases from the fuel are squeezed in passing through restricted openings, shown in Fig. 1, and are supplied with highly-heated air en route by passing through a very hot chamber, where they are mixed. Small side grates resting on the grate bars are extended along the side of the firebox to about the hight of the fire carried, thus naturally admitting a sufficient supply of oxygen through the bed of fuel to support practically perfect combustion in the furnace.

In the rear of the firebox are mounted upon the bridgewall a series of pipes, which are separated from each other so as to provide a number of openings, wide at the front and narrow at the rear. On each side of each slot is placed a tuyere, through which a very hot supply of air is passed from the ashpit and heated in its zigzag passage, such air being regulated by a damper. Upon the escaping of the air and gas from the slots they expand and become combustible. At the rear of each slot is placed a pier with deflecting surfaces to mix the gas and air, after which they meet near the rear of the piers and are again squeezed in their final exit from the combustion chamber. Fig. 2 is a sectional view of the "Bunsen" furnace under a return-tubular boiler.

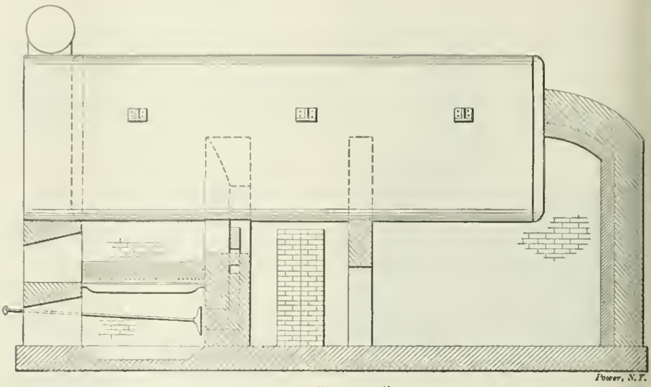
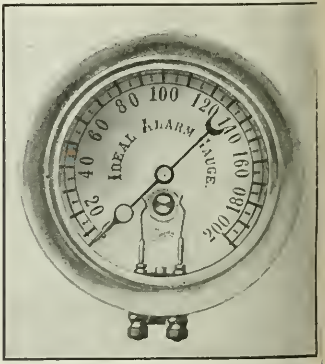


FIG. 2. SECTIONAL VIEW OF A "BUNSEN" BURNER IN A FURNACE

## Ashton Ideal Alarm Gage

A good steam, vacuum or any oth gage is appreciated by the user, but mai times the operating engineer has longe for a gage which would automatical notify him when certain pressures wei reached, and to meet this longing th Ashton Valve Company, 271 Franklii street, Boston, Mass., has recently gotten out an alarm gage which is a sentine against a drop in pressure below a certain predetermined amount.

By noting the illustration, it will b seen that on the face of the gage is circular disk in which two notches ar cut in diametrically opposite points, ir which two contact springs fit, but do no make contact when the pointer of th gage is at some predetermined point. For instance, if a pressure of 80 pounds is desired to be carried, the disk containing the notches is set so that with the gage pointer at 80 the two contact springs fit in the notches in the disk, without contact. As the pressure increases or de-



IDEAL ALARM GAGE

creases a certain amount, either side of the 80-pound mark, the disk is revolved, bringing the contact pieces in contact with the full outer circle of the disk, ringing an electric alarm, which warns the engineer that the pressure has either advanced above or fallen below the designated pressure desired.

This gage is made for hard usages, and its chief merits as an alarm gage lie in the fact that the operation of the circuit closer interferes in no way with the action of the gage itself, thus combining a reliable and sensitive gage with an alarm connection.

This gage can be used in connection with the automatic-sprinkler systems found in many manufacturing plants. It is placed on the supply pipe from the water-works system, or the plant fire pump. If the pressure of the system falls, due to leakage, burst pipes or fire, the gage immediately warns the engineer, and serious damage from water or fire may be prevented. It can also be used with the air valve on a dry-pipe sprinkler system in which an air pressure must be maintained, or else water will enter the system, thus causing trouble and freezing in the winter months. The gage immediately gives the alarm if the air pressure decreases.

Another place where this alarm can be used to advantage is with automatic pumping systems where, in case the automatic regulator fails to perform its duty, the pressure in the water system will drop and the gage, forming a contact between the contact springs, by the disk turning, immediately rings an alarm. In fact the gage can be used to advantage wherever it is desired to know when the pressure increases or decreases.

## "Duval" Packing

Duval metallic packing is made of fine white-alloy wire accurately plaited in square form. The wire is of special composition, having a maximum strength and elasticity, with a minimum of friction and wear. The claims for it are that it has great toughness and, therefore, will resist enormous pressures and maintain a tight joint without bearing unduly against the rod. Also, that its heat resisting properties are such that it cannot burn when submitted to a very high temperature, and that it does not deteriorate when kept in stock. It is also claimed that it will not cut the rod or wear it unduly, that when applied to a rod already scored it will adjust itself to the uneven surface, and that it is not affected by rust, which would increase its life and also prevent injury to the rod when the piston is in action.

It is said that this packing will maintain a tight joint against water pressure up to 5000 pounds per square inch and also against a temperature up to 900 degrees Fahrenheit. It is also said that it can be used on rods moving as fast as 1750 feet per minute, and that it can be applied with equal advantage on slow-speed plungers. It is claimed to be suitable for conditions where dirt, grit and sand accumulate, but is not recommended for brass rods. The accompanying illustrations, Figs. 1 and 2, give the reader a general idea of its shape and construction. It is manufactured by the Power Specialty Company, 111 Broadway, New York City.

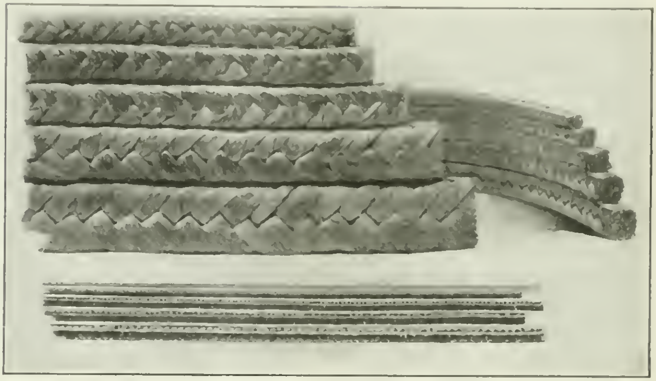


FIG. 2. "DUVAL" METALLIC PACKING

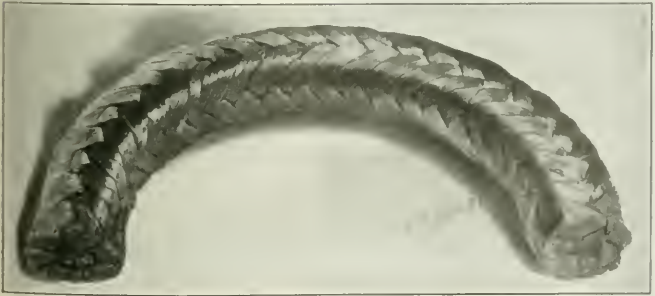
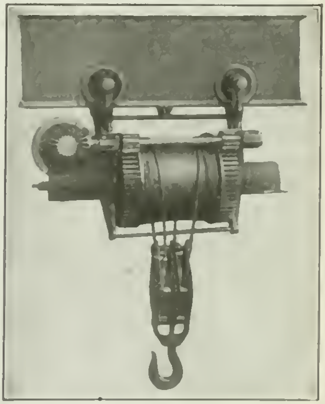


FIG. 1. "DUVAL" METALLIC PACKING

## Rasmus Electric Hoist

Among the advantages claimed for this hoist which, as shown, has a capacity of five tons, is the extremely low head room required for a hoist of this size. This is due to the employment of a worm and wheel, driven by an electric motor. This transmits power through the bevel gears and pinions shown to the drum carrying the load. The close head room will be noted when it is stated that on a five-ton hoist it is but 34 inches from the bottom of the I-beam to the bottom of the hook.

The drum of the hoist and the field of the motor are in one piece, the pole pieces from a standard motor being mounted on the inside of the hoisting drum and the armature and brushes suitably connected to drive the worm gear and transmit current to the motor. This does away with all castings and braces necessary to hold a motor in alinement and reduces the total weight of the hoist.



RASMUS ELECTRIC HOIST

The worm is keyed to the armature shaft which eliminates the necessity of a brake of any kind, as the motor is electrically controlled for speed, and when the motor is not running, all gears are locked in position by the worm, effectually preventing the load lowering when current is shut off from any cause. The whole hoist is only 16 inches wide, 38 inches long overall, and weighs 500 pounds.

The worm runs in oil and is provided with suitable thrust bearings. It is built by Gustav Rasmus, 514 West Fifty-seventh street, New York City.

## Erie Stokers

There have recently been several important changes in the design of the Erie stoker, a description of which was published in the April 13 issue.

The location of the motor has been changed from the back of the pedestal to the front in order to get the motor out of the way when the fires are being cleaned and the clinker raked out. See Fig. 1.

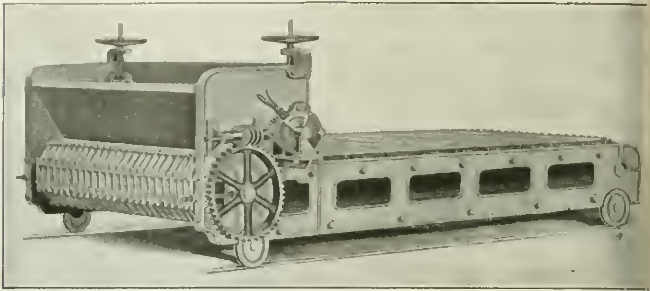


FIG. 2. FRONT AND SIDE VIEWS OF TRAVELING GRATE

Another important change is the form of the deflector which gives better diffusion of the fuel, and exhaust steam is admitted to the firebox on top of the deflector instead of through it, as formerly. The size and shape of the hopper have been changed so as to accommodate twice as much coal and facilitate the work of the fireman, and the strength of the driving chain is said to have been increased 100 per cent. The location of t choke plugs has been slightly changed order to facilitate handling, as forme they were so close together that it w difficult to take hold of them. Th stoker is manufactured by the Er Foundry Company, Erie, Penn., whi also manufactures the Erie traveli grate.

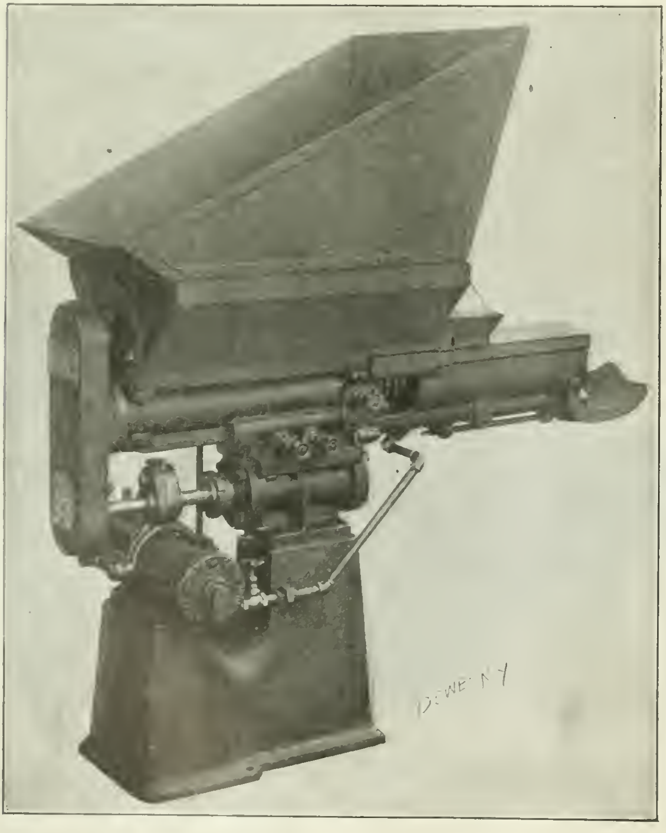


FIG. 1. SHOWING LOCATION OF MOTOR DRIVING THE ERIE STOKER

Fig. 2 shows front and side views a Fig. 3 rear and side views of this grate.

The grate surface consists of a lar number of small links of considerab depth mounted on a fixed supporti frame and traveling in the form of endless chain over supporting rollers. T motion is imparted by sprocket whe which are mounted on the driving sha and engage with the rollers on the ro supporting the grate links which form t chain.

The fuel is fed in at the front end the furnace through the hopper and, i mediately becoming ignited from und the igniting arch, is carried back towa the rear of the boiler by the travelin grate surface, passing through the su cessive stages of coking, distillation a combustion until it is discharged over t end of the traveling grate into the ash or onto the attachment. The grate ba in passing over the back shaft for th reverse travel automatically shear clinkers, thereby thoroughly cleaning t air passages, and the maximum amou of air space is always obtainable. T motion of a driving shaft is derived fr an inclosed ratchet, worm and gear wh can be located on either side of the fro end of the traveling grate and is tra mitted through an eccentric from a li shaft. The latter may be located ove head, or below the floor line, and can driven from the same line in this ma ner. The amount of coal fed is regulat by raising or lowering the cast-iron fe gate lined with firebrick on the inside fa ing the igniting arch. This regulation, connection with increasing or decreasi the speed of the grates, provides for a variation in intensity of fire which may desired.

A suitable hand lever, which alters t

nber of teeth engaged by the ratchet wl which is entirely incased and prac- ally noiseless, at each stroke enables the vel of the grate to be given any one four different speeds, the adjustment ng effected without stopping the op- tion of the grate. Thus any boiler a battery may be forced or suppressed will.

The framework consists of heavy cast-i frames, well braced, to meet the re- rements of hard service. In grates eding 7 feet in width, there is pro- d a center support for the upper roller s ts. The framework is fitted with c ragms between the chain sections to r ate the amount of air through or a nd the rear portion of the grate v re the fire is spent and the ashes dis- c ged. By lowering the front of the h per and raising the feed gate, access i. btained to the interior of the furnace. o if desired, the whole stoker can be w drawn from under the boiler along t supporting rails.

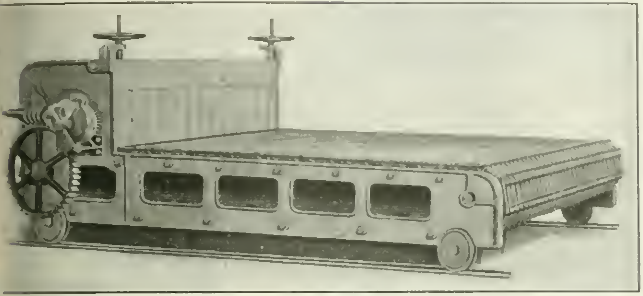
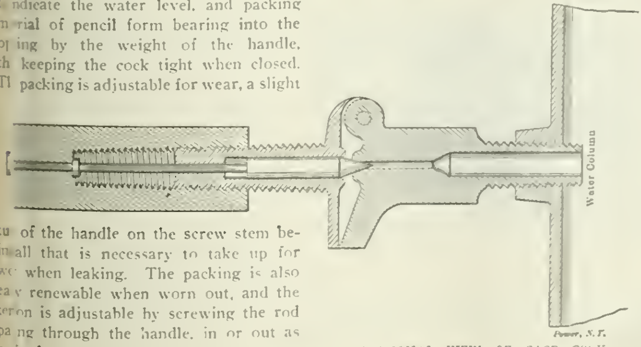


FIG. 3. REAR AND SIDE VIEWS OF TRAVELING GRATE

## A New Gage Cock

simple gage cock for steam boilers is st being placed on the market by the M n Foundry and Supply Company, M n, Ind. The device, as noted by tl sectional views shown herewith, con- f a weighted handle which is raised t ndicate the water level, and packing m rial of pencil form bearing into the o ing by the weight of the handle, th keeping the cock tight when closed. Tl packing is adjustable for wear, a slight tu of the handle on the screw stem be- in all that is necessary to take up for we when leaking. The packing is also ea y renewable when worn out, and the teron is adjustable by screwing the rod pa ng through the handle, in or out as recired.



SECTIONAL VIEW OF GAGE COCK

## The Augustine Rotary Engine

A new design of rotary engine, has been gotten out by the Augustine Automatic Rotary Engine Company, 738 Ellicott square, Buffalo, N. Y.

In Fig. 1 is shown a 125-horsepower compound engine complete.

The engine consists of an outside casing, shown in Fig. 2, to which is fitted the end cover, an outside and inside view of which is shown in Fig. 3. In the hub of the cover is fitted an adjustable roller bearing for tightening the revolving piston down onto the abutment, shown at *A*, Fig. 2, to keep a steam-tight joint. On the inside of the end covers a channel is cut in which the crosshead runs, thus guiding the blade with the true bore of the cylinder, as shown at *B*, Fig. 3. At *C* is shown the counterbalance for balancing the blade which runs on the opposite side of the shaft, the latter being shown at *D*, also the blade with its long and short arms.

Fig. 4 shows one of the abutments, in which the inlet and exhaust ports are cast, *E* representing the inlet port and *F* the exhaust port. A packing ring is shown at *G*, *H* showing the packing block which prevents any possible leakage from circulation of steam around the abutment.

A half section of the revolving piston is shown at *I*, Fig. 5, and shows where the ends of the blades extend through the disk to the crosshead, which runs in the channel cut in the cover. The blade shown at *K* extends across both flanges of the piston, its purpose being to make a steam-tight joint. The disk *J* is for the purpose of closing up the end of the revolving piston.

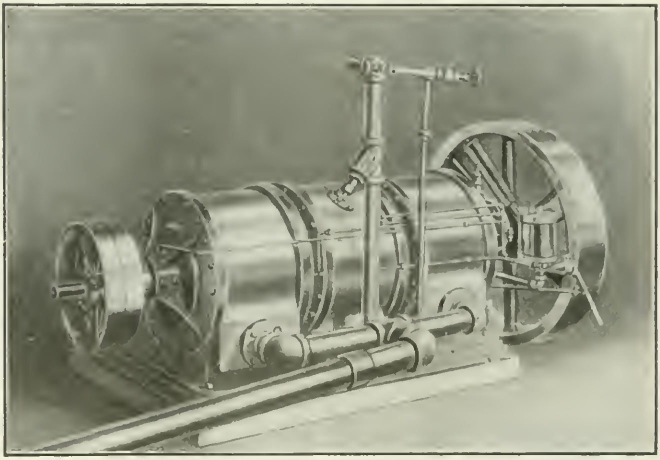


FIG. 1. A 125-HORSEPOWER COMPOUND-ROTARY ENGINE

In Fig. 6 is shown the two halves of the revolving piston *L L*, bolted together, the opposite slot, in which the blade is housed, being shown at *M*, the slot *N* also showing the blade housing.

The crosshead and one end of the blade are shown at *O*, Fig. 2, and the part *P* shows the counterbalance designed to offset the centrifugal force of the blade. The staggered ports of the automatic [illegible] are shown at S S, and the exhaust port at R.

The engine operates after the following manner:

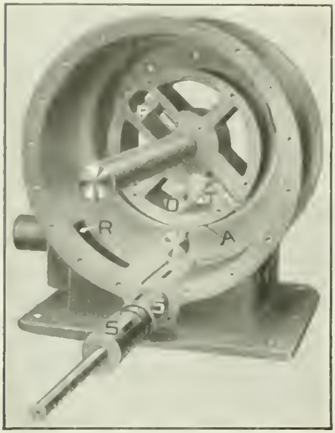


FIG. 2. CASING OF ENGINE

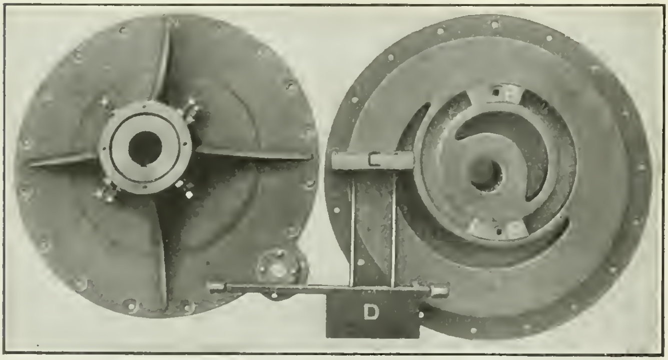


FIG. 3. OUTSIDE AND INSIDE VIEW OF COVER, ALSO BALANCING BLADE

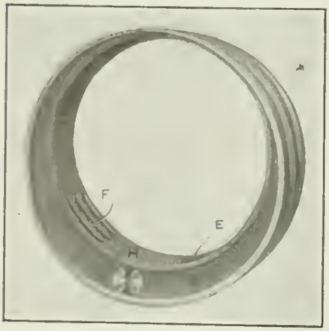


FIG. 4 ABUTMENT IN WHICH STEAM AND EXHAUST PORTS ARE CAST

The two revolving pistons or covers have two counterbalanced pistons or blades diametrically opposite to each other and each laps across the three flanges shown in Fig. 6, which form two separate compartments. They are fitted so that the pressure of the steam seals them, and a steam-tight joint is said to be obtained. The object of the long and short arm on alternate sides of the piston *D*, Fig. 3, is to run in the crossheads that operate in the covers.

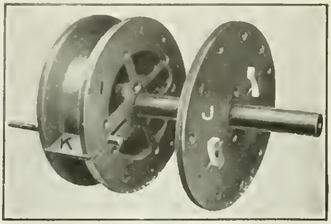


FIG. 5. HALF SECTION OF REVOLVING PISTON

When the piston blade crosses over the center of the engine at the abutment point *A*, Fig. 2, the port in the valve opens and steam is admitted to exert its pressure against the blade *T*, which is counterweighted on the opposite side of the shaft as shown at *P*, and the core or piston revolves.

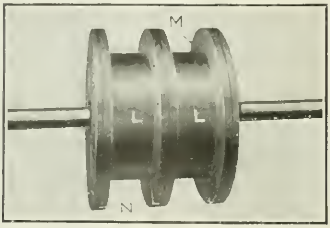
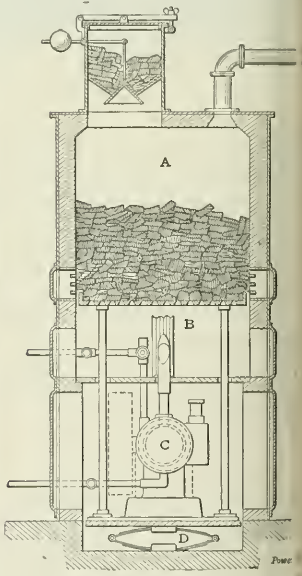


FIG. 6. PISTON BOLTED TOGETHER

The valve cuts off automatically at the point determined by the load, and expansion takes place during the rest of the revolution. While one piston is being revolved by expanding steam on one side of the shaft, the piston in the opposite chamber crosses the abutment point, and the port in the valve allows stea exert its pressure against the pisto in the first chamber. Thus one si using steam expansively while the side is using live steam, as in the of an engine at the beginning of its st

## Vibratory Disintegrator for a Gas Producer

Col. John Jacob Astor, of New City, has invented and applied f patent for a vibratory disintegrator f peat-gas producer, according to *Scientific American.* The gas gener may be supplied to an ordinary inte



JOHN JACOB ASTOR'S PEAT-GAS PROD

combustion engine *C* (see illustrati the engine-exhaust muffler *B* being pl inside the producer. The sides of muffler are thin, so as to permit the be distended and drawn inwardly variations in the pressure within muffler.

The gas escaping from the engine inder after each explosion tends to pand the muffler, and as the exhaust escapes from the muffler the sides contract. These vibrations of the walls of the muffler cause the succes compression and expansion of the within the producer, and likewise the in the pores and interstices of the p As a result, the peat is disintegrated becomes uniformly heated.

# Inquiries

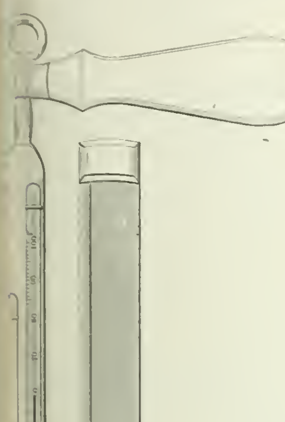
*Questions are not answered unless they are of general interest and are accompanied by the name and address of the inquirer*

### The Humidity of Air

How can we determine the humidity of air and how can it be regulated?

H. G.

Our atmosphere consists principally of a mechanical mixture of nitrogen, oxygen and aqueous vapors. The per cent. of the last named component varies almost constantly under natural conditions, and as a matter of fact is kept from varying under artificial conditions only with great difficulty. Where abnormal humidity exists in cold-storage warehouses, where the cooling of partially saturated incoming air often produces a condition of saturation, and where the per cent. of saturation may also be increased by the moisture cooled from the products stored, a deliquescent moisture-absorbing salt, such as calcium chloride, may be employed to reduce the humidity. The salt is usually exposed to the air on shallow trays provided with drip pipes which may be arranged to convey the saturated calcium-chloride brine away to a storage tank to await reclaiming, or the brine may be employed as a deporting agent on the ammonia or brine pipes over which it may be arranged to drip slowly as formed.


Power, N.Y.

THE SLING PSYCHROMETER

The only exact method of regulating the humidity of air is artificially to cool it to such a point that the amount of moisture that it will still retain at that temperature, usually after precipitating a large per cent. of its initial complement, will be the required amount when the temperature is allowed to rise to the required point. This general process is employed most extensively in connection with the dehumidifying of air used in blast-furnace work.

The humidity of the atmosphere may be determined by one of two methods: First, by cooling the air until the point of saturation is reached, in which case the per cent. of humidity for any other temperature can be readily determined from well known tables or, second, by observing the drop in temperature produced by the evaporation of a film of water at the original temperature.

Apparatus for determining humidities by the former method are known as "dew point" instruments and by the latter method as "psychrometric" apparatus, more commonly called hygrometers. These instruments are of many forms, but the two most common types are the stationary wet- and dry-bulb thermometer of which the most practical seems to be Lloyd's Hygrodeik and a sling wet- and dry-bulb thermom-apparatus known as the "sling psychrometer." This instrument is employed by the United States Weather Bureau and is the most popular humidity-determining instrument employed in cold-storage work, especially when low temperatures are to be dealt with.

The instrument consists of two thermometers so mounted on a common scale that one bulb extends below the other. This bulb is covered with a thin layer of muslin which is kept saturated when the instrument is inserted in its case, which is provided with a cup kept full of water. This cup is only sufficiently deep to allow the lower muslin-covered bulb to enter, the upper bare bulb being always dry.

In taking observations the instrument is removed from its case and swung rapidly around on its pivoted handle. Contact with the air produces a rapid evaporation of the moisture on the wet bulb, which evaporation causes that thermometer to register a lower temperature than that of the dry-bulb thermometer. The difference in the readings of the two thermometers constitutes a basis for arriving at the per cent. of humidity present in the air tested.

### Compressibility of Water

What is the difference in volume of water for different pressures?

J. C.

Water is very slightly compressible, its compressibility is from 0.00004 to 0.00051 for one atmosphere, decreasing with increase of temperature. For each foot of pressure, distilled water is diminished in volume 0.0000015 to 0.0000013. Water is so incompressible that even at a depth of a mile a cubic foot of water will weigh only about half a pound more than at the surface.

### To determine the thickness of cylinders

I need a cast steel cylinder to withstand a working pressure of 600 pounds per square inch, the diameter of the same to be 30 inches inside measurement. What thickness is required, and what thickness is required for a cylinder of cast steel, 15 inches inside diameter, to withstand a working pressure of 240 pounds per square inch?

M. D.

The thickness at which a cylinder will fail under pressure is given by the formula,

$$\frac{\textit{pressure} \times \textit{radius}}{\textit{tensile strength}} = \textit{thickness},$$

all in the same units, as inches, per square inch, etc. This would give for your two cases, assuming the tensile strength to be 60,000,

$$\frac{600 \times 15}{60,000} = 0.15$$

and

$$\frac{2400 \times 7.5}{60,000} = 0.30.$$

These are the thicknesses which would just burst with the given pressures. You would have to make them enough times that thickness to give them the necessary factor of safety.

### Nonmagnetic Steel

Can you tell us of any nonmagnetic steel and give us the name of the maker?

C. E. F.

Nickel steel is nonmagnetic, but if allowed to drop in temperature to about 30 degrees Fahrenheit, it becomes magnetic and retains its magnetism until it reaches about 1130 degrees Fahrenheit, when it again loses its magnetism.

Manganese steel is practically nonmagnetic.

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The secret of avoiding boiler explosions is regular inspections at short intervals by competent men, and prompt compliance with their recommendations in regard to repairs and the allowable working pressure. Professor Thurston concluded that but one boiler in ten thousand explodes among those that are insured and periodically inspected, and that the proportion is ten times as great among those uninsured and uninspected.

## Book Reviews

THE PREVENTION OF INDUSTRIAL ACCIDENTS. By Frank E. Law and William Newell. Published by The Fidelity and Casualty Company of New York. Paper, 104 pages, $5\frac{1}{4}$x$7\frac{1}{4}$ inches; 72 illustrations. Price, 25 cents.

This pamphlet, which has been gotten out for the benefit of, and is sent gratis to, policy holders, is a general treatment on accidents and their prevention, dealing with care on the part of employers and employees, safety devices, steam boilers, engines, electrical apparatus, elevators, the factory and wood-working machinery. The chapters on boilers and engines are particularly good, and well worth careful study on the part of engineers.

THE "MECHANICAL WORLD" POCKET DIARY AND YEAR BOOK. Published annually by Emmott & Co., Ltd., Manchester, England. Cloth; 208 pages, $3\frac{3}{4}$x6 inches; 67 illustrations; numerous tables. Price, 6d.

This is the twenty-third issue of this little book, which continues "little." It contains a lot of useful data in tabular form, but the text proper remains inadequate, considering the publication as an engineers' handbook. The Steam Turbine section is by far the best in the book; the reason for this is obvious when it is noted that that section was written by R. M. Neilson. The Boiler section is a close second, and its excellence arouses the suspicion that Mr. Neilson is also responsible here. The sections devoted to gas producers and internal-combustion engines are pitifully meager; the book would be improved by omitting them altogether.

THE "MECHANICAL WORLD" ELECTRICAL POCKET BOOK. Published annually by Emmott & Co., Ltd., Manchester, England. Cloth; 208 pages, $3\frac{3}{4}$x6 inches; 64 illustrations; numerous tables. Price, 6d.

This is a "companion piece" to the mechanical pocketbook reviewed above, and a very appropriate one. The section on Dynamos and Motors covers two whole pages and conveys the priceless information that shunt-wound machines have magnet coils wound with fine wire and connected in parallel with the external circuit; series-wound machines have coils of heavy wire connected in series with the load; compound-wound machines have both. There is not a word as to generation of e.m.f., development of torque, motor speed and generator load characteristics, regulation, heating, commutation, etc., *ad infinitum*—not even the statement that a direct-current machine has a commutator. And the preface states that "large additions have been made" to last year's edition. We should say that each section of the present book forms an excellent introduction to its subject, in future editions it might be well to say a little something about the subjects themselves.

ELEMENTS OF ELECTRICAL ENGINEERING. By Charles P. Steinmetz. Published by McGraw Hill Book Company, New York; 1909. Cloth; 455 pages, 6x9 inches; 239 illustrations. Price, $4.

This is the third edition of Dr. Steinmetz's excellent textbook, and it contains a considerable quantity of new material; the typographical errors of the second edition have been corrected, and the old material appreciably revised. The new material includes treatment of the "interpole" direct-current machine, the split-pole converter, three-wire commutating machines and the stability and regulation of induction motors.

While the book is intended solely for the use of students, it is to be regretted that Dr. Steinmetz has not revised it to the extent of giving the practical engineering equations commonly in use, as well as the abstract fundamental formulas from which they are derived. A student should be made familiar with the mathematical forms and processes used in everyday practice as well as the purely scientific principles. One of the most conspicuous examples of this defect is on page 14 where the author gives the fundamental formula for the generation of direct-current e.m.f.:

$$E = 4 f n \Phi$$

in which $f$ represents the magnetic frequency in the armature core in hundreds of cycles; $n$, the number of conductor turns in series, and $\Phi$ the magnetic flux per pole in megalines. This, the author states, is the "formula of the direct-current generator." So it is; but the reviewer has never known a designer who used it in that form. One who designs alternating-current machines constantly and a few direct-current machines sporadically might prefer it, but it is unwieldy at best.

Another characteristic which might have been remedied to the great advantage of the reader is the author's habit of explaining difficult subjects just far enough to convince the student that he can never overcome the difficulty, and leaving him there. The worst example of that sort is the discussion of direct-current commutation, which is scholarly as far as it goes but leads to no definite conclusion as to how one is to provide for successful commutation.

Again, in discussing the e.m.f. of an alternator the author says nothing whatever about the effect of the ratio of pole-face span to pole pitch and that of the ratio of coil span to pole pitch, the combination of which may modify the fundamental formula 20 per cent. or more. He introduces a wave-form factor and explains very briefly and generally what affects its value, but gives no specific figures based on pole-face span and c span ratios.

In short, the work is very uneven. discussing some vital features only barest outline of fundamental princip is given, while the discussion of so far less important features goes into pr tical engineering details to a degree necessary in a book of this kind.

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## Books Received

"Energy." By Sidney A. Reeve. Graw-Hill Book Company, New Y Cloth; 238 pages; 6x9 inches; illustrat indexed. Price, $2.

"Metal Spinning." By Prof. F. Crawshaw. Popular Mechanics, Chic Ill. Cloth; 80 pages, $4\frac{1}{2}$x7 inches; illustrations; indexed. Price, 25 cent

"The Steam Engine." By. Charles Benjamin. The Technical Press, Brat boro, Vt. Cloth; 316 pages, $5^{1}$ inches; 198 illustrations; tables; inde Price, $3.

"Handy Man's Workshop and I oratory." By A. Russel Bond. Mun Co., Inc., New York. Cloth; 467 pa 6x$8\frac{1}{4}$ inches; 370 illustrations; inde Price, $2.

"The Elements of Machine Desi Part 1. By W. C. Unwin Longm Green & Co., New York. Cloth; pages, $5\frac{1}{2}$x$8\frac{1}{2}$ inches; 387 illustrati indexed. Price, $2.50.

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## The National Tube Compan Catalog H

A reference library is an essential of the equipment of an engineer, b lot of the newest, best and practical formation for which he has the most quent use comes to him in the for circulars and catalogs. An engineer more frequent occasion to look up particulars of pipe and fittings, for stance, than the more abstruse info tion contained in pretentious handb

The National Tube Company, reco ing this, has made its new catalog such a character that it will grace shelves of any library and offer permanent and convenient form suc formation as an engineer is likely to regarding its product. The copy b us is something over the usual h book size, containing 470 pages h somely printed upon heavy paper, the being in a peculiar grade of green easy to read. The section devoted t Kewanee Union has an additional to indicate the brass parts. The en ings with which the book is replet mostly reproductions of wash dra and photographs, line engravings d only for diagrams giving the outlines fittings, with their dimensions, etc. page of classification, similar to the ontents" of the usual book, explains the n and scope at a glance and directs to the section in which he will find articular class of information, while a page index, liberally cross referenced, ects the searcher to the item sought. e tables of weights and dimensions of ught iron pipe and fitting, with the ne drawings, giving the dimensions conventional representation for fittings and valves, will make the book of ptional value to those who are en- ed in laying out piping. The book is dsomely bound in flexible pebbled her with gilt edges, and with the e of the recipient embossed in gilt n the cover. In its conception, plan execution it is one of the best ex- les of commercial literature that we e seen.

## Marine Engineers Entertainment and Ball

he annual entertainment and ball of t Marine Engineers' Beneficial Associa- t No. 33, Port of New York, was held Wednesday evening, December 8, at ngton opera house. The annual erings of this organization have al- s been great social successes, but this t far outclassed all previous efforts. decoration of bunting and floral de- s were very elaborate. Every seat in t all was taken when the curtain rose "Ye Olde Time Minstrels," by the "nch" from No. 33. Seated in a circle e front row were the M. E. B. A. f rites, Frank Martin, Jack Armour, J n Lloyd Wilson, Frank Corbett, Her- b Self, Joe McKenna, Billy Murray, J Forsman, Bob Webb and others. T nty-five members of the Bay Ridge A tic Club assisted in the choruses. udeville program of five numbers wed, at the conclusion of which the r was cleared for dancing. The ar- ment committee included William J. B is, Daniel Murphy and James J. rs. The grand march was led by nal President William F. Yates Mrs. Frank Corbett. Herbert Self t floor director.

## Commissions to Second International Congress of Refrigeration

hert M. Read, Washington, D. C., rman executive committee of the rican Association of Refrigeration, unces the completion of the Ameri- sections of the five international com- ions arranged for by the International Association of Refrigeration, ead- ters, Paris, France. These commis- s will undertake the study of questions brought up for consideration at the fir congress of refrigeration held in Paris last year and will prepare reports and recommendations on the various subjects for presentation at the Second International Congress of Refrigeration to be held in Vienna in 1910. The international commissions and American members of each are as follows:

Commission on Liquefied Gases and Units—Dr. D. S. Jacobus, chairman; Gardner T. Voorhees, Louis Block, Dr. J. E. Siebel, N. H. Hiller, Dr. Charles E. Lucke.

Commission on Methods of Testing Refrigerating Machinery and Insulating Material—John E. Starr, chairman; P. D. C. Ball, George H. Stoddard, Henry Torrance, Jr., R. H. Tait, Conrad H. Young.

Commission on General Application of Refrigeration—H. C. Gardner, chairman; Louis Doelling, Madison Cooper, Ezra Frick, A. Ruemmeli, Dr. Mary E. Pennington.

Commission on Railway and Steamship Refrigeration—E. O. McCormick, chairman; J. M. Culp, W. D. Biddle, Carl Howe, G. Harold Powell, E. F. McPike

Commission on Legislation—W. H. Gibson, chairman; Walter C. Reid, H. W. Bahrenburg, Emerson Carey, Charles L. Case, J. F. Nickerson.

The committee on Papers and Lectures is now at work on the preparation of papers to be presented at the second international congress of refrigeration in Vienna, September 29 to October 3, 1910. The committee is as follows: Gardner T. Voorhees, chairman, Engineers' Club, 32 West Fortieth street, New York City; Dr. D. S. Jacobus, John E. Starr, Henry Torrance, Jr., F. W. Pilsbry, G. Harold Powell, J. F. Nickerson.

Anyone desiring to prepare a paper on any subject pertaining to refrigeration for presentation at the Vienna congress is invited to communicate with the chairman of the above committee.

## Society Notes

On December 7 an interesting lecture on "Refrigeration" was delivered before the Modern Science Club of Brooklyn, N. Y., by Prof. A. G. Koenig. Many lantern slides were shown, illustrating the various systems in use, as well as the designs of several makes of machine.

## Personal

G. Brewer Griffin has recently been appointed manager and is directing the sales policy of the detail and supply sales department of the Westinghouse Electric and Manufacturing Company, in which department transformers, meters, fans, heating appliances, switches, switchboards, railway line material, etc., are sold. Mr Griffin has been assistant manager of this sales department for six years past, having previously been connected with the sale of detail apparatus in the Boston office.

## Engineering Societies

### AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., Jesse M. Smith, New York, N. Y.; sec., Calvin W. Rice, Engineering building, 29 West 39th St., New York.

### NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Wm. C. L. Eglin, Philadelphia, Pa.; sec. and treas., John F. Gilchrist, 139 Adams St., Chicago, Ill. Association headquarters, 29 W. Thirty-ninth St., New York.

### ENGINEERS' CLUB OF PHILADELPHIA

Pres., W. P. Dallett; sec., W. P. Taylor, 1317 Spruce St. Regular meetings 1st and 3d Saturdays.

### AMERICAN SOCIETY OF NAVAL ENGINEERS

Navy Dept., Washington, D. C. Pres., Rear Admiral John K. Barton (retired) U. S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N.

### AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, Cleveland, O.

### WESTERN SOCIETY OF ENGINEERS

Pres., Andrews Allen; sec., J. H. Warder, 1737 Monadnock Block, Chicago, Ill.

### ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., George T. Barnsley; sec., E. K. Hiles, 803 Fulton building, Pittsburg, Pa. Meetings 1st and 3d Tuesdays.

### AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., Louis A. Ferguson; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly, excepting July and August.

### ENGINE BUILDERS' ASSOCIATION OF THE UNITED STATES

Pres., A. L. Merriam, Oswego, N. Y.; sec., C. H. Sembower, Reading, Pa.

### UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, W. S. Cadwell, Chicago, Ill.; sec., Thomas H. Jones, 214 Eighth street, N. E., Washington, D. C. Next convention, Buffalo, N. Y., August, 1910.

### NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., William J. Reynolds, Hoboken, N. J.; sec., F. W. Raven, 525 Manhattan building, Chicago, Ill. Next convention, Rochester, N. Y., September, 1910.

### AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next convention, Philadelphia, Pa., June, 1910.

### OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; sec. and treas., Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio.

### MASTER STEAM BOILER MAKERS' ASSOCIATION

Pres., J. H. Smyth; sec., Geo. M. Clark, 1337 N. Maplewood Ave., Chicago, Ill.

### INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., Robert A. McKee, Peoria, Ill. Next convention, Denver, Colo., September, 1910.

### NATIONAL DISTRICT HEATING ASSOCIATION

Pres., A. C. Rogers, Toledo, O.; sec. and treas., D. L. Gaskill, Greenville, O.

## Business Items

G. L. Simonds, who for several years has handled the western agency for a number of steam specialties, has recently associated with himself as partner Clayton Tracy under the firm name of G. L. Simonds & Co., with offices at 12[illegible]1 Monadnock block, Chicago. The company will continue as exclusive western agents for Vulcan soot cleaners, Ideal flue blowers and Dean boiler tube cleaners.

Paul M. Chamberlain desires to announce that he has opened an engineering office at 1522 Marquette building, Chicago. Mr. Chamberlain was graduated from the Michigan Agricultural College in 1888, and from Cornell University in 1890. For several years he was in practical work with the Brown Hoist Company, of Cleveland, Ohio; the Frick Company, engineers, of Waynesboro, Penn.; the Hercules Iron Works, of Aurora, Ill., and then accepted the assistant professorship of mechanical engineering at the Michigan Agricultural College. At the opening of the Lewis Institute in Chicago, he took charge of the engineering work. During his connection with the Lewis Institute he carried on much consulting work with special reference to power production and factory methods. He resigned this position to act as consulting engineer for the McCan Mechanical Works, of Los Angeles, Cal. Later he accepted the position as chief engineer of the Under-feed Stoker Company of America, where for the past two years and a half he has made a special study of boiler-room equipment, economy in fuel burning and smoke abatement. He will devote his time to new designs and improvement of existing installations.

The E. Keeler Company, Williamsport, Penn., has been awarded the contract by the Pennsylvania Railroad Company for three 408-horsepower Keeler water-tube boilers built for a working pressure of 180 pounds per square inch. These boilers will be equipped with Green chain grate stokers and the setting will be especially designed for this installation for the elimination of smoke in burning soft coal. This contract includes a self-supporting steel stack lined with brick throughout its hight together with the smoke flues and the brick settings for the boilers. This equipment will be installed in the new classification yards at Northumberland, Penn. This company has also received an order from the United States Engineer Office, at Boston, Mass., for three 150-horsepower water-tube boilers to be installed in fortifications at Manila. These boilers will be equipped with superheaters. This contract follows a contract for six boilers which was placed early in the year. These boilers are now being installed at Fort Scott, Cal., Fort Stevens, Ore., and Fort Casey, Wash. The Keeler company has also been awarded the contract for one 500-horsepower water-tube boiler for the water department for the city of Fort Worth, Texas.

## New Equipment

New water works is to be erected at Johnson City, Tenn.

Jas. Gottbreht will erect an electric-light plant at Dunseith, N. D.

Peter F. Dorscel will erect a cold-storage plant at Green Bay, Wis.

Plans are being drawn for a new municipal power station at Sturgis, Mich.

The Electric Light and Power Company, Tiffin, Ohio, is enlarging its plant.

The Rockefeller Institute, New York, is erecting an addition to its power plant.

The Brockton Hospital, Brockton, Mass., is having plans drawn for a new building.

The Decatur (Texas) Ice Company is considering the enlargement of its plant.

The New Richmond (Wis.) Roller Mills Company will erect an 800-horsepower water-power plant.

The Clarenden (Texas) Water Works and Light Company will shortly be in the market for some equipment.

The Stroudsburg & Water Gap Street Railway Company, Stroudsburg, Penn., will erect a new electric power station.

The Pike County Water Works Company, Murfreesboro, Ark., is having plans prepared for a new pumping plant, which, it is said, will be one of the largest in the Southwest.

The Kansas City (Mo.) Steel Scraper Manufacturing Company has taken over the business of the Slusser-McLean Scraper Company, of Sidney, Ohio, and will erect a new plant, to cost about $750,000.

## New Catalogs

Keuffel & Esser Company, Hoboken, N. J. Circular. Blueprint papers. Illustrated.

A. L. Ide & Sons, Springfield, Ill. Bulletin No. 15. Ideal engines. Illustrated, 12 pages, 8x10½ inches.

Hoppes Manufacturing Company, Springfield, Ohio. Catalog No. 40. Feed water heaters, purifiers, steam separators, oil eliminators, exhaust heads. Illustrated, 40 pages, 6x9 inches.

## Help Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

AGENTS WANTED to sell Buckeye lubricating compound on a commission basis. Buckeye Compound Co., Pittsburg, Penn.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

ESTABLISHED New York concern ha lling well known steam specialties, desires tive partner with capital to enlarge; unq tionable honor required. Box 93, POWER.

CHIEF DRAFTSMAN, thorough experie in power plant construction, including ste equipment, building construction and electri apparatus will be required, together with a ity to handle men; state salary expected, a nationality, experience in full and give erences. Address Construction Departm Consolidated Gas Electric Light and Pov Company, Baltimore, Md.

## Situations Wanted

*Advertisements under this head are serted for 25 cents per line. About six wo make a line.*

SITUATION WANTED by a gas engin experienced on two and four cycle gas gines, also on suction and pressure ducers and can furnish first-class referen Address "C. W. 86," care POWER.

WANTED—Position as oiler or wiper; a little experience; International Correspo ence School education. Francis R. Shaw Moffat Ave., Trenton, N. J. R. F. D. No

WANTED—Position in electric light water works by college graduate in engin ing; unlimited license; ten years handl alternating- and direct-current machines, densing and noncondensing engines, pum filter plants, wiring and pipe work; best references. "Engineer," Box 88, POWER.

SITUATION by chief engineer and chanic, employed at present in large elec light and power plant operating high and pressure with alternating and direct curr generators; this is the class of work I daily: Drafting, forging, all-around machi work, alternating and direct current electr work, pipe fitting and patternmaking; rea for changing is to better my conditions. 92, POWER.

## Miscellaneous

*Advertisements under this head are serted for 25 cents per line. About six wo make a line.*

PATENTS secured. C. L. Parker, Solic of Patents, 4 McGill Bldg., Washington, D

ANY FIRM or engineer in charge o steam plant that is troubled with scale in boilers can get absolutely free, the best l cator and reducing wheel made, with vel lined mahogany case. For particulars, dress Great Lakes Chemical Works, Man woc, Wis.

JOBBING MACHINERY Supply Comp in Middle West, operating large and w equipped machine shop, desires to manu ture some article of merit in the line of chinery or mill supplies; have excellent cilities for pushing sales. Anyone with good article but without facilities to ma facture, write to Box 82, POWER.

## For Sale

*Advertisements under this head are serted for 25 cents per line. About six wo make a line.*

FOR SALE—20x48 Wheelock engine two 72"x18' high pressure tubular boilers good condition cheap. Address "Engine Box 2, Station A, Cincinnati, Ohio.

FOR SALE—24x48 Hamilton Corliss gine, $1250; 23x60 Harris Corliss eng $1150; 22x42 Harris Corliss engine, $1 18x36 Bass Corliss engine, $950; 1 Cooper Corliss engine, $850; 10½x30 Ha Corliss engine, $475. Duzets & Son, 50 Ch St., New York.

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Cooper Co., C. & G. ....
Crocker-Wheeler Co. ....
Crosby Steam Gage & Valve Co. ....

# Large Mine Hoisting Engines

## Deals with Several Types of Large Mine Hoisting Engines, Some of Which Are the Largest and Most Powerful of Their Kind in the World

### BY WARREN O. ROGERS

Unless one has given the matter atten- n, or has visited the coal and copper ines in the United States, only a vague dea can be conceived of the propor- n hoisting engines have attained. Most ngineers hold the hoisting engineer and ngine in about the same esteem that they ld a sawmill steam plant—unworthy of ecognition. Such views are erroneous, th regarding the engines and the men erating them, as the engines are both rge and powerful and somewhat compli- ated, owing to the steam-operating de- ces used to work the reversing gear, iction and brake. And there are few gineers who shoulder greater respon- ility than the men who are employed operating large hoisting engines.

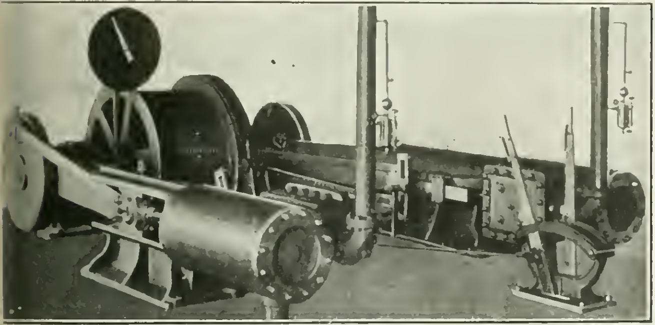


FIG. 1. FIRST-MOTION HOIST

Mine hoisting engines are made in vari- is designs, first- and second-motion en- nes being generally used in steam-op- ated hoists, while electrically driven ists are fast finding a foothold.

#### First- and Second-motion Hoist

A simple type of first-motion hoisting gine is shown in Fig. 1. It consists of o engines connected to one crank shaft which the winding drum is secured. he cranks are set 90 degrees apart, so ere is no dead center. In this type of gine slide valves are used in conjunc- n with the link motion, the engineer trolling the brake and links by means the two levers shown. Other than this, engine is constructed along lines nd in the general run of slide-valve gines. This design is manufactured by the Nelsonville Foundry and Machine Company.

Another design of hoisting engine of the single-drum, second-motion type is shown in Fig. 2. Instead of the winding drum being keyed to the crank shaft of the engine it is keyed to a drum shaft proper, which receives its motion by means of double-helical gears, as shown. The brake and reversing gears are operated by the hand levers shown between the cylinders. It represents one of the designs of hoisting engines made by the Lidgerwood Manufacturing Company.

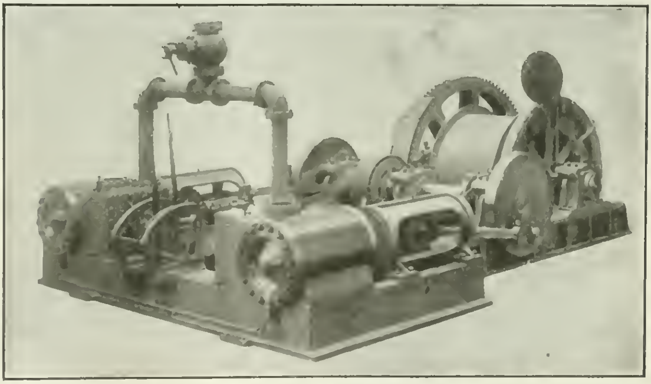


FIG. 2. SECOND-MOTION HOISTING ENGINE

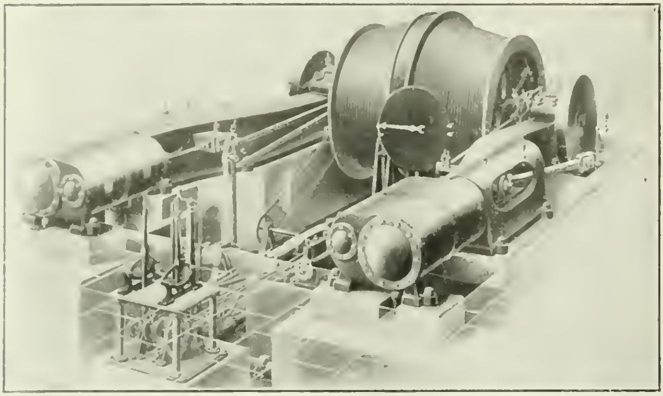
A different design of first-motion hoist is shown in Fig. 3. Here the winding drum is of the double-cone design, and is made in this way so that the rope in winding will always keep at a proper angle with the sheave wheel on top of the head frame over the shaft, and also equalize the strain on the engine when starting with the cage at the bottom of the shaft, and the weight of hundreds of feet of wire cable pulling on the drum. This illustration also shows a phantom view of the steam-operating mechanism for reversing and operating the brake and clutch.

These steam-operating devices are generally made with two cylinders having piston heads attached to a common piston rod, to which is secured a crosshead, which in turn imparts motion to an arm secured to a rock shaft, which in turn, by means of suitable links, operates the link up and down or tightens or loosens the brake or friction, as the piston of the auxiliary engine is forced from one end of the cylinder to the other. The steam valve is operated from the operator's stand by means of suitable levers and operating rod. This engine is made by the Vulcan Iron Works.

#### Cone-drum Hoist

The type of engine shown in Figs. 4 and 6 is what is known as a haulage engine, but can be utilized for hoisting from a shaft, as well as hauling out of an incline or drift, by simply changing from a straight to a cone drum. The en-

[illegible] during the hauling, drum depends on the friction brake which is thrown into [illegible] by heavy [illegible], commonly [illegible] as the umbrella type of [illegible], which throw the friction shoe [illegible] on the inside



[illegible] 3. CONE-DRUM HOIST EQUIPPED WITH STEAM-OPERATED BRAKE, CLUTCH AND REVERSING GEAR

flange of the main drum. This clutch proper is operated by two wrought-iron forged arms, which receive their motion from a lay shaft manipulated by a standard cylinder, as shown. The friction shoes are capable of hauling a load considerably in excess of what the engine can pull, making it impossible for any slip. The size of the cylinder of this particular engine is 24x48 inches

When dropping the cage and the empty car in the shaft, or running it down an incline, the clutch is thrown out and the drum runs loose on the shaft. A brake band is so arranged on the outside of the drum flange that it can catch the load

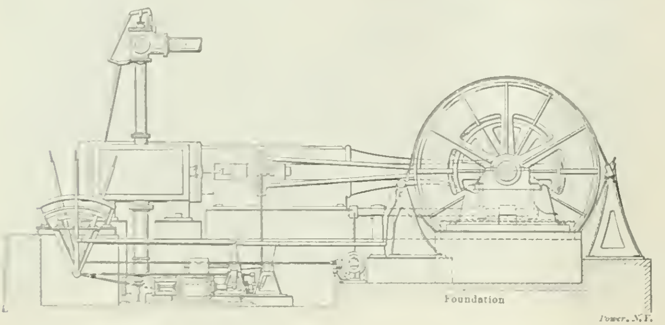


FIG. 4. ELEVATION OF HAULAGE ENGINE

at any point, thereby placing the cage and the car entirely in the hands of the operator, which he can drop at will, or at any speed he deems necessary.

The clutch on the inside and the brakes on the outside are manipulated by means of steam cylinders, the Stephenson reversing link is also operated by the same method. In fact, all the main parts are controlled throughout by steam cylinders which make them very easy for the operator to handle, by simply manipulating the levers which control each part of the engine. This design of engine is built by the Litchfield Foundry and Machine Company.

### Steam Auxiliaries

A study of Figs. 4 and 6 will give a very good idea of how the various stea auxiliary control are governed by t operating levers, and connected to t brake, clutch and link, respectively.

The auxiliary engines for steam reve consist of a steam cylinder set in tand with an oil-governing cylinder and t differential valve mechanism so arrang that the piston moves from one end of stroke, smoothly and without jar. T oil serves as a locking device to hold t links in positive position, determined the position of the operating lever.

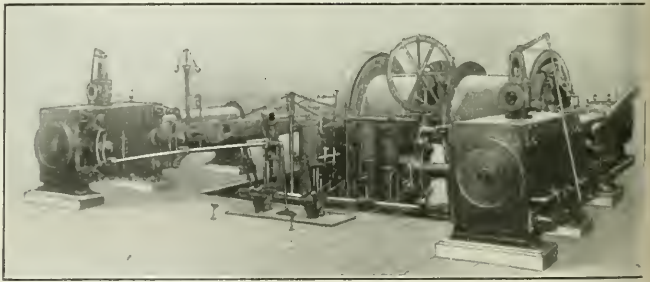


FIG. 5. CORLISS FIRST-MOTION HOISTING ENGINE

The illustrations, Figs. 5, 7 and 9, p sent the design of a first-motion hauli engine recently installed at the new mi of the Oak Hills Coal Company, Co The load that this engine will eventua be called upon to handle will be a tr of 14 cars, each loaded car weighing ( pounds, up a slope of approximately degrees from the horizontal, which w be about two miles long. The engi will work under a pressure of 125 pour per square inch.

The engines, as shown in the illust tions, consist of a pair of heavy Corl first-motion engines, having cylinders inches in diameter, and a stroke of inches, the cylinders being fitted with new design of nondetachable valve ge with a separate wristplate at each end the cylinder. These are connected to a operated by a pair of Gooch links, a the cutoff is adjustable from zero up 7/8 of the stroke. This is accomplis by shifting the block in the link, wh is actuated by the action of the gover upon the reverse cylinder centrally cated, and which is connected direct the main shaft. The governor is enti automatic and independent of the reve ing lever, or the operator. Direc mounted upon the engine shaft, which 15 inches in diameter, through the dru and middle bearings, are two main ha ing drums 7 feet in diameter and 5 f face, having an ultimate capacity of t miles of 1¼-inch hauling rope. T drums are coupled to the engine means of heavy band friction clutc and each drum is also provided with powerful hand brake for controlling descent of the empty cars into the mi

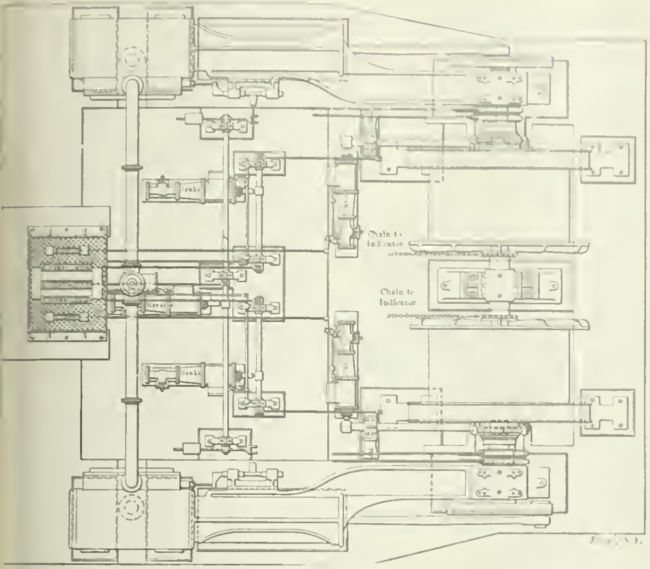


FIG. 6. PLAN VIEW OF HAULAGE ENGINE

he brakes are of the gravity type, op-ated by weights by means of which the rakes are constantly applied except hen relieved by means of vertical op-ating steam cylinders, shown in the il-strations. These cylinders, as well as se for working the clutch and the re-rse motion are equipped with cataract linders and differential valve gears, by ans of which the motion of the cyl-der corresponds to that of the hand ver on the engineer's platform.

The location of the cars on the slope indicated by a large dial indicator iven by a gear directly on the hub of h drum. Each cylinder is provided th a balanced poppet throttle valve and addition is fitted with bypass valves pipe operated by a foot lever on the gineer's platform, thus enabling him to ntrol the speed of the engine when lowering the empty cars. This hoist is manufactured by the Wellman-Seaver-Morgan Company.

### LARGEST HOISTING ENGINES IN WORLD

The largest hoisting engines in the world are to be found in the copper country of Michigan, where are located the Quincy and Tamarack hoists, built by the Allis-Chalmers Company in the nineties. Both of these hoists have two horizontal steam cylinders, each connected to a crank on either end of a shaft, carrying a single drum. The Quincy hoist has the larger steam cylinder, which is 52 inches in diameter and 48-inch stroke. The Tamarack hoists have the larger drum, which is 36 feet 9 inches in diameter in the center by 25 feet 6 inches.

The Quincy hoist was designed for pulling a load of 20 tons, up a 7500-foot slope at the rate of 3000 feet per minute.

Since these engines were designed new methods and ideas have been developed. These engines operated the hoists in the days of the slow-speed Corliss type, when single drums of large diameter were used with large steam cylinders. The high-speed Corliss engine, however, brought about changes in the size of hoist, not only in the cylinder diameter but also the diameter of the drum; the single drum in balance hoisting is also being superseded by the double drum for deep shaft hoisting. Since these changes were instituted, many hoists of equal power and several of considerable greater power have been built. Among these are the 34x72-inch duplex, single-drum hoists recently furnished the Oliver Iron Mining Company for their Chapin mine at Iron Mountain, Mich., and two 32x72 duplex double-drum units built three years ago for the Boston & Montana Consolidated Copper and Silver Mining Company, at Butte, Montana.

The Boston & Montana hoists, one shown in Fig. 8, are the most powerful hoists ever built. They were each designed

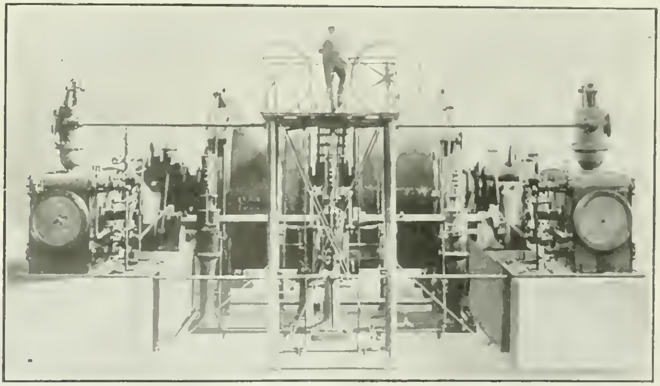
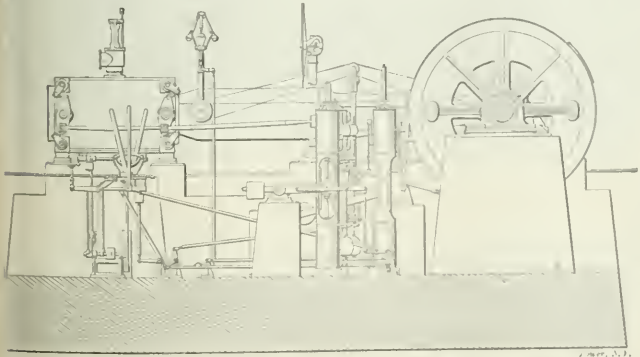


FIG. 8. MOST POWERFUL HOIST EVER BUILT



G. 7. SHOWING AUXILIARIES FOR OPERATING REVERSING GEAR, CLUTCH AND BRAKE that a dead load of 17 tons unbalanced out of a 3500-foot vertical shaft at the rate of 2500 feet per minute. They were designed to run at the rate of 64 revolutions per minute, but owing to the greater output of one of the shafts, one has been operated, it is stated, regularly for the two years at 90 revolutions per minute,

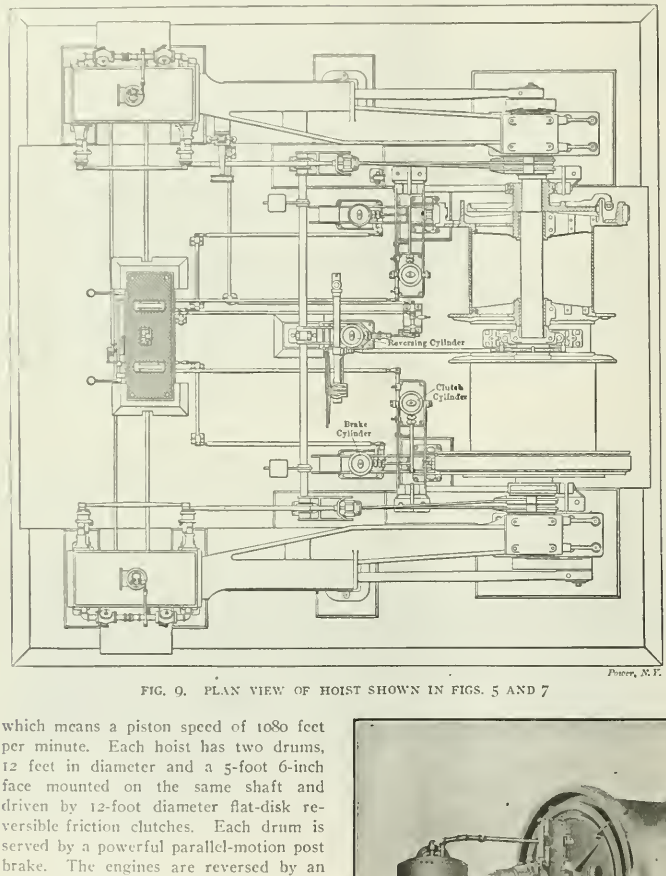


FIG. 9. PLAN VIEW OF HOIST SHOWN IN FIGS. 5 AND 7

which means a piston speed of 1080 feet per minute. Each hoist has two drums, 12 feet in diameter and a 5-foot 6-inch face mounted on the same shaft and driven by 12-foot diameter flat-disk reversible friction clutches. Each drum is served by a powerful parallel-motion post brake. The engines are reversed by an improved type of Sell spur-gear reverse. Two 10x10-inch and two 12x24-inch and one 12x24 inch auxiliary engines operate the clutch brake and reverse respectively. These auxiliary engines consist of a steam cylinder, opposed to an oil cataract cylinder, the latter controlling the steam piston in any position set by the operator, who thus has complete control of all the moving parts of the hoist. From the operating platform between the main steam cylinders, the operator, by means of small hand levers, manipulates the main throttle valve, clutches, brakes and reverse, while the hands on the 60-inch dial (miniature) just before him tells the precise location of the cage in the shaft

### Largest Electric Hoists

The electric hoist is being used in many places and one design of such is illustrated in Fig. 10. It has a drum 78 inches in diameter by 60 inches in length and is designed for a rope pull of 10,000 pounds at a speed of 1000 feet per minute. It weighs without the motor 55,000 pounds. It is equipped with a Westinghouse hoist motor, having a constant rating of 150 horsepower, which gives it an intermittent hoist rating of about 300 horsepower. The motor is connected to the hoist by means of a flexible coupling on the pinion shaft.

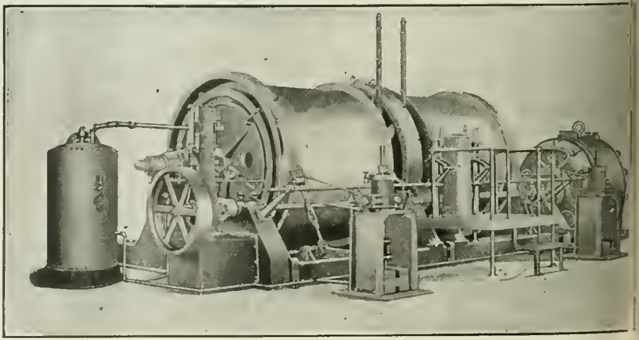


FIG. 10. ELECTRIC HOIST

The hoist is equipped with air-operated hand brakes and clutches, the air being furnished by a small air compressor connected directly to the hoist by means of a flexible coupling on the pinion-s ft extension. This is shown in the illus tion.

In the case of the clutches, the st n or air throws the clutch either in or t, but the brakes are arranged to be l on by a heavy-weighted lever, and leased by the steam or air in the ope ing cylinder raising these weights, t s insuring the immediate and autom e setting of the brake in case of accid to the pipes.

A special regulating device controls speed, with which the brakes or clut can be thrown on or off, which prev slamming of the clutch or brake and consequent sudden jars.

This is the largest design of elec hoist manufactured by The George Le Engineering Works Company.

The coal-shipping terminal at Sew Point, near Norfolk, Va., of the ne opened Virginia railway is operated novel manner and contains some inter ing machinery, including a 1000-ho power electric hoist designed and l by the Lidgerwood Manufacturing C pany, Fig. 11.

As soon as each coal-conveyer ca loaded, it is taken in hand by the h which, by means of a barney car, dr it up a 25-per cent. incline at a spee 480 feet per minute. The incline is feet long, and it takes 45 seconds for car to reach the knuckle.

The Lidgerwood electric hoist, sai be the largest of its kind ever built, which hauls the conveyer cars up the cline, is an interesting part of the eq ment. Each conveyer car, with its l weighs nearly 200,000 pounds. The h complete, with its two motors, we 180,000 pounds. But one motor is use at a time, the other being provided to sure constant operation in case of br down to either one. The motors ar of the General Electric Company's make of the M. P. C. class, and are rated at horsepower each and actually develop horsepower, it is said. The drum is iches in diameter with a face 42½ iches in width and grooved for a 4-inch main cable and having also a tion with a 7-inch face grooved for a inch tail rope for insuring the return the barney car. The flanges are 6 hes in depth, the main gear wheel is 0 inches in diameter, and the pinion hich drives it is 19 inches in diameter. e intermediate gear wheel is 72 inches diameter with a 21-inch pinion. All e gears are of cast steel with machinet teeth.

The drums have powerful post brakes ich are controlled by a solenoid rough the medium of compressed air. compressed air is supplied at a presre of 80 pounds to the inch by an elec- compressor which forms part of the isting outfit. The general operation of hoist is controlled by an operator near barney-car pit, 350 feet distant from hoist, but the hoist is provided with emergency limit switch which makes rtain that it cannot overwind in either ection. The brake is set by a weight 1400 pounds acting upon a suitable er When the current is turned on, solenoid acts, and by means of comessed air, releases the brake. When current is cut off, whether by intent accident, the solenoid drops, releasing air, and the weight brings the brake action, holding the load safely in any sition.

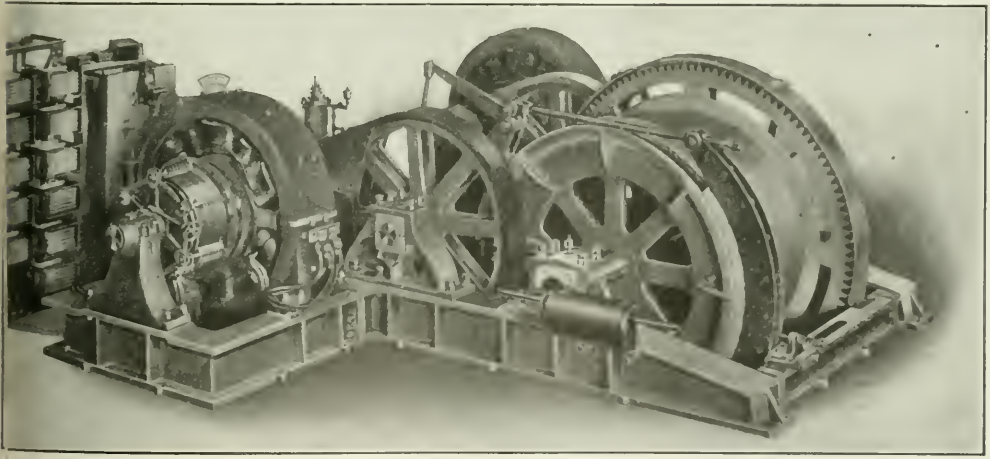


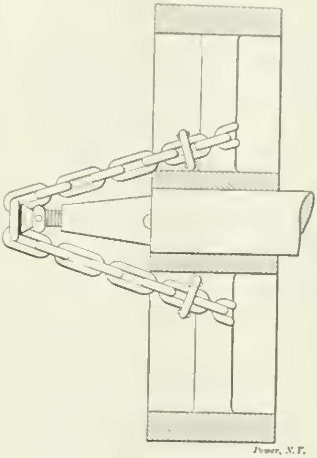
FIG. II. LARGEST ELECTRIC HOIST EVER BUILT

y such ingenious devices as illustrated al described in the foregoing, the vast per in hoisting engines is not only nessed, but absolutely subjected to the l of the operator as he watches the es, climbs from level to level, some them at the rate of 2500 feet per min- or approximately 30 miles an hour.

# A Handy Method of Removing a Flywheel

By J. A. Seager

It sometimes occurs in engine erection that after a flywheel shaft governor or similar gear has been driven on to the shaft it is found to be too tight and considerable difficulty is experienced in removing it again. The flywheel usually fits close up to the bedplate or the end bearing and it is found impossible to get at the part to be moved from the inside in the usual manner with a block of wood and a hammer to drive it off again. Moreover, in driving the wheel off the shaft with a heavy hammer there is danger of burring the shaft, and possibly cracking the casting, owing to the jamming effect caused by the displacement of the fit alternately on the top and bottom sides.



METHOD OF REMOVING FLYWHEEL

The accompanying sketch illustrates a very good method of removing such a flywheel. A strong chain is passed round one of the spokes close down to the boss and back through the end loop. Against the end of the shaft an ordinary screw jack is set horizontally and the chain is brought over the end of this, with a piece of hardwood under the link to prevent the chain from slipping off the jack. The free end of the chain is then passed around the spoke opposite the one already slung, and secured either by a shackle or by sticking the end link of the chain through an intermediate link and securing it by means of a bar or spanner inserted in the end of the link. By screwing up the jack steadily an even endwise pull will be exerted on the wheel and it will come off quite easily.

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Where for any reason a feed-water heater is not used, the feed pipe should be continued inside the boiler in order that the water may be warmed as much as possible before it is discharged into the boiler. In fact, it is best to do this even when a feed-water heater is used. The feed water should be discharged at a point where it will not chill the shell, and where the scale deposited will work the least possible mischief.

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In one of the coal deposits near Rockwood, Penn., it is said that a unique discovery of vanadium in appreciable quantity has been recently made. Details of the new discovery are not available.

## Engine-Room Suggestions

"Cleanliness is next to godliness," it is said, and this applies to the engine room. As a hint to those who wish to keep their engine floors as clean as possible, the following is given. A McIntosh & Seymour engine, of the tandem-compound type, has the valve stem on the high-pressure cylinder on one side of the engine and the valve stem of the low-pressure cylinder on the other. Naturally the high-pressure valve stem is more difficult to keep tight and some water is bound to leak out past the packing onto the floor, unless prevented. The engineer fitted a flat tin pan to the low-pressure cylinder so that it came under the stuffing box of the high-pressure valve stem. The pan was fitted with a drip pipe which carried the water away.

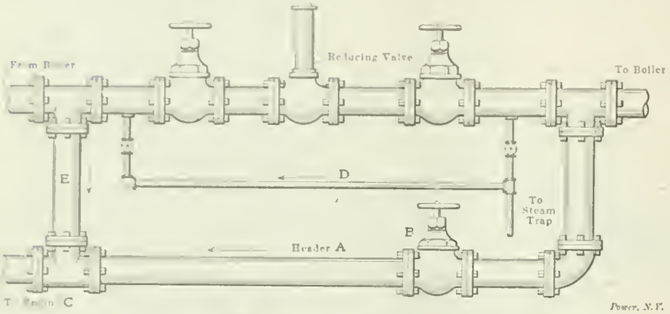
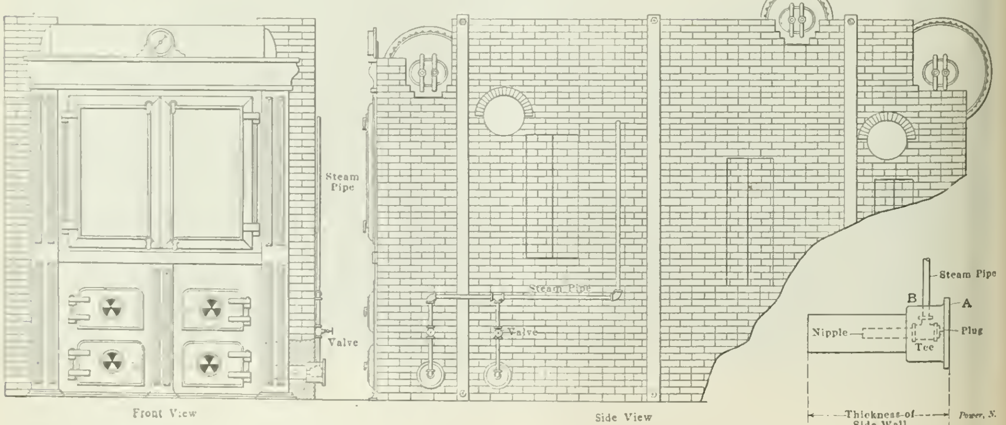


FIG. 1. LAYOUT OF PIPING

In this same plant the engineer had trouble with floods of water coming over at intervals into the cylinders of the engines. This trouble remained a mystery for some time until it was discovered that the reducing valve shown in Fig. 1 was not performing its function. The layout of the pipe work is shown. The engine was supplied by means of duplicate pipes with the valve *B* between the cross pipes running to the engine header *A*. In the boiler room were placed two gate valves, with a reducing valve between. This valve was supposed to be set so that the steam pressure on each side would always be the same, but it did not work as was anticipated, and as a consequence, engine *C* was being fed the full capacity of the 1¼-inch pipe *D*, the steam blowing in the direction of the arrow, the valve *B* being closed. This prevented water of condensation from getting to the trap; it was carried over into the pipe *E* and on to the engine. Opening the valve *B* stopped the trouble.

The boiler capacity in this plant was low at times of heavy load, and as a remedy the engineer made the homemade steam jet, shown in Fig. 2. It consisted of a piece of 6-inch pipe, and bell end, just long enough to reach through the side wall of the boiler setting, the 6x8-inch reducing bell *A* forming a shoulder against the outside of the wall. A ⅜-inch pipe was screwed in at *B*, extendi down to the center of the 6 inch pipe. tee was screwed on, in which a sho piece of pipe was fitted, the inner e being left open and the outer fitted wi a plug, for the purpose of cleaning t pipe in case it became clogged. The inch pipe extended up and over to steam pipe. Each furnace was fitted wi two steam jets, and the device gave much better draft than was procura with natural means, and helped out case of heavy overloads.



Front View

Side View

FIG. 2. ARRANGEMENT OF HOMEMADE STEAM JET

## The Resolution of Forces as Appli to a Connecting Rod

### By C. S. McGinnis

There are some puzzling queries in m chanics. Just ask a college sophomo this question: If a man pulls ten poun on a rope and his brother pulls ten poun on the other end, what is the tension the rope? If he says twenty pounds, immediately numbers himself among t unfortunate, but if he correctly says te pounds, you may oftentimes cool his e thusiasm by asking him to explain why.

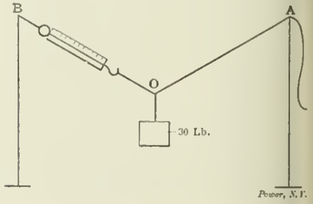


FIG. 1

This "resolution of forces" is one the most fundamental factors in the whol subject of mechanics, but its applicatio cannot be said to be difficult. A knowledge of mechanics is not at all necessary to understand it, and its simple application will help us out of many a puzzling situation. When steam pushes against a piston rod there are certain positions where

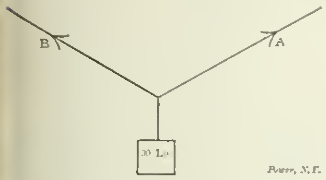


FIG. 2

the resulting thrust of the connecting rod is even greater than the total force of the steam pushing on the piston. Of course, the unknowing will say that such must be impossible, for certainly no force can produce another greater than itself.

On the contrary, this state of affairs is strictly possible, for no new energy has been created. When any force acts through a distance, such as the pressure of the steam pushing the piston rod, an amount of work is done equal to the force in pounds multiplied by the distance in feet that the piston rod travels, and this result is in foot-pounds of work. Now, barring friction, a thrust in pounds is brought into play along the connecting rod, and this when multiplied by the distance in feet passed over (in the direction of the thrust), gives the work in foot-pounds done by the connecting rod. This work must be *equal* to the work done by the steam pressure on the piston rod. So if, in the latter case, the number of pounds thrust be greater than the steam pressure, the distance moved through by the thrust must accordingly be less than the distance traversed by the piston.

The commonest case is that where

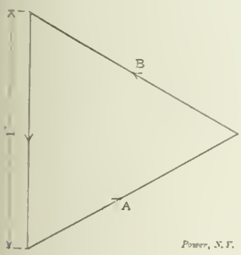


FIG. 3

hree forces act upon a body, say its veight and the tension in two strings vhich support it. Place two vertical posts n position connecting their two ends *A* nd *B* by a string from which a weight of, say, 30 pounds is suspended; also insert an ordinary spring balance as shown in Fig. 1.

Start with string *AOB* as long as possible and the balance will register something over 15 pounds, or if the string were long enough or the posts very near together, it would be exactly 15 pounds, each string withstanding half the weight. If the string at end *A* be now raised up, the balance will read more and more so that when the string makes an angle of 30 degrees with the horizontal, the reading will be just 30 pounds. If, now, the string *AOB* is shortened still more, the reading is greater than 30 pounds and continues thus to increase. The 30-pound weight has then brought into play a force greater than itself and the greater the angle *AOB* the greater this force becomes. Just like swinging in a hammock; if there is not enough sag in the rope, something is liable to give way.

For any particular position (see Fig. 2) we can tell definitely what the tensions or stresses in the strings are by a "force diagram." Let the three forces be represented by three straight lines each drawn in the direction its respective force is acting, and let 30 pounds be represented by a line one inch long. Thus, a triangle of forces results whose side *A*, in inches, multiplied by 30 gives the stress in *A*, while similarly the side *B*, in inches, multiplied by 30 gives the stress in *B*.

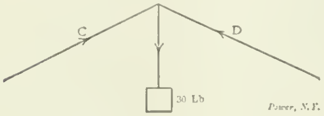


FIG. 4

We need not limit the forces to strings. Take two rigid bodies like two rafters abutting, as in Fig. 4, and hang the 30-pound weight from the apex. Then the directions of the three forces meet at the apex, and the "force diagram" will appear as in Fig. 5, so that as before, the thrusts *C* and *D* are obtained by measuring *C* and *D* and then multiplying each measurement in inches by 30.

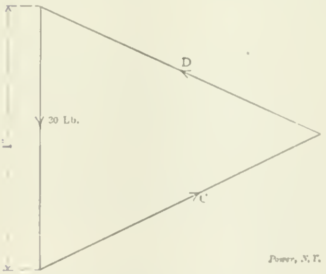


FIG. 5

If, on the other hand, the angle between the forces *C* and *D* at the apex is great, the forces *C* and *D* will be correspondingly great, perhaps much more than 30 pounds. In any case, as was explained under Fig. 1, each thrust *C* or *D* must be greater than 15 pounds. But each rafter supports just half the weight, or exactly 15 pounds, so thus considering just half the figure, we have a condition such as is shown in Fig. 6, where the force *D* is greater than 15 pounds.

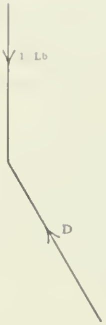


FIG. 6

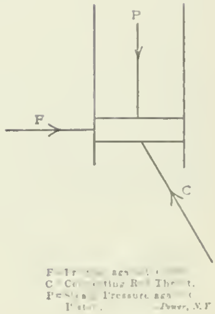

P
F
C
F = Friction against Guides.
C = Connecting Rod Thrust.
P = Steam Pressure against Piston.
Power, N.Y.

FIG. 7

This, then, is similar to the mechanism of the steam cylinder. Instead of the other rafter which gave a lateral support we have friction on the guides over which the crosshead runs and so giving a result as shown in Fig. 7. But we must remember that it is impossible to draw a "force diagram" of the conditions when the piston is in motion, i.e., when the forces are not in equilibrium. It is only when the body is at rest that a "force diagram" can be used.

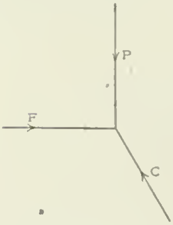


FIG. 8

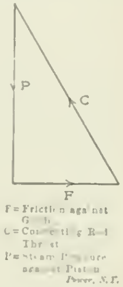

P
C
F
F = Friction against Guides
C = Connecting Rod Thrust
P = Steam Pressure against Piston
Power, N.Y.

FIG. 9

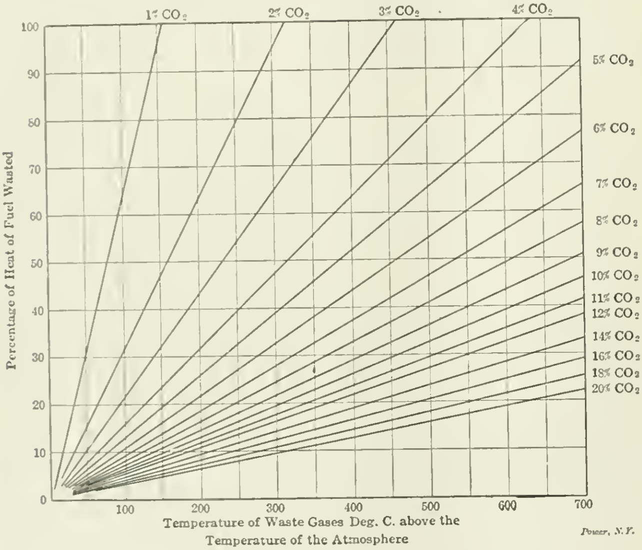
If one should hold the connecting rod tightly by a brake, thus preventing all motion, the diagram previously used in Fig. 7 would appear as in Figs. 8 and 9.

# Waste Due to Imperfect Combustion

By A. D. Williams

It is well known that the amount of $CO_2$, or carbon dioxide, is an approximate index of the fuel economy obtained in the furnace. It is not, however, of itself an indication of what is wrong, but merely that something is wrong, and it is necessary to know the amount of nitrogen, oxygen and carbon monoxide present in the waste gases in order to locate the seat of the trouble. The presence of carbon monoxide (CO) indicates imperfect combustion. This gas is rarely present in amounts exceeding 0.4 per cent., and anything in excess of that amount would show poor firing conditions. With good conditions the percentage of carbon monoxide is generally below 0.2 per cent. The amount of oxygen present is an indication of the amount of surplus air in the gases, as is the amount of nitrogen. The surplus oxygen may be due entirely to the admittance of an excessive amount of air through the fire or it may be due to leakage through the walls of the flue or the boiler setting. By taking samples of the gases at various points of the boiler setting and throughout the length of the flue, it will be possible to determine whether there is any leakage of this character. Air leakage of this kind may occur without detection, as when carbon monoxide is present in excess each air leak will cause secondary combustion to occur, provided the temperature of the gases is high enough to ignite this gas. As in other industrial operations an economy of 100 per cent. is out of reach in the boiler furnace, and while some few tests have shown results in excess of 80 per cent., the results in everyday running are bound to fall considerably below test results.

In the power station reliability is often far more important than high-test economy. The public service company must deliver its product to an exacting public, hence while it may be possible to produce a unit of power at a low fuel cost, the most economical apparatus may not be the most efficient owing to its first cost, upkeep and operating expenses. Boilers must be kept banked with steam at a high pressure so that they can be cut into service with the least possible delay. All of these considerations result in a diminution of the fuel economy possible with a constant load. In the operation of these plants it is desirable to get the best results possible under existing conditions. In obtaining this end the carbon dioxide recorder is an ally of the manager. It is, however, necessary to know the air and flue-gas temperatures in order to have a complete check upon the firing methods.



$CO_2$ EFFICIENCY CHART

The accompanying diagram shows the percentage of the heat of the fuel wasted with different percentages of carbon dioxide when the difference in temperature between the air and the flue gases is known. As given, the difference in temperature is in degrees Centigrade; but this can be easily changed to degrees Fahrenheit by multiplying the temperature values shown by 1.8 and adding 32. This diagram was computed from Si gert's approximate formula:

$$V = K\frac{T - t}{C},$$

in which

$T$ = Temperature of the waste gase
$t$ = Temperature of the air at tl grate,
$C$ = Percentage of carbon dioxide the waste gases,
$V$ = Percentage value of the he lost in the waste gases,
$K$ = Constant.

When $T$ and $t$ are in degrees Cent grade, $K = 0.65$.

When $T$ and $t$ are in degrees Fahre heit, $K = 0.36$.

This diagram can be used when tl temperature of the waste gases alone known, by considering the values of tl temperature scale as being increased l the amount of the average temperatu of the air, in which case 100 on the sca as given would be the equivalent of waste-gas temperature of 120 degre Centigrade or 248 degrees Fahrenheit.

An inspection of this diagram demo strates that with good combustion tl waste gases may be very hot witho much actual loss of heat. It is for th reason that the high rates of combu tion have been found so much more sa isfactory than the low rates. Wit plants dependent upon natural draft tl heat of the waste gases is important reducing the amount of stack investme necessary, for draft purposes alone, ar hot flue gases with a good percentage carbon dioxide may be much more ec nomical than a low temperature of tl flue gases with a low content of this ga

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## Turbines for Cargo Boats

Among the steamers now lying at Nev castle-on-Tyne is the steamship "Vespe ian," which is likely to excite a good de of interest before long. She was sent a Mediterranean round trip with a speci staff of engineers on board, whose duty was to make careful note of the vessel speed and coal consumption. Having r turned from this trip, her old reciproca ing engines have been removed, and their place specially designed slow-spe turbines have been substituted. She now ready for sea, and it is understo that the special engine-room staff wi again be sent out with her, in order t take notes of her performances, and con pare them with the results recorded by h reciprocating engines. In this way, val able data will be collected, and the appli ability of the turbine to cargo steame will, it is thought, be proved or disprove just as it turns out.—*The Marine Revie*

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Drip cocks should be arranged at tl lowest point so that the feed pipe ca be thoroughly drained when laying up plant.

# What Is the Zero Circle of a Planimeter?

## Reason for and Amount of Correction to be Made in the Reading of the Planimeter when the Stationary Point Is inside the Area Traced

### BY C. J. MASON AND W. G. HAWLEY

The planimeter is an instrument used for measuring the area of irregular curve-bounded figures such as indicator diagrams, and while the use of it is widely known by a large number of engineers, not many, comparatively speaking, know anything about the principles upon which the instrument is constructed, and, of course, it is not absolutely necessary to understand the theory of the planimeter in order to learn how to use and apply the instrument to the measuring of diagrams. For the most part it is looked upon as an ingeniously constructed tool, the use or practical application of which is the only thing to be concerned with. But there is one point at least that probably will be of interest to many engineers who perhaps have not given the matter any thought before, and that is, what is the zero circle, how is it found, and under what circumstances is it of importance to know of the existence of such?

If the anchor point of the instrument is located *outside* the figure to be traced, the zero circle of the instrument used is not brought into play, and therefore has no influence on the area as recorded by the revolving wheel. This is the case in the application of the planimeter to indicator diagrams. But when the anchor point of the instrument is *inside* the area to be measured, then the zero circle has to be taken into consideration and due allowance made therefor. There are some textbooks that refer to the zero circle and give the algebraical expression for the radius of the circle, but unless a person is well advanced in an understanding of the theory of the instrument as a whole, it will require some deep thinking to arrive at a satisfactory conclusion in relation to the matter. Perhaps the following brief and pointed explanation may be of help to any who do not at present quite understand what the zero circle is, and how to find it for any given instrument.

First, look at Fig. 1, which illustrates the ordinary polar planimeter. The anchor point is at *A*, the pivotal point at *B*, the tracing point at *C*, and the point of contact of the recording wheel is marked *D*. Let the distance from *A* to *B*, equal *b*, measure 5.35 inches; distance from *B* to *C*, equal *a*, measure 4.15 inches, and the distance from *B* to *D*, equal *c*, measure 0.83 inch. These measurements were actually obtained by the writers from the planimeter which was used.

Fig. 2 is a diagrammatic representation of the instrument shown in Fig. 1. The same letters are used to designate the parts, and the values previously given are to be applied. No attempt has been made to draw this figure to scale; it is simply intended to convey the application of the methods involved.

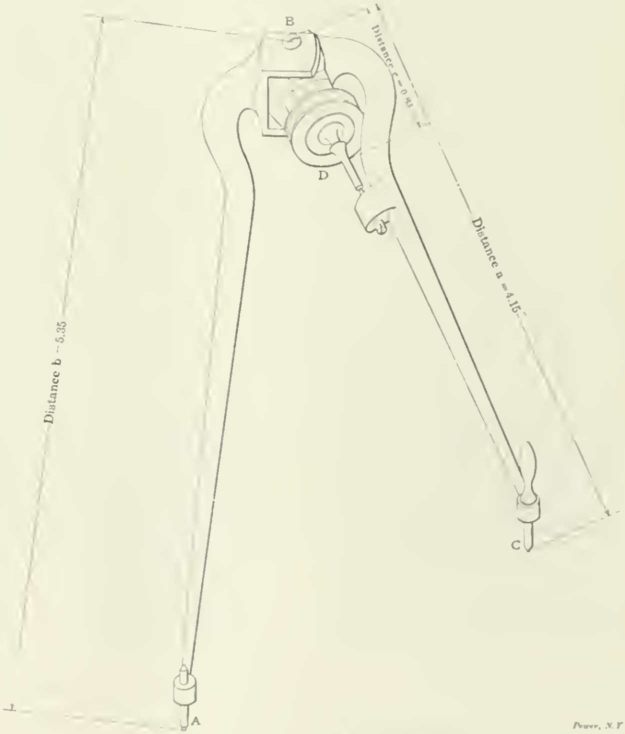


FIG. 1. ORDINARY POLAR PLANIMETER

In this particular case the revolving recording wheel is located between the pivot *B* and the tracing point *C*. The line *A C*, designated by *R*, will be the radius of the so-called "zero" or corrective circle which will be traced by the instrument while the recording wheel follows the path of the smaller circle in the diagram. It will be noticed that the axis of the wheel is tangent to this circle, as at *D*, that is, when the angle *A D C* is 90 degrees. In brief, when the anchor point of the instrument is at *A* and the tracer be made to follow the path of the larger circle, the recording wheel will follow the smaller circle, and while so doing will not revolve at all, so that no area is recorded, although the tracer will have made one full revolution and will have actually traced the area of the large circle.

Each planimeter will have a zero circle which, of course, should be known, so that the necessary correction may be made when the instrument is used in the way referred to. In the right triangle

ABC the square of the hypotenuse is equal to the sum of the squares of the other two sides, or

$$\overline{AC}^2 = \overline{AD}^2 + \overline{DC}^2, \text{ or } AC = \sqrt{\overline{AD}^2 + \overline{DC}^2};$$

but

$$\overline{AD}^2 = \overline{AB}^2 - \overline{BD}^2 = b^2 - c^2$$

and

$$DC = BC - BD;\ \overline{DC}^2 = (BC - BD)^2,$$

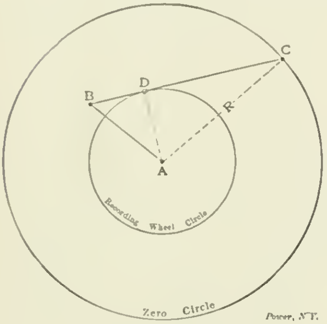
or

$$\overline{DC}^2 = (a - c)^2 = a^2 - 2\,ac + c^2.$$

Then,

$$AC = R = \sqrt{b^2 - c^2 + a^2 - 2\,ac + c^2};$$

$$R = \sqrt{a^2 - 2\,ac + b^2}.$$



Power, N.Y.

FIG. 2. RECORDING WHEEL BETWEEN PIVOT AND TRACING POINT

Substituting the given values in this latter formula,

$$R = \sqrt{4.15^2 - 2\,(4.15 \times 0.83) + 5.35^2} = 6.24$$

inches, which is the radius of the zero circle for the example under consideration. With this radius the area of the circle is

$$\pi R^2 = 6.24^2 \times 3.1416 = 122.384$$

square inches. This is the value to algebraically add to the reading of the wheel in the case cited, when obtaining the area of any figure, and when the anchor point is inside the figure to be so measured.

There is still one more case to be considered, and that is, where the pivot is between the wheel and tracer of the instrument, as occurs in some makes. Using the same letters for like parts, Fig. 3 illustrates the case diagrammatically. The formula will require to be changed slightly. As before,

$$AC = R = \sqrt{\overline{AD}^2 + \overline{CD}^2},$$

but

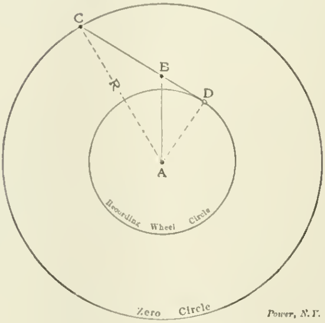
$$\overline{AD}^2 = \overline{AB}^2 - \overline{BD}^2 = b^2 - c^2$$

and

$$CD = BC + BD,$$

$$\overline{CD}^2 = (BC + BD)^2,$$

$$\overline{CD}^2 = (a + c)^2 = a^2 + 2\,ac + c^2.$$



Power, N.Y.

FIG. 3. PIVOT BETWEEN WHEEL AND TRACING POINT

Then,

$$R = \sqrt{b^2 - c^2 + a^2 + 2\,ac + c^2};$$

$$R = \sqrt{a^2 + 2\,ac + b^2}.$$

If actual numerical values were applied in this case as before, relative results would be obtained.

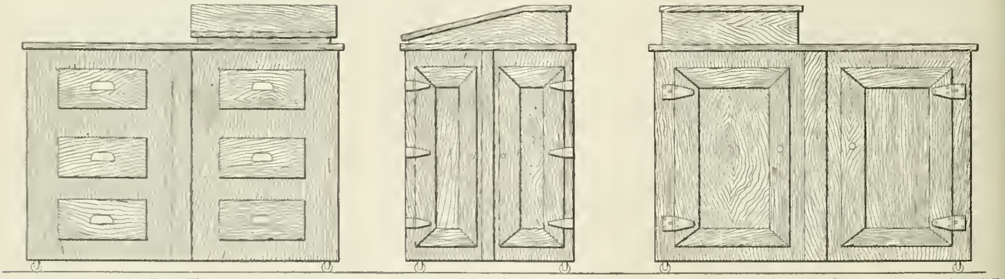
It will have been seen that the reason the recording wheel does not turn while the pointer is tracing the zero circle is because of its tangential position all the way around. The writers tried the foregoing, case 1, on an instrument and found that the result from the calculation, namely that the radius of the zero circle for that instrument was 6.24 inches, checked up exactly with an actual trial. Thus, each method verified the other.

## A Novel Tool Desk

A tool desk of novel design may be found in the large compressor plant at High Falls, N. Y. It was designed by the chief engineer, W. J. Shortate. This plant consisted of ten compressors, the air being used for working pumps, drills and other excavating devices on the new aqueduct work for the city of New York. The ten compressors occupy considerable space and are set side by side; it being quite a journey from one end of the room to the other.

The tool bench or desk shown in the accompanying illustration is fitted on top with a desk section, while the front is divided into six sliding drawers for various supplies. The ends have two doors, each opening into shallow cupboards, while the back is also fitted with two cupboards suitable for wrenches, packing hooks and other small tools.

With this arrangement, when a machine requires attention the entire collection of tools and small supplies is wheeled to the machine, and there is no running to and from a toolboard or workbench. Such an arrangement would hardly do for a small plant, and in fact would not be required, but for a plant of considerable size it is believed to be just the thing.



Power, N.Y.

THREE VIEWS OF THE SHORTATE TOOL DESK

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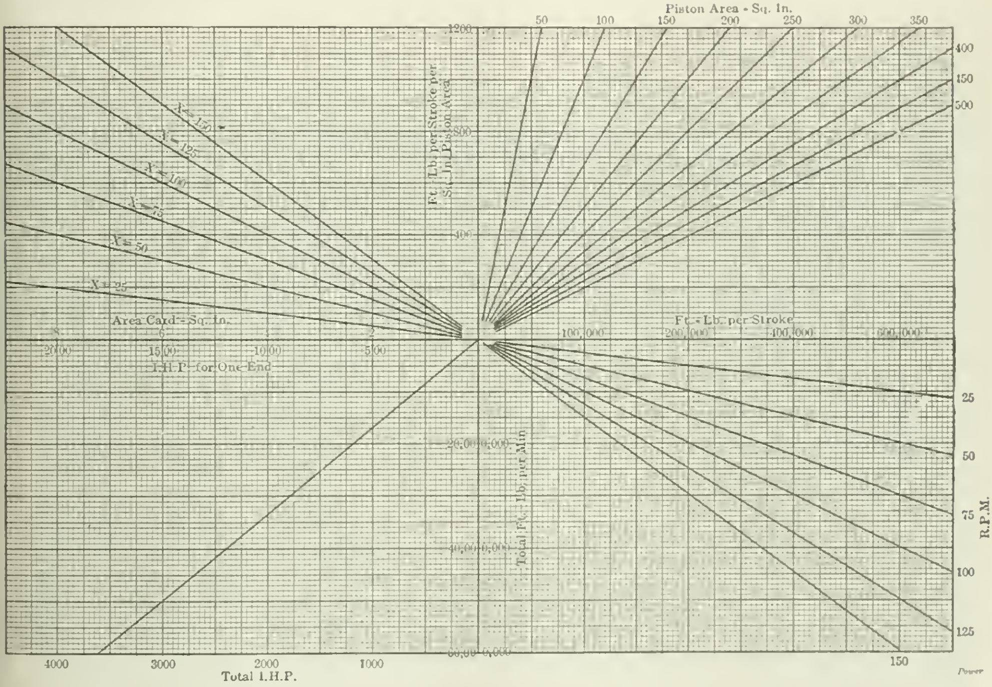
Neat portland cement has been used as a protective coating in comparison with linseed oil and red lead paint in some tests made by Prof. F. E. Geisecke, of the Texas Agricultural and Mechanical College. The object was to ascertain if neat cement could be used instead of oil or red lead on structural steel to be encased in concrete. The experiments were made by coating rods with the various coverings, bedding them in concrete, and then determining the resistance of the rods to withdrawal by means of a testing machine. The results indicate that if the adhesion between concrete and uncoated steel is taken as a basis of comparison, red lead reduces the adhesion 90 per cent., linseed oil reduces it about 80 per cent. and neat cement increases it 35 per cent.

## Chart for Horsepower Calculations

By W. T. Damon

The accompanying chart represents all data usually at hand when it is desired to take the indicated horsepower of a steam engine from indicator diagrams. Given the following:

$a$ = Area of diagram in square inches,
$x$ = Foot-pounds of work per square inch of diagram area,
$A$ = Area of piston in square inches,
$N$ = Revolutions per minute of crank,



HORSEPOWER CHART

$P$ = Mean effective pressure on piston in pounds per square inch,
$L$ = Length of stroke in feet,
$l$ = Length of diagram in inches,
$s$ = Scale number of spring, pounds per square inch per inch of spring motion,
$r$ = Reduction of motion ratio = $l \div (12\ L)$;

hen

$$x = s \div (12\ r).$$

But

$$P = as \div l,$$

nd

$$PL = aLs \div l = as\ (12\ L) \div (12\ l) = as \div (12\ r) = ax$$

The indicated horsepower (for one end only) equals

$$PLAN \div 33{,}000 = axAN \div 33{,}000,$$

and the indicated horsepower (for both ends) equals

$$PLAN \div 16{,}500 = axAN \div 16{,}500,$$

in which latter $a$ = the average diagram from both ends and $A$ = the average piston area. These two formulas are the ones upon which the chart is based. A slight error is introduced by using the averages for determining the indicated horsepower for both ends; it is more accurate to determine them separately and add.

For example, suppose it is known that the diagram area for the head end equals 8 square inches, the number of scale of spring equals 60, the reducing-motion ratio equals 1 to 20, the piston area for the head end equals 400 square inches, and the revolutions per minute equal 100. Then,

$$x = 60 \div (12 \times 1/20) = 100.$$

Beginning at the diagram area equals 8 square inches, run up to the line of $x$ = 100, thence across to line of piston area 400, and down to R. P. M. 100. Thence across to the single line in the lower left corner, thence up to the I. H. P. scale for one end, upon which it is seen that the indicated horsepower for the head end equals approximately 970. Substituting in the formula:

$$I.H.P. = axAN \div 33{,}000 = 8 \times 100 \times 400 \times 100 \div 33{,}000 = 970,$$

as it should. Having found $x$ for one reducing motion and spring, a line may be drawn on the diagram to correspond and may be used for all future computations.

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In a paper read before the fifth annual meeting of the Illinois Gas Association, Robert B. Harper considers clean coal-tar pitch, free from water, acids, or soluble mineral matter, as the most efficient type of covering for the prevention of soil and electrolytic corrosion of iron pipes. Such a pitch, he states, should be as hard as it is possible to make it without being brittle at ordinary temperatures, and should not crack when struck a hard blow. The pipes to be coated should be smooth, free from moisture, rust and loose scale, or any foreign matter. Burs or other projections of metal should be filed down before coating. The clean pipe should be left in a melted bath of pitch until the metal and dip are of the same temperature, which should be just sufficient to melt the pitch to a uniform liquid condition. The pipe, when removed, should have a smooth, uniform, black, glossy coating 1/32 inch thick

# An Oil Engine Auxiliary Power Station

## Diesel Engines Driving Two-phase Alternator Develop Kilowatt-hour on 0.1 Gallon Crude Oil at cost of 0.4 Cent. Operating Cost 0.91 Cent

### BY J. W. HIMMELSBACH

The plant herein described was installed by the Pittsfield (Mass.) Electric Company in order to help out its main steam-generating plant and also as a first step toward the transference of the main station from its present quarters to the new properties on the edge of Silver lake, a small body of water perhaps a half mile long and a quarter mile wide, and about three-quarters of a mile distant from the main station. The installation of a Diesel oil engine was somewhat in the nature of an experiment and taking all things into consideration, it has proved to be a successful one.

The building is of concrete and steel construction throughout, $73\frac{1}{2}$ feet long and 60 feet wide, and contains merely an engine room and a basement. The walls are built up of concrete blocks, which were made on the ground by a Pettibone machine; there are two parallel tiers of trument, as [illegible] total wall thickness of approximately two feet. A hand-operated traveling crane is installed which has a capacity sufficiently great to handle the largest single piece of machinery in the station. The arrangement of the building is extremely simple and with its many windows there is ample daylight everywhere. As Fig. 2 shows, the appearance of the building is attractive, and its character is not indicated by chimney or coal pile.

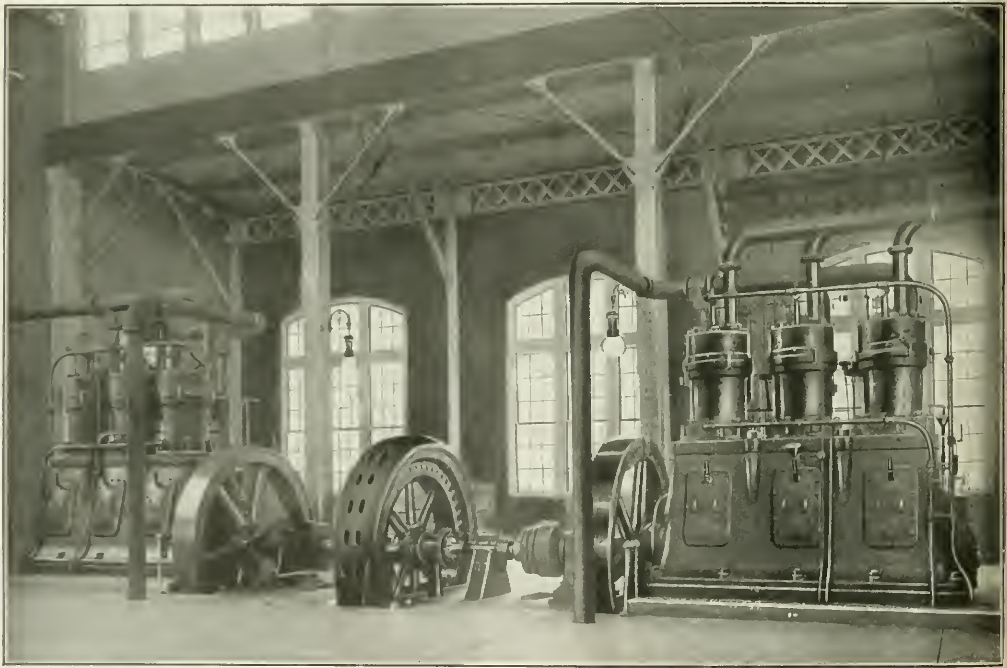


FIG. 1 THE GENERATING UNIT IN THE PITTSFIELD AUXILIARY STATION

While the station is laid out for two units, only one has been installed thus far. The complete generating unit consists of two three-cylinder Diesel engines, with cylinders 16 inches bore and 24 inches stroke, both coupled to a two-phase revolving-field generator rated at 330 kilowatts. The generator delivers 2400 volts at 60 cycles, and was built by the Stanley Electric Manufacturing Company; its speed is 164 revolutions per minute. Fig. 1 is a view of the unit.

Ordinary crude oil is used for fuel, and it is stored in three tanks on the east side of the building, each tank having a capacity of 3000 gallons. These tanks are so placed that they receive the oil by gravity direct from the tank cars on the railroad siding on the north side of the plant. From the storage tanks the oil is pumped once every hour into two smaller tanks supported on the east wa of the engine room, a hand-operate Bowser pump being used which record the number of gallons of oil that pas through it. From these tanks the fu is delivered to the engine cylinders.

Under favorable conditions the fu consumption will average 0.1 gallon p kilowatt-hour. The accompanying tabl give a very good idea of the regul performance of the engine.

The February record, Table 1, shows a average fuel consumption per kilowat hour of 0.136 gallon, and an average co of fuel per kilowatt-hour of 0.4 cent. Table 2 gives the total operating expense, by items, for the same month. As the

TABLE 1. WEEKLY RECORD OF OPERATION FOR THE MONTH OF FEBRUARY, 1909.

| Week. | Hours Run. | Total Gallons. | K W. Hours. |
|---|---|---|---|
| First | 96.67 | 1,801 | 12,830 |
| Second | 103.15 | 1,946 | 14,510 |
| Third | 104.08 | 2,121 | 15,600 |
| Fourth | 107.53 | 2,076 | 15,560 |
| Total | 411.73 | 7,941 | 58,500 |

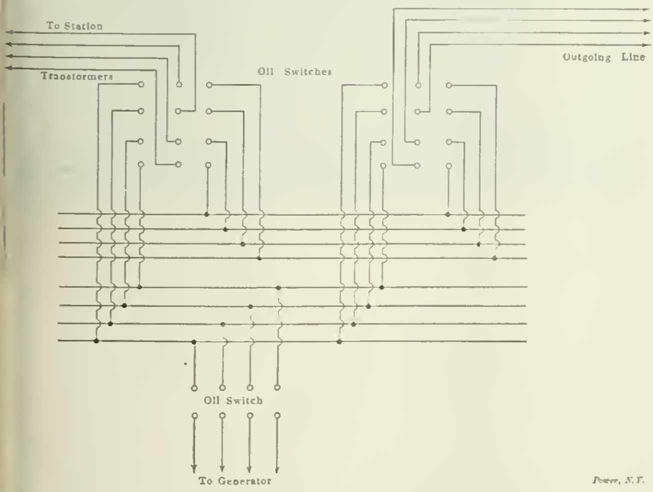
total cost for the month was $532.41 and the total output was 58.500 kilowatt-hours, the average cost per kilowatt-hour for the month was 0.91 cent. Table 3 is a specimen daily record as kept by the station operator.

FIG. 2. THE STATION BUILDING

The water for the cylinder jackets is umped directly from the lake by means f a Gould triplex pump with cylinders ½x8 inches, driven by a 5-horsepower wo-phase induction motor. The temperature of the circulating water entering the ylinder jackets averages about 50 degrees, and the discharge temperature is about 140 degrees. The amount of circulating water used varies from 2500 to 6000 pounds per hour, according to the load.

TABLE 2. GENERATING EXPENSES FOR THE MONTH OF FEBRUARY, 1909.

| | |
|---|---|
| Fuel oil | $238.32 |
| Lubricating oil and waste | 21.63 |
| Water | 2.52 |
| Station wages | 230.65 |
| Station repairs | 1.28 |
| Oil system repairs | 34.41 |
| Electrical repairs | 3.80 |
| Total | $532.41 |



Power, N.Y.

FIG. 3. SCHEMATIC DIAGRAM OF PRINCIPAL STATION-CIRCUIT CONNECTIONS

The exhaust gases are discharged through two pipes into a 30-inch tile conduit which runs underground along the south side of the building. This conduit is kept full of water, receiving its supply through a 6-inch tile pipe from a small brook on the west side of the building. The water enters and leaves the conduit through openings at the top, and is thereby kept full. Around the east and south sides of the building runs a 6-inch tile drain for collecting waste water which is finally discharged into the swamp ground near the plant.

TABLE 3.

| Time. | Gallons for Each Hour | Kilowatts. |
|---|---|---|
| 9 | 18 | 175 |
| 10 | 16 | 165 |
| 11 | 15 | 190 |
| 12 | 16 | 225 |
| 1 | 16 | 260 |
| 2 | 22 | 265 |
| 3 | 23 | 275 |
| 4 | 19 | 200 |
| 5 | 17 | 175 |
| 6 | 17 | 175 |
| 7 | 20 | 250 |
| 8 | 21 | 265 |
| 9 | 21 | 265 |
| 10 | 20 | 250 |
| 11 | 20 | 250 |
| 12 | 19 | 220 |
| Total, | 300 | 3605 |

Average gallons per hour, 18.7.
Average gallons per kilowatt-hour, 0.83.

The station is provided with one motor-driven exciter set, located in the north-east corner of the engine room. It consists of a 15-kilowatt 120-volt generator coupled to a 35-horsepower two-phase induction motor running at 900 revolutions per minute. Near the exciter set are two 25-horsepower, two-phase induction motors, driving two Norwalk Iron Works air compressors in the basement. The compressors pump the air into six storage "bottles" along the north basement wall, from which are led the pipes used in starting the engine and spraying the fuel into the cylinders.

The starting compensators for all the motors are mounted on the east wall of the engine room. Two-phase current at 220 volts is used for driving all the auxiliaries and is obtained from two 40-kilowatt transformers taking their primary current from the 2200-volt busbars. These are installed in the basement.

The generator leads run through the engine foundations to the oil switch in the basement, where the busbars and the balance of the high-tension apparatus are located. A diagram of the busbars and principal connections is shown in Fig. 3.

The switchboard consists merely of two marble panels, one generator panel and one feeder panel. The generator panel is equipped with a full complement of indicating and recording instruments of Westinghouse make. The operating handles on the board operate the oil switches by means of reach rods and bell cranks. On the feeder panel is mounted a Tirrell regulator, controlling the voltage of the station. The operating gears for the oil switches controlling the outgoing lines and the auxiliary circuits are also mounted on this panel. All current and potential transformers are installed in the basement, as well as the lightning-arrester equipment.

The writer is indebted to W. A. Whittlesey, of the Pittsfield Electric Company, for the operating records given herewith.

## Large Turbine Power for Britain's Giant Cruiser

The cruiser, or, to be more correct, the battleship cruiser, which is to be started on at Devonport dockyard next month, is evidently to be a record maker in size, power and speed. The turbines are to be no less than 70,000 indicated horsepower. The horsepower of the "Mauretania" is 66,000, giving a shade above 25 knots. This new cruiser will be some 200 feet shorter, a few feet narrower, and yet will have 4000 more horsepower. The present St Vincent class of dreadnoughts now completing have about 25,000 indicated horsepower, while the invincible class, which have reeled off 27 knots, have 45,000 indicated horsepower.—*Marine Review*

# The Care of Commutators and Brushes

By J. E. Latta

A great deal has been said through the technical press about the prevention of sparking at the brushes of direct-current dynamos and motors. However, since most of the trouble encountered in the operation of such machines is with the brushes and commutator, a few additional suggestions on this subject, coming from practical experience, may not be out of place

In a plant where the writer was working, the brushes on a dynamo began to spark very badly. This dynamo had been running eight hours a day, carrying on an average about 70 per cent of the rated full load, for nine years. It had never been overloaded. New brushes had been supplied several times, and the commutator had been kept in good condition. The voltage being 125, carbon brushes were used, of course. This machine had never given any considerable trouble up to this time.

When the sparking referred to commenced, the usual remedies for such a disorder were immediately applied. The commutator was ground smooth and round with fine sand paper, the brushes were ground to fit it snugly, and so on. But the trouble grew worse daily. The sparking would be very bad when the machine was started up and would continue until the brushes, commutator and armature were so hot that a burn-out seemed certain; then it would stop, and the dynamo would run at a dangerously high temperature until shut down.

A rush order was sent to the factory for a new armature. During the wait for this it was decided to try boiling the brushes in paraffin. They were boiled half an hour or so, and laid on the cylinder of the engine to dry. When put back on the dynamo they worked beautifully. This occurrence was three years ago, and this same set of brushes has been in constant daily use ever since, having been boiled two or three times in this period. The new armature has never been taken from the crate in which it was shipped.

In all probability these brushes had become so dry that there was insufficient lubrication of the commutator. And yet it is hard to see just why the sparking should have stopped as soon as the commutator and brushes got very hot. Aside from the improvement in lubrication, the boiling produced a good effect, no doubt, in freeing the brushes of commutator compound; for some of this had been used. Without attempting to go into details, however, as to just how the paraffin produces the desired effect, it may be stated as a fact well worth remembering that boiling old carbon brushes in this substance will make them run almost like new ones. In plants where a large number of direct-current machines are used a considerable saving in the annual cost of brushes may be realized by taking advantage of this fact; and in any plant, however small, great worry and inconvenience may be thereby avoided sometimes.

I wish, in this connection, to say a word of warning to the uninitiated concerning the use of commutator compounds. Preparations of this class should be used just as little as possible. A moderate use of them may stop sparking temporarily; but if it is continued long, trouble is almost certain to follow. My latest experience with commutator compounds was when an attendant applied one of them to the commutator of a new exciter. The result was that for half an hour, until the commutator and brushes could be cleansed of this stuff, it was impossible to hold the voltage of the alternator within 20 per cent. of the desired value for a minute at the time, though a man stood with his hands on the field rheostats all the time. The exciter commutator got very hot, and, in spite of all possible adjustment of the rheostats, the current supplied to the alternator-field winding fluctuated badly. There is little excuse, except laziness on the part of the engineer, for using much of anything on a commutator. If this part of the dynamo be kept clean and smooth and round, and the brushes be set properly, there will not be trouble-some sparking until the brushes have been used a long time, and then the simple treatment of them suggested above may be depended upon to give relief.

Where dynamo attendants insist on using some sort of application on the commutator, the best thing is to allow them to put on a little vaseline occasionally with a clean linen or hard-finish cotton cloth. But, as already stated, the best practice by far is not to use anything at all.

# A Novel Reversing Gasolene Engine

By Dr. Alfred Gradenwitz

The Howaldswerke, of Kiel, Germany, has recently developed a reversible internal-combustion engine which embodie some interesting features.

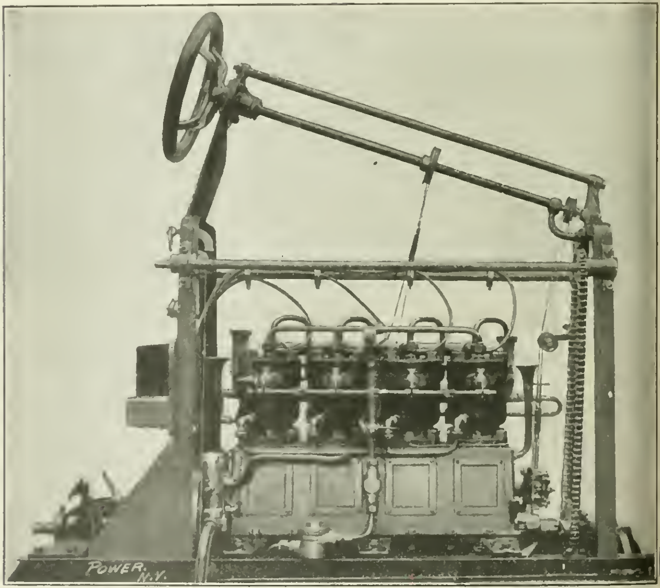
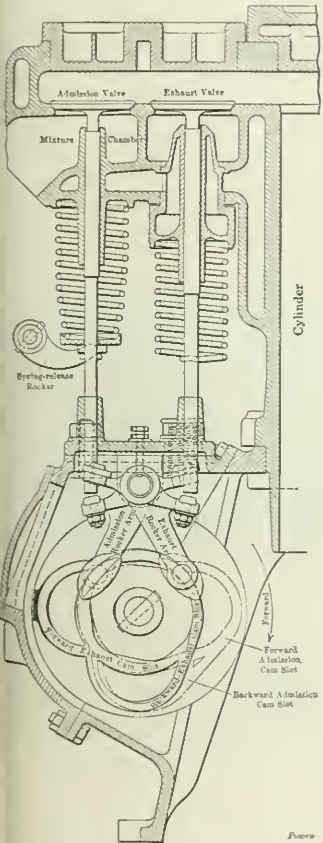


FIG. 1. REVERSING GASOLENE ENGINE FOR MARINE SERVICE

This engine, as represented by the ac companying illustrations, is of simple con struction. It is a vertical single-actin four-stroke engine, operated by an volatile fuel such as benzene, gasolene o even alcohol. The cylinders are bolte to a closed crank case and provided wit removable heads. As Fig. 2 shows, bot the barrel and the head are provided wit water jackets. They are, of course, mad of cast iron.

The piston, which is of the trunk typ ground to its final diameter, is provide with packing rings of cast iron. Th piston pin is of hardened steel, ground t size. The crank shaft is of high-grade steel, forged in a single piece, and runs in bearings of ample dimensions which are lined with white metal. The cam shaft, which rotates at half the speed of the crank shaft, is located parallel to the latter, from which it is driven through the usual spur gearing. From the cam shaft is driven all the accessory mechanism of the motor—valves, pumps and ignition devices. Separate suction and main-admission valves are provided, the latter being operated from the cam shaft while



G. 2. VALVE-GEAR OF REVERSING GASOLENE ENGINE

he former are driven either in the same anner or independently of that shaft, eing opened by the vacuum produced in he cylinder by the motion of the piston, nd closed by a spiral spring as soon as his vacuum ceases. The mechanically perated valves are operated through lotted cam disks mounted on the cam haft. The valves are all made of nickel teel, and the automatic suction valves sed on the small engines are of a pecially practical and light construction, allowing of a rapid opening and closing and reducing the resistance to the gas flow.

Fig. 2 shows the arrangement of the reversing valve gear. Slotted cam disks are mounted on the cam shaft for actuating the admission and exhaust valves. Each disk is provided on one of its plane faces with two cam slots in which moves a slide pivoted on one arm of a bell crank, the other end of which lifts the valve stem. The two slots correspond to the two directions of rotation of the engine. These slots are so designed that the valves are lifted uniformly with both directions of rotation. The slide and the slots are so designed that the former is compelled to move in the slot corresponding to the actual direction of rotation as long as that direction is maintained, but will automatically enter the slot corresponding to the other direction, as soon as the engine is reversed.

The engine is reversed simply by shifting the ignition timer, without any other manipulation of the engine. When the engine is running at slow speed, moving the "spark lever" to the "backward" position shifts the timer so as to produce ignition during the compression stroke long before the piston has completed the stroke, and the back pressure on the piston is sufficient to overcome the inertia of the flywheel and reverse the direction of rotation. The succeeding ignition then is not advanced but, owing to the reversal of the engine, becomes a late ignition. By then shifting the lever to the "full" position, the timer is adjusted for the ignition to occur at the proper point to give maximum power. During reversal, the load is thrown off, of course, by throwing out a flywheel friction clutch by means of a pedal.

On the cam shaft are also mounted two eccentrics which operate the cooling water and the oil pumps. The former is a piston pump with suction and pressure valves, provided with rubber disks to insure noiseless working; the latter is also a piston pump, but it is provided with ball valves. On the cam shaft is finally mounted the ignition timer. Battery current and an induction coil are used to produce high-tension current for "jump spark" ignition, and in the smaller engines this is the only ignition mechanism. In the large-sized engines there is also provided a magneto operated from the cam shaft through gears.

The fuel is gasified by a carbureter provided with means for regulating the mixture ratio for full and slow speed respectively and the carbureter is warmed by means of the exhaust gases of the engine.

For marine service the motor is controlled from a maneuvering board mounted on a support, by means of a handwheel and a small lever, the motion of the wheel and lever being transmitted mechanically through wire ropes to the ignition timer and carbureter respectively, as illustrated in Fig. 1.

A friction clutch, with disengaging forks, is arranged inside of the flywheel and controlled by a pedal, allowing the propeller to be thrown into and out of gear with the engine, as in the case of an ordinary automobile clutch and transmission.

## No Oil for Marine Cylinders

By F. Caldwell

In one of the recent issues, a correspondent wonders how marine engines can be run without cylinder oil and not injure the cylinder walls or piston packing.

There is not a boat in the United States navy, from the battleship down to the 30-foot launch, that uses cylinder oil or compound, direct to the cylinder or valve chamber, either in the main engines, or auxiliaries, ventilating, force-draft, reversing. The piston rods on the main engines are swabbed at regular intervals, not with the idea of getting oil into the cylinder, but to save the packing in the stuffing box and keep the rods tight. When a ship anchors for over a week in port, it is customary to remove cylinder heads and valve-chest covers, and swab the bearing surfaces with vaseline.

If the main engines are fitted with D-slide valves, of the ordinary or double-ported type, they are, as a rule, if large and heavy, connected to a balanced piston on top. This balance chamber is practically an inverted dashpot, with the bottom of the piston exposed to the atmosphere, whereas, the clearance on top of the piston is connected to the condenser. The average vacuum carried is 26 inches. This balanced chamber is designed large enough to remove the "dead" weight from the eccentrics and link block.

To reduce the excessive friction on the valve space, with this type of valve, there is fitted on the back of the valve a brass or composition ring, secured in such a manner as to be steam-tight on the back of the valve at all times. The inside of the ring is connected to the condenser by a small pipe. In the United States navy, steam, in itself, is sufficient lubrication for internal wearing surfaces.

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It is reported that China, Chile and Argentina have placed orders in Europe for eight ships of the Dreadnought type. If this report is true, there will be, for the year 1909, either built or under construction or authorized, no fewer than 70 ships which may be regarded as belonging to the Dreadnought era, each representing on an average an expenditure of $10,000,000 and therefore aggregating a total outlay of about $700,000,000.

# Making Weir Measurements in Open Streams

## How to Build the Ordinary Rectangular Weir and Modifications of the Standard Weir. Comparing the Flow of Water over Weirs and Dams

### BY FRANKLIN VAN WINKLE

Weir measurement is especially well adapted to gaging the flow of natural streams, but to those who are inexperienced, the proper setting of a weir for the purpose is frequently attended with many annoyances. To the average individual it may seem to require but little more trouble than to set a weir board across the thread of a stream; but the difficulty of holding it there only is rarely appreciated. The site should be selected not only with reference to securing proper approach and discharge, but also with regard to the fact that properly constructed, the weir should be a tight dam for measuring water which passes over the weir and that any water which passes down stream by going under, around or through the dam is lost to measurement or any reliable estimate.

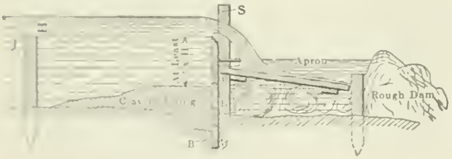


FIG. 1. Side View

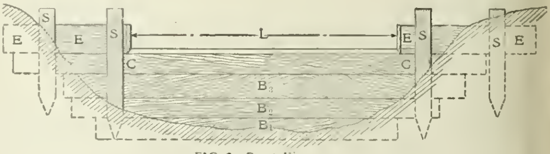


FIG. 2. Front View

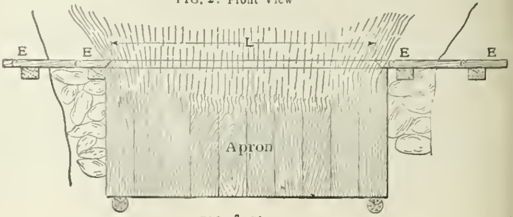


FIG. 3. Plan

Power, N.Y.

The mistake most commonly made by the novice is to undertake construction of the weir by employment of a single beveled-edge plank or thin board of liberal length and breadth. Figs. 1 and 2 show a more convenient and effective manner of constructing a gaging weir in a small running stream than employing a single piece of plank for the purpose. For holding the dam tight, several sections of narrow tongue-and-groove boards *B* should be used, with the tongues of the boards set upward. Each section should have its ends set into the banks a short distance and held plumb at each end by two or three stakes *S* placed at each end of the boards on their down-stream side.

These stakes may be of light material shored by inclined braces on the down-stream side if found necessary, and as the different sections of boards are laid up, stones or additional stakes with rough wedges behind them should be placed against the boards to hold them up against the force of the current. After scraping away any loose material or vegetable matter, a puddling of clay should be tamped behind the boards on their up-stream side as the dam is being raised, and it will be well to afford greater security to the construction against washing out by throwing up a rough dam a little further down stream for raising the level of back water, as shown in Fig. 1.

In building up the weir some care should be taken to set the boards $B_1$, $B_2$ and $B_3$, Fig. 2, level. Their position can be estimated from the surface of the water as they are being set in place. The board *C C* for the crest can be set in the same manner. It should be prepared with a beveled edge planed off to a thickness of about ¼ inch, and extended nearly the full length of the dam, with the bevel on the down-stream side. The crest board need not be over 4 to 6 inches wide, and before it is set in place a stake *J*, Fig. 1, should be set to one side of the stream, 6 to 8 feet above the weir, in readiness to be driven down to the level of the water when it begins to flow over the crest of the weir. As few nails as possible should be used for holding the weir boards together until after the crest has been set perfectly level and all is in readiness for making the weir as nearly tight as possible. If the crest board does not set level, the high end of the sheathing boards will usually permit of being pounded down a little; or if enough settlement cannot be made in this manner to bring the crest board level, raise the high end of the crest board and hold it up, tacking thin cleats over the down-stream side of the joint at the lower edge of the crest board; the cavity formed on the up-stream side can readily be filled and sealed.

The length of the weir should be closed off by boards *E E*, and these should be adjusted near enough together to secure at least one inch in thickness of the stream as it flows over the weir. The boards *E E* can be set down on the beveled edge at the ends of the latter, and if provided with bevel reverse of that of the weir board, the joint is readily sealed by tacking a cleat over the down-stream side of the joint and filling the cavity formed on the up-stream side with clay. The ends *E E* are readily built up to any desired hight to suit the thickness of stream flowing over the weir, with the ends beveled off to form end contractions, as shown in the plan view, Fig. 3, though if the thickness of stream flowing over the weir is less than one-tenth of its breadth, no particular pains need be taken regarding the end contractions, as the simple formula,

$$Q = 3.33 \times L \sqrt{H^3}$$

is to be employed for ascertaining the flow in cubic feet per second.

Some kind of apron, such as is shown in Figs. 1 and 3, should be placed in fron of the weir to catch the spill, which, i permitted to churn up the bottom, is very destructive to the puddling seal on th back of the dam, as the bottom in fron of the dam will quickly wear away, thereby undermining the dam and allowing the puddling to be washed out under the weir. The apron can be a rough platform of boards held close to the weir by stakes and can be kept down by loading with stones or by spiking fast to the stakes supporting the weir. The seal at the back of the dam should be topped off with clay or loamy material so as to reveal the presence of any leakage, which will show itself by forming holes where repairs are needed. The location of leaks in the backing of the dam is hard to determine when only stones are used for topping off the backing. In placing the filling against the back of the weir, it should be remembered that for proper proportions the bottom should not be raised higher than to come within twice the head *H*.

Measurements of *H* can be made direct from the top of the water to the top of stake *J*, Figs. 1 and 4, provided it has been set level with the crest of the weir. For most practical purposes this can be done well enough with an ordinary rule. If the puddling becomes washed out from neglect or temporary abandonment of the weir, the crest will generally settle out of level, and the stake *J*, as originally placed, will no longer indicate the true hight of the crest. This should be guarded against by testing the level, and if the weir is to be used for any length of time, the hight of the stake *J* and that of the weir should be tried and occasionally compared to some permanent bench, and no measurements of *H* should be taken for computation of the flow excepting when leakage around and under the weir, as well as directly through it, has been reduced to a minimum.

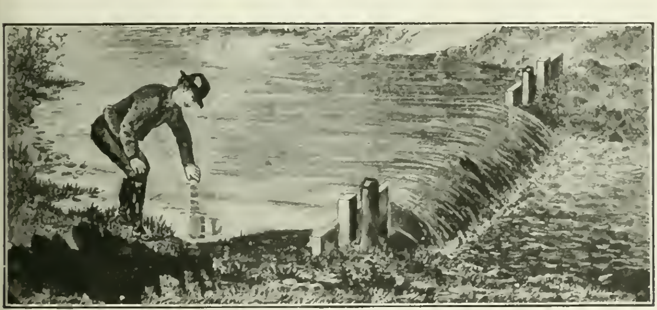


FIG. 4. MEASURING DEPTH OF WATER BACK OF WEIR

To facilitate weir calculations based on weir measurements made in inches and fractions of inches Table 1 following, has been quoted. This gives within 1 per cent. results of calculations per the formula,

$$Q = 3.33 \times L \sqrt{H^3}$$

reduced to the number of cubic feet of water per minute which will pass over a standard sharp-edged weir for each inch of its length, and for each 1/8 inch of head *H*, from 1 inch to 25 inches. The first vertical column gives the head *H* in even inches, and the horizontal line at the head of the table gives additional fractional parts of inches of head. The body of the table shows the number of cubic feet of water flowing per minute for each inch of length of the weir with different amounts of head *H*.

TABLE 1. FLOW OVER WEIR PER INCH LENGTH FOR VARIOUS HEADS.

| Inch. | | 1/8 | 1/4 | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.40 | 0.47 | 0.55 | 0.65 | 0.74 | 0.83 | 0.93 | 1.03 |
| 2 | 1.14 | 1.24 | 1.36 | 1.47 | 1.59 | 1.71 | 1.83 | 1.96 |
| 3 | 2.09 | 2.23 | 2.36 | 2.50 | 2.63 | 2.78 | 2.92 | 3.07 |
| 4 | 3.22 | 3.37 | 3.52 | 3.68 | 3.83 | 3.99 | 4.16 | 4.32 |
| 5 | 4.50 | 4.67 | 4.84 | 5.01 | 5.18 | 5.36 | 5.54 | 5.72 |
| 6 | 5.90 | 6.09 | 6.28 | 6.47 | 6.65 | 6.85 | 7.05 | 7.25 |
| 7 | 7.44 | 7.64 | 7.84 | 8.05 | 8.25 | 8.45 | 8.66 | 8.86 |
| 8 | 9.10 | 9.31 | 9.52 | 9.74 | 9.96 | 10.18 | 10.40 | 10.62 |
| 9 | 10.86 | 11.08 | 11.31 | 11.54 | 11.77 | 12.00 | 12.23 | 12.47 |
| 10 | 12.71 | 12.95 | 13.19 | 13.43 | 13.67 | 13.93 | 14.16 | 14.42 |
| 11 | 14.67 | 14.92 | 15.18 | 15.43 | 15.67 | 15.96 | 16.20 | 16.46 |
| 12 | 16.73 | 16.99 | 17.26 | 17.52 | 17.78 | 18.05 | 18.32 | 18.58 |
| 13 | 18.87 | 19.14 | 19.42 | 19.69 | 19.97 | 20.24 | 20.52 | 20.80 |
| 14 | 21.09 | 21.37 | 21.65 | 21.94 | 22.22 | 22.51 | 22.79 | 23.08 |
| 15 | 23.38 | 23.67 | 23.97 | 24.26 | 24.56 | 24.86 | 25.16 | 25.46 |
| 16 | 25.76 | 26.06 | 26.36 | 26.66 | 26.97 | 27.27 | 27.58 | 27.89 |
| 17 | 28.20 | 28.51 | 28.82 | 29.14 | 29.45 | 29.76 | 30.08 | 30.39 |
| 18 | 30.70 | 31.02 | 31.34 | 31.66 | 31.98 | 32.31 | 32.63 | 32.96 |
| 19 | 33.29 | 33.61 | 33.94 | 34.27 | 34.60 | 34.94 | 35.27 | 35.60 |
| 20 | 35.94 | 36.27 | 36.60 | 36.94 | 37.28 | 37.62 | 37.96 | 38.31 |
| 21 | 38.65 | 39.00 | 39.34 | 39.69 | 40.04 | 40.39 | 40.73 | 41.09 |
| 22 | 41.43 | 41.78 | 42.13 | 42.49 | 42.84 | 43.20 | 43.56 | 43.92 |
| 23 | 44.28 | 44.64 | 45.00 | 45.38 | 45.71 | 46.08 | 46.43 | 46.81 |
| 24 | 47.18 | 47.55 | 47.91 | 48.28 | 48.65 | 49.02 | 49.39 | 49.76 |

As an illustration of the use of the table, suppose the length of the weir is 30 inches, and the head *H*, measured at the stake *J*, Fig. 4, is 4¾ inches. Then, by first finding the whole number "4" in the first vertical column and following along horizontally until the vertical column "¾" is reached, the value 4.16 is found. This value is the quantity of water discharged in cubic feet per minute, for each inch of length of the weir; hence a weir which is 30 inches long would discharge

$$30 \times 4.16 = 124.80$$

cubic feet of water per minute.

### Modification of the Standard Weir

The weir with complete contractions is undoubtedly the most convenient apparatus for measuring large quantities of water, but the rectangular weir with horizontal sill and vertical sides, in which three contractions are introduced, possesses some disadvantages for use where the head is variable, as the coefficient of discharge varies with different proportions of head to the length of weir. It has previously been stated[*] that end contractions have small effect in modifying the coefficient of discharge 3.33 in the formula,

$$Q = 3.33 \times L \sqrt{H^3},$$

when the length of weir exceeds ten times the head, as when those proportions are present the flow is reduced only about 1 per cent., and becomes less with greater proportion in length of weir. But it often becomes desirable to leave a weir in place for measuring a variable flow. When as in time of freshet, the head becomes greater than 10 per cent. of the length of the weir, the formula for flow in cubic feet per second becomes,

$$Q = 3.33 \left(L - n \frac{H}{10}\right) \sqrt{H^3},$$

and is to be so employed in cases where end contractions are of importance. In this formula *n* equals the number of end contractions. A simple table of coefficients representing flow per unit length of weir for different values of *H* is not applicable to different lengths of weirs, and the construction of a table of coefficients covering all probable measurements of *H* for each weir becomes a tedious operation.

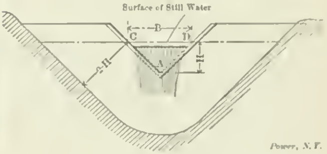


FIG. 5. THE TRIANGULAR WEIR

Besides these variations in the coefficient depending on proportions between length of crest and head, there are other variations which should be taken into account, such as degree of contractions for different heads which have been reduced to no general law, to say nothing of difference in viscosity and limpidity of liquids due to variation of temperature. It would seem remarkable, therefore, that independent experimenters using rectangular weirs and each establishing his own apparatus and conditions should come closer together in their results than 3 to 5 per cent.

To avoid the inconvenience attendant upon employment of a rectangular weir with different heads, Professor Thomson, of Belfast, adopted a form of weir in which the section of the issuing jet is always a similar figure, viz., a triangle with apex downward, as shown in Fig. 5. Let *H* in Fig. 5 be the depth in feet of the apex *A* of the triangle below the surface of still water in the reservoir or pond, and *B* equal the breadth in feet of the weir at the level of still water; then the area of the triangle *ACD* is ½ *B* ×

$H$, and theory gives for the discharge in cubic feet per second,

$$Q = C \times \frac{8}{15} \times \frac{BH}{2} \sqrt{2gH}$$

Although for a given weir the coefficient $C$ is nearly constant for all depths of $H$, it varies with different angles of the notch $CAD$. Experiments made for the British Association gave for the coefficient $C$ the following values: When $B = 2H$, then $C = 0.595$, and the quantity discharged in cubic feet per second becomes,

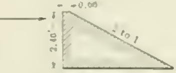
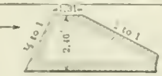
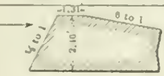
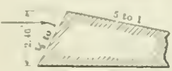
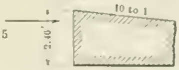
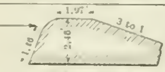
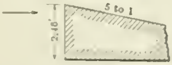
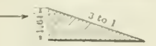
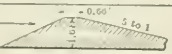
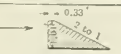
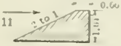
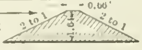
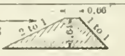
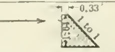
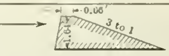
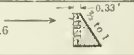
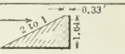
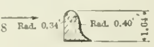
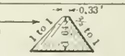
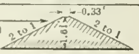
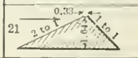
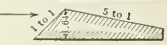
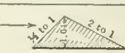
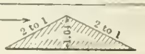
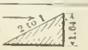
$$Q = 2.54 \sqrt{H^5}.$$

and when $B = 4H$, then $C = 0.620$, and the quantity discharged in cubic feet per second, becomes,

$$Q = 5.30 \sqrt{H^5}.$$

For a given angle $CAD$ a table of discharges for various values of $H$ is readily constructed. The triangular shape of notch is an admirable form of weir for situations where the size of channel is large in proportion to the flow, but unfortunately its employment is frequently prohibitive on account of the space required, which must need be not only the size of the largest triangle $ACD$ necessary for flow, but in order to afford complete contraction of the stream in passing over the weir, the cross-section of the channel of approach should be at a distance of $2H$ from the edges of the weir, as indicated in Fig. 5.

TABLE 2. VALUE OF COEFFICIENT "C" FROM BAZINS EXPERIMENTS

| | Section of Dam | Head H on Crest of Dam in Feet | | | | | |
|---|---|---|---|---|---|---|---|
| | | 0.4'=4.8" | 0.6'=7.2" | 0.8'=9.6" | 1.0'=12." | 1.2'=14.4" | 1.4'=16.8" |
| 1 |  | 2.68 (80%) | 2.90 (87%) | 3.13 (94%) | 3.35 (101%) | 3.52 (106%) | 3.64 (109%) |
| 2 |  | 2.77 (83%) | 2.83 (85%) | 2.92 (88%) | 3.05 (92%) | 3.16 (95%) | 3.29 (99%) |
| 3 |  | 2.80 (84%) | 2.85 (86%) | 2.90 (87%) | 2.97 (89%) | 3.05 (92%) | 3.14 (94%) |
| 4 |  | 2.83 (85%) | 3.00 (90%) | 3.15 (95%) | 3.27 (98%) | 3.38 (101%) | 3.47 (104%) |
| 5 |  | 2.86 (86%) | 2.88 (86%) | 2.93 (88%) | 2.96 (89%) | 2.98 (89%) | 3.00 (90%) |
| 6 |  | 3.04 (91%) | 3.12 (94%) | 3.19 (96%) | 3.26 (98%) | 3.36 (101%) | 3.48 (104%) |
| 7 |  | 3.06 (92%) | 3.10 (93%) | 3.14 (94%) | 3.18 (95%) | 3.20 (96%) | 3.23 (97%) |
| 8 |  | 3.08 (92%) | 3.33 (100%) | 3.49 (105%) | 3.54 (106%) | 3.60 (108%) | 3.64 (110%) |
| 9 |  | 3.12 (94%) | 3.23 (97%) | 3.34 (100%) | 3.47 (104%) | 3.56 (107%) | 3.64 (109%) |
| 10 |  | 3.14 (94%) | 3.44 (103%) | 3.67 (110%) | 3.83 (115%) | 3.83 (115%) | 3.86 (116%) |
| 11 |  | 3.18 (95%) | 3.37 (101%) | 3.54 (106%) | 3.68 (110%) | 3.80 (114%) | 3.88 (116%) |
| 12 |  | 3.18 (95%) | 3.34 (100%) | 3.49 (105%) | 3.65 (110%) | 3.79 (114%) | 3.90 (117%) |
| 13 |  | 3.20 (96%) | 3.38 (101%) | 3.56 (107%) | 3.74 (112%) | 3.85 (116%) | 3.95 (119%) |
| 14 |  | 3.20 (96%) | 3.68 (110%) | 4.02 (121%) | 4.26 (128%) | 4.42 (133%) | 4.20 (126%) |
| 15 |  | 3.24 (97%) | 3.40 (102%) | 3.60 (108%) | 3.76 (113%) | 3.86 (117%) | 3.97 (119%) |
| 16 |  | 3.26 (98%) | 3.70 (111%) | 4.06 (122%) | 4.31 (129%) | 4.00 (120%) | 3.80 (114%) |
| 17 |  | 3.40 (102%) | 3.70 (111%) | 3.88 (116%) | 3.98 (119%) | 4.05 (122%) | 4.10 (123%) |
| 18 |  | 3.40 (102%) | 3.76 (113%) | 4.08 (122%) | 4.36 (131%) | 4.56 (137%) | 4.56 (137%) |
| 19 |  | 3.41 (102%) | 3.74 (112%) | 4.00 (120%) | 4.20 (126%) | 4.18 (125%) | 4.24 (127%) |
| 20 |  | 3.44 (103%) | 3.64 (109%) | 3.80 (114%) | 3.94 (118%) | 4.04 (121%) | |
| 21 |  | 3.47 (104%) | 3.72 (112%) | 3.87 (116%) | 4.01 (120%) | 4.13 (124%) | 4.23 (127%) |
| 22 |  | 3.56 (107%) | 3.54 (106%) | 3.57 (107%) | 3.62 (108%) | 3.66 (110%) | 3.70 (111%) |
| 23 |  | 3.74 (112%) | 3.81 (114%) | 3.88 (116%) | 3.93 (118%) | 3.98 (119%) | 4.02 (121%) |
| 24 |  | 3.86 (116%) | 3.87 (116%) | 3.92 (118%) | 4.02 (121%) | 4.08 (122%) | 4.16 (126%) |
| 25 |  | 4.06 (122%) | 4.20 (126%) | 4.20 (126%) | 4.18 (125%) | 4.15 (125%) | 4.12 (124%) |

*Power, N.Y.*

### THE CIPPOLETTI TRAPEZOIDAL WEIR

The inconvenience in employment of the ordinary form of weir for measurement of water under varying heads has been aptly referred to by the modern Italian engineer, Cesare Cippoletti in the following terms: "The weir with complete contractions was formerly considered to be the most accurate and convenient means for measuring large quantities of water. The form commonly used has been the rectangular weir with horizontal sill and vertical sides and with three complete contractions. With this form of weir, the coefficient of discharge is not constant, but increases with the length of the weir, and diminishes when the head on the sill increases. Furthermore, because of the effect of end contraction, with equal heads, the quantities discharged are not proportional to the length of the sill, and with constant sill length the discharge does not vary proportionally to any power of the head because of bottom contraction. These facts constitute objections to the rectangular weir."

At the time the Villoressi canal was projected (1881) these defects of the rectangular weir for gaging water used by customers was appreciated, and the government of the province of Milan regarded the objections as sufficiently serious to adopt another form of module which would be more desirable. Cippoletti was instructed to devise a module, based on the theory of the weir which would be free from such objections.

Appreciating that in the ordinary weir, the cause for variation of the coefficient of discharge was mainly due to end contraction, he undertook to design a form of weir in which the reduction of flow from this cause would be compensated by broadening out the upper portion of the weir opening, and from analysis of the formulas which take weir end contractions into account, arrived at the trapezoidal form of weir in which the vertical ends of the rectangular form are spread apart so as to give each an inclination of 1 horizontal to 4 perpendicular, as shown in Fig. 6. His description of the reasoning is well contained in his own words, as follows:

"Keeping in mind, as ascertained, that the effect of this (end) contraction is proportional to the depth of the stream, and equivalent to diminishing the breadth one-tenth of the depth, nothing prevents the ends of the weir, instead of being vertical, being inclined outward in such a ray that the water which passes through he two triangles may compensate exacty, for each head, for the loss caused by he lateral contraction. This is equivalent o constructing a weir of the trapezoidal orm, in which the inferior base, *A B* in 'ig. 6, is assumed as the breadth and the ischarge is then given by the common ormula,"

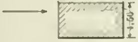
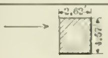
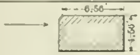
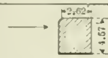
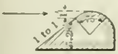
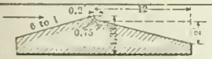
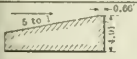
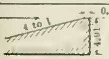
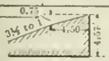
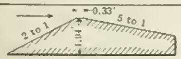
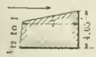
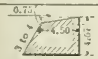
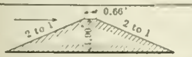
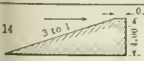
$$Q = 3.33 \times L \sqrt{H^3},$$

in which only the horizontal contraction is taken into account.

Cippoletti assumed that this modification of the common form of weir when employed within the range of lengths and heads necessary for discharging quantities required of the proposed module could be relied upon for accuracy of results within ½ of 1 per cent.

From carefully conducted experiments* Messrs. Flynn and Dyer have determined that in consequence of the variable degree of contraction due to different heads, exactness within ½ of 1 per cent. in use of the formula is realized only under limited range of proportions of head to breadth of weir, and for velocities of approach not exceeding 1½ foot per second. But no more serious error is liable to be introduced than about 2 per cent under ordinary conditions, and they conclude that as a module, the trapezoidal form of weir possesses superior practical advantages, requiring only a simple set of coefficients for flow in cubic feet per second, for various values of *H* per foot in length of sill, and which will be applicable to all lengths of weirs regardless of proportions to head.

TABLE 3. VALUES OF COEFFICIENT "C" FROM CORNELL EXPERIMENTS

| Section of Dam | | Head H on Crest of Dam in Feet | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 |
| 1 |  | | 2.45<br>(73%) | 2.49<br>(75%) | 2.51<br>(75%) | 2.56<br>(77%) | 2.59<br>(78%) | 2.67<br>(80%) |
| 2 |  | 2.85<br>(86%) | 2.89<br>(87%) | 3.03<br>(91%) | 3.16<br>(95%) | 3.30<br>(99%) | 3.50<br>(105%) | 3.71<br>(111%) |
| 3 |  | 2.85<br>(86%) | 2.82<br>(85%) | 2.90<br>(87%) | 2.90 | 2.92 | 2.95 | |
| 4 |  | 3.12<br>(94%) | 3.20<br>(96%) | 3.31<br>(99%) | 3.45<br>(103%) | 3.63<br>(109%) | 3.78<br>(113%) | 3.92<br>(118%) |
| 5 |  | 3.20<br>(96%) | 3.50<br>(105%) | 3.60<br>(108%) | 3.70<br>(111%) | 3.84<br>(116%) | 3.95<br>(119%) | |
| 6 |  | 3.23<br>(97%) | 3.34<br>(100%) | 3.42<br>(103%) | 3.45<br>(104%) | 3.47<br>(103%) | 3.52<br>(106%) | |
| 7 |  | 3.37<br>(101%) | 3.33<br>(100%) | 3.31<br>(99%) | 3.29<br>(99%) | 3.23<br>(97%) | 3.16<br>(95%) | 3.14<br>(94%) |
| 8 |  | 3.37<br>(101%) | 3.33<br>(100%) | 3.31<br>(99%) | 3.29<br>(99%) | 3.25<br>(98%) | 3.20<br>(96%) | 3.21<br>(96%) |
| 9 |  | 3.52<br>(106%) | 3.47<br>(104%) | 3.55<br>(107%) | 3.62<br>(109%) | 3.68<br>(110%) | 3.72<br>(113%) | |
| 10 |  | 3.61<br>(108%) | 3.68<br>(110%) | 3.65<br>(110%) | 3.72<br>(112%) | 3.80<br>(114%) | 3.93<br>(118%) | |
| 11 |  | 3.61<br>(108%) | 3.57<br>(107%) | 3.62<br>(109%) | 3.63<br>(109%) | 3.67<br>(110%) | 3.71<br>(111%) | 3.80<br>(114%) |
| 12 |  | 3.62<br>(109%) | 3.54<br>(106%) | 3.52<br>(106%) | 3.57<br>(107%) | 3.55<br>(107%) | 3.69<br>(111%) | |
| 13 |  | 3.68<br>(110%) | 3.71<br>(111%) | 3.81<br>(114%) | 3.90<br>(117%) | 4.09<br>(120%) | 4.06<br>(122%) | |
| 14 |  | 3.76<br>(113%) | 3.68<br>(110%) | 3.68<br>(110%) | 3.70<br>(111%) | 3.75<br>(113%) | 3.83<br>(115%) | |

Power, N.Y.

## Flow Over Dams

It frequently happens that for measuring the flow of streams no more convenient method presents itself than to make estimates of flow from measurements of the hight of water flowing over a dam. The form of crest, arrangement of channel of approach and hight of water on a dam all tend to influence the discharging capacity, and it is rare to find that the proportions of cross-section and other conditions would warrant application of the ordinary weir formulas, although erroneous testimony of witnesses as to quantities of water flowing over mill dams, founded on the standard weir formulas, has often been admitted by courts. The law of flow over dams of the ordinary forms and under varying heads is very complex, and the only estimates of flow which are worthy of serious consideration are those based upon coefficients which have been determined for the flow over a dam of the form of the one under consideration; or if that is not available, then the next best method of computation is to employ a coefficient of flow which has been found suitable for a dam which agrees as closely as possible with the form of cross-section of the dam in question. A most valuable series of experiments on this subject was made by Bazin, under the auspices of the French government, in which weirs of a great variety of forms were employed under various heads up to about 20 inches. In the Bazin experiments, end contractions were suppressed in all cases, and as the sides of the channel of approach were continued beyond the weir, there was no freedom for access of air beneath the discharging sheet of water, a condition very commonly present in discharges over the crests of dams.

Table 2 gives values for coefficient *C* for use in the common formula,

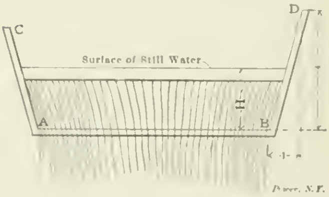


FIG. 6. CIPPOLETTI TRAPEZOIDAL WEIR

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*Transactions American Society of Civil Engineers, July, 1894.

$$Q = C \times L \sqrt{H^3},$$

for different sections of dams, for finding, according to Bazin's experiments, the flow in cubic feet per second for various heads from 0.4 foot to 1.4 feet. The table also gives in parentheses the percentages which these coefficients are of the value 3.33, which is the value of C as ordinarily employed in the formula for flow over sharp-crested weirs without end contraction. A very complete series of experiments on the subject of flow over weirs of various forms of cross-section has more recently been conducted by G. W. Rafter and Prof. G. S. Williams for the United States Board of Engineers on Deep Waterways. The experiments* were made at the Cornell university hydraulic laboratory, where excellent opportunities were afforded for the measurement of flow over weirs of various forms. Carefully conducted experiments were made with various heads on weirs about 6 feet 8 inches long, raised 4.6 to 4.9 feet above the bottom of the channel. In these experiments provision was made for free access of air beneath the sheet of water passing over the weirs. This set of experiments is especially valuable in determination of flood flows, as the experiments were made on weirs of cross-sections commonly used for dams in this country, and under heads ranging from about 2 to 5 feet. The coefficients of discharge for values of C and the percentages which these coefficients are of the value 3.33, as determined from these experiments, are shown in Table 3 for a number of the commoner forms of dams.

Inspection of the tables, especially of the percentages of 3.33, will show at a glance the degree of error which would be made by employment of the ordinary coefficient 3.33 in place of the proper one for the several cases illustrated. In both sets, for better presentation, the different cross-sections have been arranged so as to bring the crests vertically one over another, and are quoted in the order of increase of the coefficient for the lowest head tabulated. It is to be observed that in the first example quoted in Table 2, the flow for the least head, if taken per the coefficient 3.33 would be 20 per cent. too large and if this same coefficient were taken for the greatest head, the estimated flow would be 9 per cent. too small; also that in this same example the coefficient of flow for the highest head quoted is largest for any of the first seven quoted under this head. Of the whole number of sections quoted in Tables 2 and 3 it may be observed that by use of the common coefficient 3.33 the error is liable to vary from plus to minus 20 per cent.

In estimating the flow over a dam care should be taken to make proper allowance for leakage. This can be done by weir measurement below the dam in time of low water. A table of discharges for various heads may be readily constructed, either by calculating the flow for each head from the formula,

$$Q = C \times L \sqrt{H^3},$$

assigning proper values to C according to the shape most nearly coinciding with those given, or by employment of coefficients obtained from tables for ordinary weirs, and applying the proper percentage tabulated for the nearest section of dam in Tables 2 and 3.

Under most favorable circumstances it cannot be expected to measure the flow over a dam closer than about 5 per cent. of the true quantity. Velocity of approach can usually be neglected. The average hight of crest should be determined by accurate level rod readings, or on a stake set up stream when water is beginning to spill over different portions of the crest. Some error in reckoning the head from the average level of crest is unavoidable, but decreases with increase of head.

## A Heat Value Calculator for Fuel Gas

By Charles C. Sampson

In making tests of engines using gas as fuel one of the most important determinations is that of the heat value of the gas. This may be determined with a calorimeter or by computation from the quantities of combustible gases present per cubic foot and their known heat value. In the latter method the composition of the fuel is determined by means of one of the flue-gas testing sets and the heat value is calculated from the analysis by multiplying the per cent. of each gas present by its heat value per cubic foot at standard conditions.

For example, blast-furnace gas is composed of carbon monoxide (CO), carbon dioxide ($CO_2$), hydrogen (H), methane ($CH_4$) and nitrogen (N) of which the first, third and fourth are combustible and have heat values at 62 degrees Fahrenheit, 30 inches barometer as follows:

$CO$ = 324.45 B.t.u. per cubic foot.
$H$ = 274.78 B.t.u. per cubic foot.
$CH_4$ = 915.08 B.t.u. per cubic foot.

A gas having the analysis

$CO$ = 26.3 per cent.
$CO_2$ = 13.4 per cent.
$H$ = 3.6 per cent.
$CH_4$ = 0.2 per cent.
$N$ = 56.5 per cent.

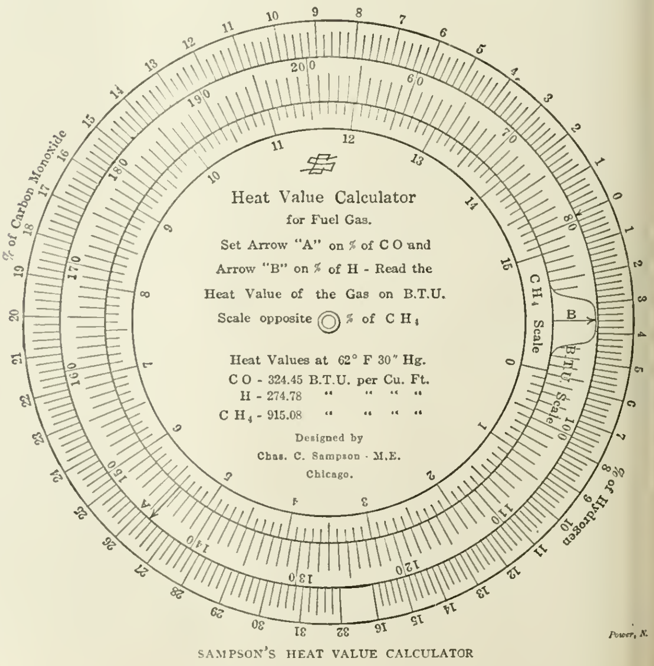
would have a heat value of

$0.263 \times 324.45 = 85.33$ B.t.u.
$0.036 \times 274.78 = 9.89$ B.t.u.
$0.002 \times 915.08 = 1.83$ B.t.u.

Total = 97.05 B.t.u.

per cubic foot at 62 degrees Fahrenhei and 30 inches barometer.

The device shown is arranged for performing the above multiplication and addition mechanically. It consists of thre graduated disks pivoted at the center s that they may be turned one over th other. The outer disk is graduated from 0 per cent. to 16 per cent. of H, and



SAMPSON'S HEAT VALUE CALCULATOR

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*Transactions American Society of Civil Engineers, December, 1900.

per cent. to 32 per cent. of CO; the inner one from 0 per cent. to 15 per cent. of $CH_4$, and the middle one from 50 to 200 B.t.u.

To determine the heat value of the gas given above, set the arrow *A* opposite the 26.3 per cent. of CO in the gas and the arrow *B* opposite 3.6 per cent. of H. Then read the heat value per cubic foot at standard condition opposite 0.2 per cent. of $CH_4$ on the middle or B.t.u. scale. The reading will be approximately 97 B.t.u. This is not as accurate as the result determined by actual multiplication but is well within the limit of accuracy of the gas-analysis apparatus.

To construct such a calculator first decide upon the maximum quantities of CO, $CH_4$ and H to be found in the gas to be used. Then find the heat value of each at their maximum. In the device shown these were taken:

$$CO = 0.32$$
$$H = 0.16$$
$$CH_4 = 0.15$$

The heat value corresponding is found to be:

$$CO = 0.32 \times 324.45 = 103.824 \text{ B.t.u.}$$
$$H = 0.16 \times 274.78 = 43.964 \text{ B.t.u.}$$
$$CH_4 = 0.15 \times 915.08 = 137.262 \text{ B.t.u.}$$

Then since the CO and H scales are to be on one circle the B.t.u. scale must contain at least as many divisions as the sum of their B.t.u., which is 147.79, which makes 150 divisions convenient for the B.t.u. scale.

This number of divisions can be used if the B.t.u. corresponding to 15 per cent. $CH_4$ is not more than 150, and since

$$0.15 \times 915.08 = 137.26,$$

the B.t.u. scale is divided into 150 parts.

The outer scale is now laid off from 0 to 32 for the CO portion so that the 32 divisions extend over 103.82 parts of the B.t.u. scale and from 0 to 16 for the H portion to extend over 43.96 parts of the B.t.u. scale. The divisions of these two scales are further divided into five parts each, making them good for 1/10 of 1 per cent. by reading half divisions.

The $CH_4$ scale is put on the inner disk so that 1 per cent. is the same length as 9.15 B.t.u. divisions. This scale is subdivided into tenths of 1 per cent.

The arrow *A* is now put on the B.t.u. scale at its zero by counting back from the 50, and the arrow *B* is put at the zero of the $CH_4$ scale, the little tab being extended to reach to the H scale to allow more accurate setting.

In order to have the space near the $CH_4$ zero free for use in blast-furnace gas determinations, the arrow *B* was moved a small distance to the left and to correct for the error thus introduced, the arrow *A* had to be moved the same distance.

The disks should be made of a good tough paper and the center pivot can be made from an eyelet paper fastener.

# A Case of Waterhammer

By Alonzo G. Collins

Recent articles on waterhammer bring to mind an incident in my own experience, which goes to prove that an endeavor to employ all known safeguards will not always bring the desired results, and that the best-laid plans will sometimes go astray. And it also proves that waterhammer may be caused in pipes that have no sag in them, and that a comparatively insignificant steam pressure may have the faculty for developing an enormous amount of mischief, if the conditions are right.

It was a good many years ago, and I was just finishing the erection of a large (for those days) electric-lighting plant, in which the steam from several boilers was collected into a 16-inch header, supported on brackets along the boiler-room wall, and from which branch pipes were run through the wall to the different engines in the engine room.

The header was not such a long one (as headers go), being about 100 feet in length, but it was provided with two expansion joints to prevent strains in the boiler connections, as the room at our disposal did not admit of long-sweep bends, even if there had been facilities for making them, which were not very numerous in those times.

The pipes from the boilers to the header and from the header to the engines, were connected into the top of the header, so that water of condensation would not be drawn from the header to the engines, and connections were made in the bottom, at each end of the header, for draining; the intention being to place steam traps in these connections to discharge the condensation through these traps to the feed-water heater.

The makers of the traps were slow in making delivery, and as our contract time was nearly up, I decided to start slow fires under the boilers, to dry out the brickwork and warm up the piping, carrying the slow fires for several days before the boilers got warm enough to show any steam at the drain pipes, and then, the traps not having arrived, I concluded to try a little pressure on the pipes, intending to keep the header clear of condensation by manipulating the valves in the drain pipes and letting the drip go to waste.

All went well the first day with two or three pounds of pressure showing on the gages, and I went home that night, leaving the night engineer in charge, with instructions not to let the steam pressure go above five pounds, and to be sure and keep the header free of water by manipulating the valves on the drain pipes.

I arrived at the plant the next morning a few minutes after the day engineer got there and found a pitiable state of affairs, considering that according to our contract the city lights were to go on that night. The casing of one of the expansion joints and some of the other fittings of the header were in fragments on the floor.

There was considerable difficulty in unraveling the mass of contradictory evidence presented by the two parties most responsible, but they were both agreed that when the day engineer came on duty there was 20 pounds of pressure; and then they sharply diverged, the night man claiming that there was no water in the header, because there was none escaping from the valves, and the day man asserting that the reason no water was getting away was because the valves were shut, and when he opened one of them the explosion occurred.

At any rate, there was then no way to determine how much water had been in the header, but water there undoubtedly was, as the pressure was not sufficient to do the damage that had been done. Luckily I had provided cutoff valves in the header, by which it could be separated into sections, and by shifting the remaining expansion joint and closing some of the cutoff valves, I was able to get steam to enough of the engines to care for the city lights until we could get the broken expansion joint and fittings replaced.

The plant was designed to operate with 120 pounds pressure, and the piping had been tested by hydraulic pressure to 250 pounds, and was supposed to have an ultimate strength of about 500 pounds pressure. Unfortunately the recording gages were not connected up, so there was no way to determine what the bursting pressure was, but it must have been in excess of 500 pounds.

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The 5000-horsepower Pelton-Francis turbine intended for the Utah Light and Railway Company's Weber Cañon power plant is ready for installation. This turbine will be direct connected to a Western Electric alternator running 360 revolutions per minute. Special importance is attached to this turbine because of its size. The effective water head is 138 feet. The pipe line tapers from 84 inches to 74 inches, terminating in a special wicket gate on the turbine having a 67-inch diameter inlet. The regulation will be effected by a Pelton special oil-pressure governor actuating the bronze wicket gates. The latter are mechanically connected to a special 32-inch Pelton relief valve for preventing undue pressure rise in the pipe line should severe load fluctuations occur causing the governor to instantly close the wicket gates. The turbine is of the double, inward-flow, reaction type, the casing alone exclusive of the draft elbows and pipe connections weighing some 25 tons.

# Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think,
Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

## Electric Drives for Factories

In the November 16 issue, H. J. Macintire writes on electric drives for factories, in which, however, he loses sight of the principal arguments in favor of the electric drive.

The principal claims for the electric drive are, reduction in power, flexibility and increase in productive capacity. The last two are of even greater importance than the first. In ordinary factory work, it is advisable to use as many motors as there are line shafts of any considerable importance; that is, line shafts on which the power is sufficiently great to warrant the installation of a motor, it being unwise to use motors of small capacity, owing to their comparatively low efficiency and increased first cost of the installation. The use of a single motor per floor in most cases is not warranted, particularly in those factories where shafting is on all four sides, as frequently happens in woodworking and shoe factories, in order to obtain the best results from the lighting.

Where one motor per floor is used, not only is there friction loss from shaft to shaft, but there is also what is infinitely worse, the possibility of a very considerable decrease in speed beyond that shown by the pulley ratios, due to the slip of the belts. The result is that the total productive capacity of the plant is not realized; and further, this motor has to be made large enough to handle all of the machinery that may be operating on that floor, whereas the average conditions may be a very small proportion of the machines on the floor in operation.

Group drives require careful installation with a careful choice of the number of machines per motor, and the size of the motor should be adapted to the average demand for power, and not the maximum, allowing the motor to take care of the maximum load by its overload capacity and choosing the group of such size that the overload which may be possible on the motor from that group, does not exceed the overload capacity of the motor.

The question of what type of motor to use depends entirely on conditions of installation and the work to be done. In many cases direct-current motors are more satisfactory than alternating, and then again the reverse is true.

It is apparent from Mr. Macintire's article, that the installation in the plant he speaks of was improperly done. There is no necessity for having a power factor so low as 65 or 75 per cent. in well laid out factory installations, where the power required can be comparatively readily figured. It is probably more than likely that the low power factor was due to too large motors, and possibly to too few of them. I do not mean that the motors in themselves were too large, but that the motors were too large for the work they were called upon to do, as there is no reason why induction motors should not operate at considerably over 75 per cent. power factor, if worked up to or near normal capacity.

The installation of a synchronous motor to take care of the wattless current, is by no means as troublesome a piece of work as he seems to consider. The motor might be installed to drive any piece of apparatus which is constantly in operation, and need not necessarily be of any such large capacity to make an improvement in the power factor.

We recently installed a synchronous motor for the purpose of improving the power factor, which raised it from 55 to 85, or 90 per cent., and the actual power required by the synchronous motor was in the neighborhool of 30 kilowatts, the total load on the system averaging 300.

The principal points to be considered in the layout of any electric system are, keep the motor well loaded, use sufficiently high voltage so as to allow of comparatively small copper in the distributing system, a small loss and, therefore, good regulation over the distributing system; proper installation and location of capacity, either rotary or fixed, to overcome lagging current, if necessary, the proper grouping of the motors and machines, so as to obtain the maximum flexibility of operation, and the assurance that under no conditions can the maximum overload capacity of the motor be exceeded. In the groups, it is absolutely necessary to plan for a good belt system, so that the belts are never taxed and the slip practically eliminated. This may mean a slight increase in first cost, but it is more than compensated for by the decreased maintenance cost and increase in production.

Where possible, the direct-current motor has some advantages over the alternating, these being, however, principally in the slight increase in efficiency and the avoidance of any of the power-factor troubles. On the other hand, there is the increase in maintenance cost; and, if it is necessary to inclose or partially inclose them on account of fire, there is also the increased first cost. Where motors are constantly started and stopped, particularly if of moderate size, or of large size compared to the generator, there is no question as to the advisability of the use of direct-current motors. Their installation, however, requires a careful and thorough investigation before deciding on the type of motor, and must be judged in accordance with this study.

HENRY D. JACKSON.

Boston, Mass.

## Unscientific Scale Prevention

The article on "Unscientific Water Softening" in a recent issue, reminds me of a similar experience I once had when "chief engineer and oiler" of the Claybury Electric Light and Laundry Corporation.

The chief assistant, who was a technically trained man (correspondence), got the idea that by feeding coal tar into the boilers, the scale would stick to the tar and could be thus blown out by means of the blow-down cock. He experimented by mixing scale and tar in a bucket and found that it acted excellently, so after chalking formulas all over the boiler front, he ordered 20 gallons a day to be pumped into the boilers. All went well for a month, except that the safety valves got gummed up and would not lift and the water gages did not seem to work as they used to do. But he said that did not matter, as he had worked it all out mathematically and chemically that the boilers would not need cleaning for a year.

The crisis came one Sunday night, when we were running on the batteries, although the engine was running because the stop valve was jammed and could not be closed. The head fireman, who was greatly agitated and ghastly white, woke me up, and said that the bottom of the boiler was visibly swelling, and then "hiked" for home. I ran round to the boiler room to investigate and found the furnace crown resting on the firebars.

I nearly cried with joy! This was the chance I had been waiting 16 years for, so as to make good and show my worth, and I saw visions of the boss congratulating me and clapping on $50 a month to my wages.

So I hung a couple of spare firebars on the safety valve and stopped the feed pump in case of accident and, dashing into the engine room, disconnected the needle valve from the lubricator and hustled back to the boiler room. Then I tied the needle valve to a slice bar with a bit of my boot lace and pricked the blister very carefully. This let all the foul matter out and with a sigh of relief the furnace crown rapidly resumed its normal shape, so that I had no difficulty in keeping the engine running until the cylinder cover blew off a week later. I, of course, wrote an article telling the world how I saved the town from a frightful disaster, and had the pleasure of seeing my name in print, which more than compensated me for not getting the anticipated raise.

U. R. A. Nother.

Claybury, Mo.

## Engine Cylinder Can't Act as a Pump

In the November 9 issue, under the heading, "A Peculiar Power Plant Accident," W. Mellen states his opinion as to how the water got into the cylinder, and ends up with the following words: "The steam cylinder offered the least resistance, as it was acting as a pump."

I should like to ask Mr. Mellen to explain how a steam cylinder can act as a pump using the exhaust pipe as a suction pipe? In my opinion it cannot be done, as the construction of the valves forbids it.

Peter Petersen.

Boston, Mass.

## Engine Room Safety Appliances

On page 753, of the November 22 issue of Power and The Engineer, C. R. McGahey mentions several fatal accidents due to men stepping into uninclosed flywheel pits.

Railings around flywheels are, perhaps, unknown in certain sections of the country, but I am sure the conscientious factory inspectors or mill superintendents will insist that all wheel pits must be guarded.

Entirely inclosing the wheel with a wooden casing, as is sometimes done with balance wheels, is surely not good practice, and very inconvenient if the engineer wants to make a thorough inspection of the arms or rim of the wheel. This inspection should take place, at least weekly, and the arms carefully cleaned and examined for fractures. A little time for examination may, perhaps, prevent a serious flywheel explosion. The most common railings are of wood or ordinary iron pipe and fittings. The objections to guards of this kind are that they have enough space between rails to allow planks or bars to get caught between the arms of the wheel. With engines directly connected to roll trains, the breaking of the driving coupling box is not unusual, and the broken pieces rolling between guard rails can easily drop on the arms or rim of the revolving wheel.

The best kind of guard should be made out of $\frac{1}{8}$-inch black sheet steel, which can easily be clamped to the pipe railings if they are in place. These plates should be at least from 4 to 5 feet high, and should extend around each end of the flywheel, over the engine bed, and at the main and outboard bearings. Suitable openings, or hinged doors, should be provided for getting the engine off centers. Railings of this kind look neat, are easily cleaned and are a good protection; no dirt or sweepings can find their way into the pits and any bars or chunks of wood must drop in from above. The engineer cannot slip or make a misstep and fall between the rails, or slip off the steps at the outboard bearings and fall into the wheel pit.

Recently certain large corporations have spent thousands of dollars for safety appliances or guards to prevent accidents. In some cases I know that prizes have been awarded to the workingmen giving the best suggestions for safeguarding extremely dangerous places. I believe that the most dangerous places around machinery or engines will be found in plants owned by one or two men, who do not care to go to the expense of installing safety appliances.

Equally as dangerous as an open flywheel pit is the flywheel itself, especially so if the engine is not protected with a speed-limit controller and engine stop, having suitable push-button connections distributed throughout the plant. Other dangerous places are crank disks, eccentrics and connecting rods; the fan-tail type of disk is very dangerous. Suitable guards with access for feeling the crank pins are easily made of thin sheet steel and at small cost.

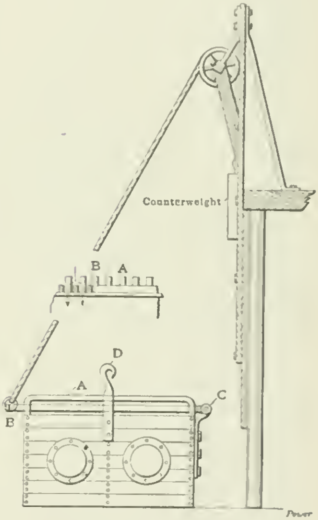
Unprotected tail rods should have removable pipe railings around them or covered with a sheet-iron casing. Any indicator attachments, such as a steel pointer attached to the crosshead, are very dangerous. The engineer accustomed to walk around the engine knows the dangerous places, and indicator pointers attached for a short time only have in several cases caused serious accidents. Set screws and projecting keys at the governor spindle and pulleys frequently get caught in the engineer's jumpers. At all switchboards or electrical connections of any kind, there should be danger notices.

Chicago, Ill. W. P. Watson.

## Seaweed and Condensers

The following is an account of the fight waged against the seaweed nuisance at a certain power house. Most all kinds of suction strainers had been tried with poor results, and eternal vigilance, in the shape of daily examinations of the tubes of the surface condenser, and the strainer plate of the jet condenser, was the price paid for operating those apparatus with due regard to the vacuum maintained. With mind continually trained on the subject, however, the simple arrangement shown in Fig. 1 was finally constructed, which has proved so effective that these troubles have become but memories.

A chest, large enough to accommodate the foot valves of the two suction pipes, was built of 2-inch white-oak planks that had previously been treated in a creosote vat. The specially cast grating *A* was secured to the top edge of the box by copper screws. The grating bars are $\frac{3}{8}$ inch thick by $1\frac{1}{8}$ inches deep, and are pitched $\frac{3}{4}$ inch from center to center. The grate *B* drops down in the $\frac{1}{2}$-inch interstices to such a distance that the water inlet on each side of it is a scant $\frac{1}{4}$ inch. The grate is hinged at *C*, and the simple act of lifting this grate up will clear the upper grate *A* of all accumulated rubbish. It is necessary, however, to swing the grate *B* backward and forward in the water to free it of the dirt it has lifted off the grate *A*. Sometimes, especially after a rough sea, the grate is leaned over against the dock planks, and a long-handled rake passed over it.



PROTECTION TO CONDENSER PIPES

To balance the weight of the grate and assist in swinging it, the contrivance shown on the edge of the wharf, consisting of a rope sheave and counterweight, was rigged up. The cleaning is attended to daily. The hooks *D*, two in number, were introduced to facilitate raising the grate when it becomes necessary.

R. O. Richards.

Framingham, Mass.

## A Modern Ice Plant in Chicago

In the table given on page 694 for the economy and cost data for Skinner engine in run No. 5, under "Average Absolute Pressures" is given the following:

Absolute pressure at cutoff 98.36 pounds.

Weight of steam per cubic foot, 0.2575 pound.

And similarly for release and compression.

On comparing these figures with Peabody's steam tables, I find that the weight of steam for an absolute pressure of 98.36 pounds is 0.2236 pound per cubic foot. If we add 14.7 pounds to 98.36 pounds, we have 113.06 pounds pressure, and the weight per cubic foot becomes 0.2548. It would, therefore, seem that the pressures given in column headed "Average Absolute Pressures," should be "gage pressure" rather than "absolute pressure."

In determining the steam used per indicated horsepower-hour, the weight of steam present in the cylinder at cutoff has been determined, the weight of steam present in the cylinder at release has been determined, and the average of these two values minus the weight of steam in cylinder at compression has been taken to represent the water rate of the engine. When the engine is operating as shown in run No. 5, the steam consumption determined at the point of release is 39.5 per cent. greater than when it is determined at point of cutoff, and the average of these two rates has been taken as representing the steam consumption of the engine. The averaging of these values makes a very nice-looking water rate for the engine, but I do not see that it represents, even approximately the amount of steam which the engine is actually consuming.

The difference between the weight of steam present in the cylinder at release and at cutoff must be due to the reevaporation of steam initially condensed in the cylinder during admission. The figures given indicate that this cylinder condensation is high, and we have no means of knowing whether all of the steam condensed in the cylinder during admission is reëvaporated by the time the point of release is reached or not.

Assuming that the steam furnished the engine is approximately dry steam, it means that the condensation in the cylinder has been furnished to the engine as live steam, and should therefore be charged up against the engine in determining the water rate; therefore the water rate should be determined by using the amount of steam shown to be present in the cylinder at release, rather than that in the cylinder at cutoff, or the average of these two values; and even in this case the actual amount of steam required by the engine might be considerably greater, due to the presence of condensed steam in the cylinder which had not been reëvaporated up to the point of release.

At the bottom of page 694, next to the last paragraph in the third column, is the sentence, "The steam used per kilowatt-hour was found in the same manner, by using kilowatt hour instead of indicated horsepower-hour in the previous water-rate formula." The meaning of this sentence involves apparently the existence of an indicated kilowatt-hour, and this method of obtaining water rate per kilowatt-hour is beyond me. The method ordinarily adopted is to divide the rate per indicated horsepower-hour by 0.746, and the combined efficiency of the engine and generator.

In the second paragraph, page 695, it is stated that the cost of evaporating is $0.1128 per thousand pounds. Immediately following this the cost per kilowatt-hour is determined by multiplying 0.1128 × 40.54, and obtaining 4.61, which in the table on page 694 is shown as 4.61 cents. There must have been some decimal points lost in this equation somewhere, for if the cost of evaporation is $0.1128 per thousand pounds, the cost per pound will be 0.01128 cent, and 40.54 pounds will therefore cost 0.457 cent. If the cost per kilowatt-hour is 4.61 or 4.57 cents, then the cost of evaporating 1000 pounds of water must be $1.128. I very much doubt the reliability of the figure $0.1128.

It is further on stated that in manufacturing 125 tons of ice, 28.50 tons of coal were used at a cost of $38.50, or $1.35 per ton. The rate of evaporation is therefore 250,000 pounds divided by 56,000 pounds, or 4.5 pounds of water evaporated per pound of coal. The cost of coal for evaporating 1000 pounds of water would therefore be

220 × (1.35 ÷ 2000) = $0.1485.

R. D. De Wolf.

Rochester, N. Y.

In the October 26 issue, is a description of a modern ice plant with figures of power costs, etc. Being interested in such matters I greatly enjoyed reading the article but in comparing the different figures for power costs, etc., I could not arrive at any definite conclusion, and would like some further information on a few points.

It is stated on page 695, that the output of this plant is 125 tons of ice per 28.5 tons of coal, with the remark that this falls a trifle short of the standard ratio of 6 tons of ice per ton of coal.

125 ÷ 28.5 = 4.38

tons of ice per ton of coal;

6 — 4.38 = 1.62 *tons*,

or 27 per cent. less than the standard ratio, and the output of this modern plant will have to be increased accordingly to make up this trifle mentioned.

What is a trifle in Chicago anyhow?

The cost of evaporating water is given as $0.1128 per 1000 pounds = $0.2256 per ton, which with 28.5 tons of coal at $38.50 equals

38.5 ÷ $0.2256 = 170

tons of water, or an evaporation of

170 ÷ 28.5 = 6

pounds of water per pound of coal. Is this another trifle short of another standard?

We beat that here every day in plants that are a long way from modern.

The above figures account for 170 tons of water, which at a cost of seven cents per 1000 gallons equals $2.87, but the cost for water is given as $5.94 or equal to 353 tons.

Of this, 125 tons is made into ice, but what do they do with the other 228 tons? In looking at the figures of engine performance (under weight of steam in cylinder at cutoff and release, lower columns, run No. 1, page 694), there is much more steam at release than at cutoff, and this may account for some of the missing water, but how does it get in the cylinder after cutoff?

It is stated that the alternators do not operate very well in parallel. Having had a little experience in this line I would like to offer a suggestion, free of charge. Get another governor like the one on the Skinner engine and put it on the Ideal and adjust it so the engine will run just 0.2 revolution per minute faster than the Skinner and sell the synchronizing apparatus. When you get a governor that will regulate like the one on that engine it certainly has them all skinned. It is stated that the most economical load for this 75-kilowatt unit is about 50 kilowatts or 2/3 load. Working out the efficiencies at various loads, they equal:

At
68.425 kilowatts = 76 + per cent.
64.85 kilowatts = 79.3 per cent.
58.775 kilowatts = 76.02 per cent.
27.525 kilowatts = 65.2 per cent.
25.05 kilowatts = 65.5 per cent.

From this it will be seen that the point of maximum efficiency is about 65 kilowatts, and if the figures for cylinder condensation and leakage were given to not less than 5 decimal places, we would find the point of maximum efficiency to be somewhere near the full load, say 75.2049 kilowatts to be in harmony with the rest of the figures.

Comparing run No. 2 with No. 9, we find that an increase of 0.35 kilowatt increases the efficiency about 12 per cent., but when we compare run No. 3 with No. 7 we find that an increase of 2.475 kilowatts *lowers* the efficiency.

The load of 25.05 kilowatts must be the critical point, is it not? Or has the extra 0.05 kilowatt any influence in this performance?

When columns of figures are given to 5 decimal places, and loads of $\frac{5}{1000}$ kilowatt are taken into consideration, we have to sharpen our pencil to a fine point at one end, and use the whole lead at the other to guess at the amount of cylinder condensation and leakage that the indicator missed, and then we ought to be exact in multiplying. For instance, on page 695 we find this: $0.1128 \times 40.54 = 4.61$ cents per kilowatt-hour, which is just $\frac{3}{1000}$ of a cent too much, and in the last column of kilowatt-hour costs, on page 694, we find all of them out, some to the extent of $\frac{5}{1000}$ of a cent, and in 1023 years it would make a big difference to the man who foots the bill.

Taking the figures as given for the load of 64.85 kilowatts and adding 20 per cent. to the given water rate of 40.54 making the rate 48.648 pounds, we find that it takes exactly 8.108 pounds of coal per kilowatt-hour, for the plant in question.

Well, the load is coming on and the governor is slowing her up so I will slow up too.

ALBERT IHLENFIELD.

Cleveland, O.

## Safety Cams and Trip Collars

I have read with much interest Harry W. Benton's article in the November 2 issue, page 756, but still I am not convinced that his method of setting the trip cams on a single-eccentric Corliss engine is correct. While it would be satisfactory if the engine were to run under ideal conditions, at all times, it must be remembered that few of us are so fortunate as to always meet with those conditions.

Mr. Benton states that with my style of setting and with a temporary overload the engine would at times take steam nearly full stroke and the speed would be unsteady.

I still maintain, however, that it is the best that can be done, and far preferable to being down and out, which would be the case if the point of cutoff were limited to three-eighths stroke.

As Mr. Benton and I seem to be unable to agree I would like to hear what others have to say on the subject.

L. ROUNDRY.

Concord Junction, Mass.

## Cylinder Lubrication

I have been greatly interested in many of the articles on steam-engine cylinder lubrication that have been published in late numbers and am desirous of adding my mite to the fund of information that POWER is collecting on the subject.

For sixteen years, prior to 1897, I was employed as an operating engineer; since then my entire time has been devoted to the testing of lubricants, and in overcoming the difficulties experienced in the lubrication of machinery.

As a result of such employment my opportunities for studying the subject of lubrication have been greater than those of most engineers.

I find that to secure perfect cylinder lubrication the oil should enter the steam as it journeys to the cylinder; the oil thus becomes atomized (not vaporized), but is broken into small atoms and in the form of a spray covers the valves, valve seats, piston and cylinder walls with a film of oil. The oil intervening between the wearing parts reduces the friction of the same in proportion to the value of the oil as a lubricant.

Frequent tests have demonstrated the fact that the power used by an engine in overcoming the friction of its moving parts varies from 3 to 20 per cent of the total power the engine is capable of developing, and the proportion of power lost in overcoming the friction of the moving parts of an engine depends, to a great extent, upon the manner by which the cylinders are lubricated.

Some idea of the amount of power lost by the failure to lubricate steam cylinders can be gotten by the one who is curious to know in the following manner:

Do not admit any oil to the steam cylinder or cylinders of a pump that is operating against a fixed pressure (such as a pump supplying water to the boilers) for a period of three or four hours; at the expiration of that time count the number of strokes the piston is making in thirty seconds, then open the lubricator valve and allow the oil to flow freely to the steam cylinder; the admission of the oil will always result in an increase in the speed of the piston. This increased speed is due solely to the reduction of the cylinder friction made by the lubricant.

Nearly every engineer who reads this article will recall times when having filled the lubricator (which has been permitted to "run dry") and again started the oil into the steam end of the pump, he has been compelled to partially close the throttle valve to prevent the pump from "running away." It is to prevent cylinder friction, and thus permit all the steam used to do useful work, that a lubricant is used in the cylinder. That a given quantity of one cylinder oil will reduce friction to a greater extent than the same quantity of another is, of course, true.

Many engineers do not appear to realize how great the loss of power due to imperfect cylinder lubrication may be, nor that cylinder friction can be more economically overcome by the use in proper quantities of a good cylinder oil than it can with coal.

During a recent test of cylinder lubricants two drops per minute of "600 W" cylinder oil were used in a 14x24-inch slide-valve engine, making 130 revolutions per minute. This engine was connected by means of a belt to a dynamo, and all of the bearings of the engine and dynamo were operated in a bath of oil. Thus lubricated, and with the engine operating the dynamo at full speed, but without developing any power, a series of indicator cards was taken simultaneously from both ends of the cylinder. These cards when measured with a planimeter showed that 18 horsepower were required to overcome the friction of engine and dynamo.

Having secured the friction cards, the load was thrown on the engine, and it was operated for a period of four hours during which time no oil was admitted to the steam cylinder. At the expiration of the four hours the load was again thrown off and a series of friction cards were taken in the same manner as had previously been done; these cards when measured showed that 27 horsepower were required to overcome the friction of engine and dynamo, or that the cylinder friction had increased 9 horsepower.

At this point an oil having the same gravity, flash, burning point, and viscosity as "600 W" cylinder oil, but made by a different process was admitted to the cylinder at the rate of two drops per minute for a period of 30 minutes, when another series of cards were taken, which upon being measured showed that the friction had been reduced to 24½ horsepower. Four drops per minute of the same oil were then fed to the engine for another period of thirty minutes, after which cards were again taken. These cards when measured showed that 22 horsepower were required to overcome the friction. Recourse was then had for fifteen minutes to "600 W" cylinder oil, which was admitted to the cylinder at the rate of two drops per minute, with the result that the cards then taken showed the friction had been reduced to 18 horsepower. At no time during the test did the engine show any outward sign of cylinder friction either by groaning in the cylinder, vibration of the valve rods, or by heating of the eccentric, but it ran as quietly without any lubricant as it did when perfectly lubricated.

The fact that oils have the same flash, burning point, specific gravity and viscosity does not indicate that they are the same oils or possess the same power to overcome friction.

The value of an oil for the purpose of overcoming friction depends upon the grade of the crude oil itself, the process of manufacture and its general treatment. The value of a cylinder oil should be determined by its power to reduce friction and not by its price per gallon. The fact that an engine operates quietly does not always prove that the cylinder friction has been reduced to a minimum.

CHARLES H. GARLICK.

Pittsburg, Penn.

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A few notes relative to the cylinder lubrication of our plant here may prove of interest and especially so as engines of all ordinary types are included and running under different conditions from high-class Corliss compound-condensing units in power-house service to the old reliable slide-valve type running under the disadvantage of surrounding dust, and 25 per cent overspeed.

Considering first the power-house engines which have a 24 hour service practically every day the sun rises, a barrel of cylinder oil of one of the best grades is used each month under the following conditions: Steam pressure 115 to 120 pounds, force-feed lubrication on each high- and low-pressure cylinder, and ample steam-header drainage to insure practically dry steam.

To estimate the oil consumption per horsepower-hour the size, speed, etc., of the different engines must be considered as follows:

(a) One Corliss cross-compound condensing unit 18 and 34 by 36, revolutions per minute 86, and average horsepower 350; oil is piped to enter on top of each admission valve and the feed regulated to about one drop per two revolutions for the high-pressure side and to about one-half this amount for the low-pressure side. Any reduction of this feed will easily show up the increased friction of the valves through the valve gear and eccentrics not working so free.

(b) One Corliss cross-compound condensing unit 16 and 30 by 36, revolutions per minute 84, and average horsepower 250; oil feed, piped and regulated practically the same as (a).

(c) Two Corliss cross-compound units, positive valve gear, flywheel governor, 16 and 27 by 20, revolutions per minute 150 and average horsepower of 150 each; oil is piped to steam pipe just above throttle for the high-pressure cylinder and into the steam chest midway between the two admission valves for the low-pressure side. As these engines are governed through the high-pressure admission valves alone, it is necessary to keep them well lubricated to insure close regulation and for that reason it has been found good practice to feed from two to three times the oil on the high-pressure side that is fed on the low-pressure side.

(d) Two Cameron pumps, tandem compound, 14 and 28 by 20, piston speed about 80 feet per minute and average horsepower of 75 each; oil is fed by common hydrostatic lubricator into steam pipe alone at a rate of about one drop per minute and this feed also supplies the steam cylinder of the jet condenser, 12x18 and piston speed of 90 to 100 feet per minute giving average horsepower of say 25.

As but one of the pumps and one of the 16 and 27 by 20 generator engines are run continuously (being run alternate 12-hour runs) the total horsepower of the plant amounts to (a) 350 + (b) 250 + (c) 150 + (d) 100 = 850 under average conditions. This for a 24-hour service gives 850 × 24 × 30 = 612,000 horsepower-hours per month. At the rate given above of one barrel per month, the consumption amounts to 612,000 ÷ (50 × 4) = 3060 (say 3000 flat) horsepower-hours per quart of oil. As the price is largely dependent upon the freight rates, the local cost per barrel would not be of much use for purposes of comparison. However, it may be said that the present high-grade oil used is found to be much cheaper than a former oil which was from 25 to 30 per cent. cheaper per barrel.

Another trial of the "cheaper" kind (the accompanying cigars being N. G.) on a couple of slide-valve twin engines 14x20, with piston speed of 650 feet per minute, resulted in trouble all round. The engines were at a distance of about 100 yards from the boiler house and with no traps or separators in the steam line, quite a lot of water was passed through them at various times, resulting in washing the oil film off the valves and valve seats. Upon examination of these surfaces it was found that the valve seats of some of the cylinders were cut and grooved to a depth of 3/8 of an inch, and the valve faces from 1/8 to 1/4 of an inch deep. After facing off the valves and putting in new valve seats made in a hurry from a section of old boiler-room cast-iron flooring, the cylinder oil was changed to the high-grade make and no further trouble has been experienced.

That a cheap oil has its place in certain cases is apparent from the steady service of another slide-valve engine, of cross-compound type 16 and 28 by 36, piston speed of 480 feet per minute and situated at the same distance from the boiler house as the twin engines mentioned above. This engine, which is about 350 horsepower will run nicely on 2 quarts of the cheap oil per day of 10 hours and goes to prove that a moderate piston speed is an important factor in the lubrication of the cylinders. The twin engines before referred to were run at an in[illegible]e of 30 to 33 per cent. of their normal speed, and hence, carried a large overload.

And finally, as an example of an engine run part of the time on cheap cylinder oil and the balance of the time on none whatever, we have the case of a slide-valve engine in the machine shop. The lubricator of this typical shop engine is filled every semi-once-in-a-while by the shop boy (oftener in cold weather), and yet a recent inspection of the rubbing surfaces proved them to be in first-class condition. This engine has been known to run a couple of weeks at a stretch (10-hour days) without cylinder lubrication.

So that it seems, as some other correspondent said, that the problem of cylinder lubrication is largely one for individual solution, depending upon local conditions and type of engine.

J. A. CARRUTHERS.

Bankhead, Alberta.

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I am using a good grade of compounded oil called "cylinder oil No. 10," which costs about 25 cents per gallon.

The steam pressure at boilers is 150 pounds with no superheat.

One engine, a double-eccentric Corliss 30x48-inch, running from 70 to 90 r.p.m., in taking steam through 100 feet of 12- and 10-inch pipes (covered) with a separator near the engine uses six quarts per 24 hours, costing 37½ cents per day.

One engine 30x48-inch, piston valve, 85 to 98 r.p.m., taking steam through 130 feet of covered pipe with separator near engine uses five quarts per 24 hours, costing 31 cents per day.

One engine 20x36-inch Corliss, running 102 r.p.m., with 50 feet of steam pipe connected to bottom of header and no separator uses two quarts per 24 hours, costing 13 cents per 24-hour day. This cylinder is frequently opened and is found to be well lubricated with this oil and the wearing of the cylinder and piston seems to be uniform without scoring or cutting.

One engine, 12x14-inch slide valve at 210 r.p.m., 40 feet of steam line (covered), no separator, uses one quart per 24 hours, except when boilers prime; then about one pint more is used, costing six to nine cents per day. In addition to the oil that the above mentioned cylinders get, each one is given about two tablespoonfuls of flake graphite every 24 hours mixed with engine oil and pumped in with the hand pump. The reason for using engine oil with the graphite is that it is thinner and will carry the graphite better. There have been several oils tried on these engines in the last three years, some costing as high as 60 cents per gallon and some cheaper than that which is used now. After a satisfactory test the above mentioned brand was selected as the best for the money. "600 W" oil was tried but the cost could not be kept down as low as at present. I do not think this oil is compounded to give the best results in all places, but is doing all right here.

I do not think that a certain oil will give the best results in all plants owing to a difference in pressure, moisture, superheat and type of engine, also condition of steam line, but the only way to get a satisfactory oil is to try different kinds and choose the one that gives the best results for the same cost whether it be 25 cents per gallon or 70 cents per gallon, and the engineer in making a change in oil must keep a very close watch on the cylinder in order to know what is going on inside.

One pound of flake graphite fed as above stated with the oil will do as much good as five gallons of oil and only costs about 15 cents per pound.

J. C. Hawkins.

Elyria, O.

In regard to the letter by A. I. Haight in the November 9 issue, would say that I have been shipmate with large marine engines where oil was used in the cylinders and where no oil was used, and could not observe any difference in the running of the machinery. It must, however, be borne in mind that the modern marine engine is of the vertical inverted type, having almost invariably piston valves on the high-pressure cylinders, very commonly piston valves on the intermediate cylinders and sometimes piston valves on the low-pressure cylinders. It will be seen that the weight of the piston and part of the piston rod is not carried by the cylinder, as in a horizontal engine. This is especially true of an engine having tail rods to guide the piston and keep it central in the cylinder. It is customary to have a bucket with cylinder oil and a brush to swab the rods to prevent them from getting hot as mentioned by Mr. Haight. It is often necessary to put a little oil in the low-pressure cylinder upon starting up, and in many cases kerosene is used, or kerosene with a little graphite added.

As to cutting, it does not occur, but the wearing surfaces take on a polished, mirror-like surface instead. The water of condensation undoubtedly acts, in a certain measure as a lubricant, as it is often necessray to stand by the low-pressure rod with a swab while the engine is running slow to prevent heating, for the cylinder is running under a vacuum which prevents water penetrating the packing.

It is customary to fit the cylinders with liners of hard, close-grained iron, which are secured by being flanged and bolted to the cylinder at the bottom and are made tight at the top with packing and a follower, or with a copper wire calked into an undercut groove which allows the cylinder and liner to expand lengthwise independently of each other. When the liner becomes worn so that it will not pay to rebore, it may be removed and another one inserted at a moderate expense.

Valve chests are occasionally lined with bronze instead of cast iron but only where expense is a secondary consideration. While I am not in a position to say whether or not there is more friction in running a piston-valve vertical engine without oil than there is in running the same engine with oil, I think it is more economical to dispense with oil when it can be done. The small amount of friction is in my opinion more than balanced by the purer feed water, as the steam is condensed and used for boiler feeding. Of course graphite is not so objectionable in a boiler, but oil in boilers carrying the high pressures now carried at sea is to be avoided if possible, and it is cheaper in most cases to run without oil than to fight oil in boilers. Separators could, of course, be used to extract the oil, or filters like those in common use could be depended on to separate the oil from the feed water, but I think the better plan is to dispense with the use of oil where possible.

I do not think it possible to run the engines mentioned by Mr. Haight without oil in the cylinders. It is of the greatest importance that the valves of Corliss and similar types having releasing valve gear should run without undue friction on the valves.

Albert T. Rowe.

Wethersfield, Conn.

## Meeting an Emergency

The editorial, "Emergencies Bring out the Man," reminds me of a case that came under my notice. An engine used for rolling-mill work had the rod from the governor sleeve to the knock-off lever threaded into brass eyes without check nuts. After a term of about 15 years the vibration had worn the threads, so that the rod pulled out of one of the brass eyes, thus breaking the connection between the governor and the cutoff hooks.

The engineer was on the crosshead side of the engine looking out into the mill and saw a bar go into the rolls faster than usual. He turned to look at the crank and saw at once that the engine was speeding up. He jumped around the high-pressure cylinder and taking hold of the cam rollers, one in each hand, unhooked both steam valves and held them so until the engine came to a stop. To have closed the throttle would have taken 15 turns of the handwheel, and before that could have been done, the engine would no doubt have been a wreck, as when the speed began to increase, all the mill hands stopped working to see what was the matter, and thus threw most of the load off the engine.

The engineer went to the carpenter's shop and got a piece of wood about the right length, had the carpenter bore holes in each end the size of the pins on the sleeve and knock-off crank and had the mill going again in 20 minutes. After it was all over the master mechanic came around and scolded because he had not noticed that the rod was loose in the threads. He may have been at fault, but evidently he had his head with him when there was danger to be overcome.

W. E. Hopkins.

Torrington, Conn.

## Piston Speed Puzzle

On page 878 of the November 23 issue, Mr. Tallmadge asks whether it takes the same time for the piston of a reciprocating engine to move from the center of its stroke to the head end and back to the center again as it does from the center to the crank-end and back to the center; or if not, at which end does it move the faster.

A brief study of the accompanying sketch will show that at the head end the piston is moving considerably faster than at the crank end. *A B D* shows the relation of the connecting rod and the crank when the piston is at the center of the forward stroke, and *A C D* the same relation when at the center of the return stroke. It is seen that during the head-end cycle the crank moves from the position shown at *C* to the position *B*, which is an angular movement of less than 180 degrees, while during the crank-end cycle it moves from *B* to *C*, an angular movement of more than 180 degrees.

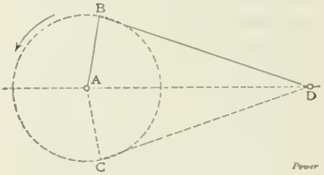

DIAGRAM OF CRANK CIRCLE

Assuming that the angular velocity of the crank is uniform, it is easily seen that it will take less time for the crank to move from *C* to *B* than from *B* to *C*, and since the distance traveled by the piston is the same in each case it follows that the velocity of the piston during the head-end cycle must be greater than during the crank-end cycle.

W. L. Durand.

Brooklyn, N. Y.

If a person will make a little sketch of the pistons, crosshead and flywheel, he will readily see that the crosshead travels the fastest at the crank end of the stroke. Start with the crosshead at the crank-end dead center and move the piston to the center of its stroke, when it will be seen that the crank will not be in a vertical position, due to the angularity of the connecting rod, but will have a small distance to go before the crank reaches the quarter.

Then move the piston on to the end of its stroke when the crank will be at the head-end center, but the travel of the crank has been more than one-fourth of a turn by the amount it was from the vertical position before. A reverse action takes place on the return stroke. Therefore, if the crank is revolving uniformly, it takes less time for the first part of the stroke than the second, but the piston goes the same distance in each case.

B. L. Adams.

Ithaca, N. Y.

## Manning Boiler Explosion

In your editorial in the November 9 issue, you state that the explosion of the Manning boiler at the Amoskeag Manufacturing Company, is the first of this type of boiler to explode since its introduction, about 20 years ago.

You are mistaken, as there was a similar explosion of a Manning boiler about 15 years ago, in Nashville, Tenn., at the plant of the Cumberland Electric Light and Power Company. The lower end of every tube let go in the lower tube sheet. The sheet was bulged down about 14 inches.

One man was badly scalded, two others slightly, and the property damage was small. The boiler was raised vertically from its setting.

The writer was in the plant about two hours after the explosion happened. I am of the opinion it was a case of low water, and not faulty construction of the boiler.

H. R. Rockwell.

Mount Vernon, Ill.

The failure of the tube sheet of the Manning boiler described in the issue of November 9, page 780, justifies my contention that the tube ends of all fire-tube boilers should be beaded over, and especially in a boiler where the tube ends are exposed to the direct action of the fire. Flaring the ends serves the same purpose in a water-tube boiler, but will not do in a fire-tube boiler, for the reason that the thin projecting ends necessarily become overheated, and in a very short time lose all the holding power they ever had.

The experiments made by the Hartford company on the holding power of tubes, mentioned in an editorial in the issue of above date, are valuable as far as they go, but they do not take into account the fact that one man will roll a tube much harder than will another. It is quite possible, and in fact is usually the case, that tubes are rolled so hard that the walls are crushed to some extent, thus embedding the tube sheet in a groove, which adds greatly to its holding power, but to what extent this is done depends altogether upon the particular man doing the work. The ideal condition would be to roll the tube just hard enough to make it tight, yet not crush it at all, in which case its holding power would be very little. This ideal condition is probably never realized, but it is approached to varying degrees, so that in all cases the ends should be beaded over.

Mr. Manning's theory that the water was driven away from the tube sheet is quite reasonable, and may have been the cause of the failure, but on the other hand, it is practically impossible to keep the lower tube sheet clean in a boiler of this type, and a very slight accumulation of scale and mud would cause the tube ends to become overheated to practically the same extent as they would had the water been driven away from them. In either case, had the tube ends been properly beaded, it is very unlikely that the failure would have occurred.

M. Kennett.

Webster Groves, Mo.

## The Boiler Explosion at the Amoskeag Mills

The editorial in the November 9 issue, concerning the boiler explosion at the Amoskeag mills, has caused a somewhat uncomfortable feeling among engineers and firemen in these parts, who are operating boilers similar in construction to the one that exploded at Manchester, N. H.

The conditions are very much the same at all cotton and woolen mills, as to the excessive load at starting time in the morning, frequently being as much as 40 per cent. more than at midday. I have in mind a plant where the boilers are being operated at fully 80 per cent. above their rated capacity, and burning nearly 30 pounds of coal per square foot of grate per hour. It is found necessary to shut off the feed a few minutes every morning, the water level being in sight all the time. Now, the question comes up, is this a dangerous thing to do? Are our boilers liable to go up like a rocket because of this practice? And another question arising with the men who are working in front of these boilers, are the automatic stokers, with their forced blast, more liable to cause explosions of this kind than hand firing with natural draft?

There are quite a number of boilers in this locality similar to the one that exploded at Manchester, in respect to the tubes not being beaded. We were told by the designer and builder that the tubes should not be beaded at either end, and now we learn that all the tubes at the Amoskeag are to be beaded. This means new tubes if the boilers have run any considerable length of time. What we want to do is to avoid this sky-rocket movement of our boilers.

C. D. Thurber.

Biddeford, Me.

## How Shift Changes Waste Money

My harmless little articles, printed on page 498, has excited the kind attention of A. L. Anderson, on page 757, and Leon Roundy, on page 800 of Power and The Engineer. I agree with these gentlemen in the advisability of paying firemen liberally. In fact, I have taken the position, in print and elsewhere, that firemen should be paid more than stationary engineers. I also believe that a fireman should not be called upon to handle more than from 1000 to 1200 pounds of bituminous coal per hour, on a common grate, although many firemen handle more than twice that amount. In other words, it pays to have firemen underworked, so that they can give proper attention to their duties and produce desired economies. Again, I am an advocate of three shifts where plants operate continuously.

Having now stated my views, which really agree with those of your other correspondents, I desire to add that my article was prepared for clients who attend to the wage matter without my advice. I might add that in plants with three shifts I have experienced the difficulties complained of in my article, namely, that the firemen rush out as soon as possible and that the fires are neglected for a period of at least 30 minutes at each shift change.

J. M. Whitham.

Philadelphia, Penn.

Since the article by J. H. Whitham under the above heading appeared, September 21 issue, I have followed the discussion with growing interest. The replies to Mr. Whitham's article are alone sufficient evidence that there is not near so much coal wasted as he would have us believe.

The 12-hour shift in any plant of consequence is one of the greatest grinds with which men are burdened, but it is encouraging to note that many plant managers know that the eight-hour shift is a decided money maker and saver.

There are some small plants operating under some conditions where the 12-hour shift does not work any serious hardship or loss; for instance, a 100- to 300-horsepower plant where the engineer or fireman can sit down for from one to three hours or even more during the day.

A 1000-horsepower plant would hardly be for street-railway service, and that is about the only class of plant that consumes more power at time of changing shifts. Cotton and woolen mills might be a good example of a 1000-horsepower plant, and 12-hour shift, but there we find a decidedly high class of firing, and in many cases the use of mechanical stokers. In the great majority of cases there is plenty of boiler capacity, and there is no need of a wholesale dumping of coal into the furnace.

Another point which seems strange to me is that any concern could make money by allowing an engineer or chief of a department to keep such men, who waste more money in coal than their wages. I would first give my chief engineer a gentle reminder that coal costs money, and if the firemen had to shovel and heave coal twelve hours per day and were dead tired at night, as most of them are, I would change to the eight-hour shift and see if the coal cost would not be a great deal less.

L. Earle Brown.

Roundup, Mont.

## A Centrifugal Pump Puzzle

In the issue of November 2, appeared a short article by A. I. Haight on the above subject, in which he wished to know how much water a certain centrifugal pump will pump.

I made a few calculations in regard to this problem in trying to determine how big the diameter of the casing was. This dimension is not given in his figure, and according to my calculations, which are given below, this pump will not raise water to the hight given in the problem.

Kent's handbook states that the lift of a centrifugal pump depends on the tangential velocity of the circumference of the pump, every tangential velocity giving a constant hight of lift, whether the pump is large or small. It is also stated in an article in the same issue of Power, by Paul Nettmann, that this relation between hight of lift and circumference velocity is true. This article happens to be directly below the one of Mr. Haight's. Kent gives (page 607) as a general formula that the velocity of the circumference of a pump to raise water to a certain hight is

$$V = 550 + 500 \sqrt{\textit{Hight of Lift.}}$$

Apply this formula to the problem stated by Mr. Haight; for a lift of 24 feet we have

$$V = 550 + 500 \sqrt{24} = 3000$$

feet per minute.

The circumference of the pump measured on the inside should be, at 350 revolutions per minute, 3000 divided by 350, which equals 8.57 feet. Solving for the diameter of the pump we find the diameter is equal to 2.73 feet, or 32¾ inches. It is clear that this size pump could not have runners only 10 inches long, for if the runners were straight and had no curve the maximum diameter would be the length of two runners, plus the diameter of the shaft, which equals 22½ inches in this case.

I would like to know what the diameter of the runner wheel is in this case, and since, in the drawing, the runners extend out to the inside diameter of the casing of the pump, as stated by Mr Haight, the problem does not appear simple to me

G. A. Glick.

Madison, Wis.

A centrifugal pump will do better work and with less attention and expense for Mr. Conners than a reciprocating pump. I have forced water 30 feet, 4 inches with a centrifugal, the vacuum being 15 inches and the lift 18 feet.

To pump water up over 50 feet a two-stage pump will, in my opinion, give satisfactory service. The suction pipe must be perfectly air tight and the shorter the better. I have my condenser vacuum pump connected below the check valves and discharge pipe, and use this pump to start the centrifugal pump.

Thomas Gordon.

Cheyenne, Wyo.

## Stress on Cylinder Head Bolts

In the November 16 number, page 838, Otto Johnson submits an illustration of a spring balance, which I think unfair because it does not truly represent the conditions.

Of course it is undisputable that if two or more weights were hung on the hook of a spring balance the total weight indicated would be the sum of the several weights, but that is no representation of the case.

I would suggest taking a light-weight basket or pail and secure it to the floor by a strong cord that is long enough to reach up 2 or 3 feet from the floor, and take the spring balance and hook it into the bail and draw upward until a tension or stress of say 10 pounds is indicated on the scale. This stress is, of course, exerted, between the force lifting the spring balance and the floor, through the empty basket or pail and strong cord, and is identical with the stress on the bolts exerted by the nuts when tightened up against an empty cylinder.

Now it will be found that we can put approximately 10 pounds of weight into our basket or pail without exerting any further tension on the spring balance, and, in fact, in order to increase the tension on the balance by adding weight we must put in more than 10 pounds.

The weight so added to the basket is identical to the pressure of the steam charges within the cylinder.

Therefore there is no additional stress on the cylinder-head bolts, unless the total stress exerted by the steam is greater than the total stress exerted by the nuts.

Charles F. Clark.

Hartwick, N. Y.

## Pound in an Engine

I read a letter under the above heading in the October 19 issue, page 672. It is stated that the engine is an old Atlas, and that as soon as the throttle is closed it "knocks horribly." From this I assume that when under steam the engine operates with a reasonable degree of quietness. It is further stated that "it is the opinion of the engineer that the shoe is driven downward against the guide at each forward stroke."

I do not see how this could be, since the crosshead shoe will be held under these conditions to the bottom guide by its own weight, when the engine is running with steam shut off. When the engine, running under, is under steam, then during the stroke the crosshead bears against the top guide, except when passing the centers, when it will drop to the bottom guide.

If the angle which the connecting rod forms with the piston rod when the engine crank is approaching and when on the quarters, is noted, and the direction of the forces acting on them, it will be seen why this is so. This is why an engine running under must be more closely adjusted in the guides than one running over. If the pound were in the crosshead, due to loose adjustment, then, as stated, the trouble would be more pronounced when under steam, than when running with throttle closed.

Again, if the trouble was due to loose wristpin brasses, as stated, the trouble would be more pronounced when the engine is under load than when steam is shut off, because the lost motion would, in that case, be taken up with greater shock.

I would suggest that the most likely causes would be that the clearance is not properly equalized, and this could be easily determined, and corrected by setting the piston rod further into or out of the crosshead.

I have two high-speed Atlas engines, with balanced valves, in which the valves slam badly when shutting down, but this slamming of the valve is easily distinguished from a pound in the connections from piston to crank. The slamming of the valves is caused by the engine being converted into a compressor as soon as steam is shut off, and the compression forces the valve from its seat, and the pressure plate being held against it by strong springs, seats it with a slam as soon as the engine piston reaches the end of its stroke, or the valve reaches a position where the compressed air can escape. Opening the cylinder cocks may lessen this slamming, but can hardly prevent it, as they present an outlet too small to care for the volume of air.

William Westerfield.

Lincoln, Neb.

# Shop Tests of the Westinghouse Double Zone Gas Producer*

During the past two years the Westinghouse Machine Company has had in experimental operation at its shops a 175-horsepower gas producer of the double zone type, designed for the gasification of bituminous coal and low grade fuels. Runs were made on all classes of fuel, from low-grade lignites to Pocahontas semi-bituminous coal, some trials were also made with peat. Some of the results of this series of tests were presented in a paper read by J. R. Bibbins before the Gas Power Section of the American Society of Mechanical Engineers. Table 1 is a schedule of the tests covered by Mr. Bibbins' paper, and Table 2 gives the proximate analyses of the fuels referred to in Table 1, as well as of the meadow peat used in unreported tests.

TABLE 3. FUEL DATA.

| Test | Lb. Charged Including Standby. | Lb. Charged. |  | Lb. per Sq.Ft. per Hr.[1] | Fuel Consumption. |  |  |  |
|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  | per B.H.P.-HR. |  | PER KW.-HR.[4] |  |
|  |  | Per Hr. | Max. |  | Gross.[2] | Net.[3] | Gross. | Net. |
| A | 5,003 | 151.6 | 160.8 | 15.2 | 2.3 | 2.3 | 3.33 | 3.33 |
| B | 60,740 | 194 | 228.5 | 19.4 | 1.59 | .... | 2.31 |  |
| C | 53,925 | 181.1 | 207 | 18.1 | 1.14 | .... | 1.66 |  |
| D | 27,157 | 169.2 | 222 | 16.9 | 1.39 | 1.19 | 2.01 | 1.73 |
| E | 35,647 | 184.6 | 202 | 18.5 | 1.24 | 1.08 | 1.8 | 1.56 |
| I | 4,849 | 104.2 |  | 10.4 | 1.37 | .... | 2.0 | .... |
| J | 6,065 | 126.4 |  | 12.6 | 1.25 | .... | 1.81 | .... |
| K | 6,403 | 133.4 |  | 13.3 | 1.06 | .... | 1.54 | .... |
| L | 10,699 | 149.1 |  | 14.9 | 0.983 | ... | 1.12 | .... |
| M | 16,964 | 233.1 |  | 23.3 | 1.82 | .. | 2.64 | .... |
| N | 14,503 | 272.1 |  | 27.2 | 1.80 | . | 2.61 | ... |
| F | 8,813 | 14.9 |  |  | This standby rate applies to previous tests. |  |  |  |
| G | 1,680 | 10.0 |  |  | Standby rate reduced by reducing updraft on fire. |  |  |  |

[1] Based on area at level of green fuel.
[2] Including standby coal.
[3] Standby fuel deducted.
[4] Based on 92.5 per cent. generator efficiency.

TABLE 1. SCHEDULE OF TESTS.

| Test | Date | Fuel. | Duration. Hours. | Hours per Day. | Load on Producer. |  | Remarks. |
|---|---|---|---|---|---|---|---|
|  |  |  |  |  | B.H.P. | Max. |  |
|  | 1908 |  |  |  |  |  |  |
| A | 4- 2- 4 | So. Am. lignite. | 72 | 11 | ... | ... | Purged gas. |
| B | 1-16-30 | Col. lignite | 314 | 24 | 121.7 | 156.9 | Continuous test. |
| C | 5- 8-23 | Pittsburgh | 298 | 24 | 158.3 | 129 | Continuous test. |
| D | 7-16-31 | Pittsburgh | 370 | 10 | 158.5 | 206 | Intermittent test. |
| E | 8- 1-25 | Pittsburgh | 514 | 10 | 170.8 | 190.7 | Intermittent test. |
| F | 9- 1-19 | Pittsburgh | 432 | Standby | . | ... | Standby test.<br>Fires blasted<br>1 hr. once in 24-hr. day. |
| G | 10-12-19 | Pittsburgh | 168 | Standby | .. | ... |  |
| H | 11- 9-11 | Pittsburgh |  | 10 | 137 to | 204 | Washer test and capacity test. |
|  | 1909 |  |  |  |  |  |  |
| I | 6- 1- 2 | Pocahontas | 46½ | 22½ | 75.6 |  | Continuous test. |
| J | 6- 3- 4 | Pocahontas | 48 | 21 | 101.4 |  | Continuous test. |
| K | 6- 5- 6 | Pocahontas | 48 | 24 | 126.5 |  | Continuous test. |
| L | 6- 7- 9 | Pocahontas | 72 | 24 | 150 |  | Continuous test. |
| M | 6-[illegible]0- 2 | Texas lignite | 72 | 24 | 128 | 135 | Continuous test. |
| N | 7- 7- 8 | Texas lignite | 42 | 24 | 157.2 |  | Continuous test. |

TABLE 2. TYPICAL PROXIMATE ANALYSES OF FUELS TESTED.

| Class of Fuel. | Moisture | Volatile. | Fixed Carbon. | Ash. | Sulphur. | B.t.u. per Pound As Fired. | B.t.u. per Pound Dry. |
|---|---|---|---|---|---|---|---|
| Meadow peat—Massachusetts ... | 38.10 | 40.54 | 17.86 | 3.50 | 1.05 | 6,410 | 10,340 |
| Lignite—South America. | 20.05 | 34.44 | 30.85 | 14.66 |  | 8,035 | 10,045 |
| Lignite—Northern Colorado ... | 16.63 | 33.78 | 42.22 | 7.37 |  | 9,589 | 11,500 |
| Lignite—Texas | 24.08 | 38.55 | 28.76 | 8.61 | 0.57 | 7,974 | 10,503 |
| Bituminous—Pittsburgh run of mine | 2.03 | 34.98 | 56.22 | 6.77 | 1.29 | 13,305 | 13,590 |
| Semi-bituminous—Pocahontas run of mine | 1.39 | 16.01 | 74.28 | 8.32 |  | 13,983 | 14,170 |

In the test with Texas lignite an important fact was brought out, which has especially puzzled theorists for some time, viz: That with a poor fuel the rate of combustion can be increased sufficiently to permit the same rating of the producer as with better fuel. This removes a heavy restraint on the development of producers for the enormous lignite fields of Texas, Wyoming, Colorado, Montana and the Pacific States. In test *N*, Table 3, a charging rate of 27.2 pounds per square foot per hour was maintained with Texas lignites and 15 pounds with Pocahontas, both at 150 horsepower load; with Pittsburg run-of-mine it was slightly higher (18.1).

In heat value the gas is not high; but, more important, it is fairly uniform, as shown by the typical log, Figs. 1, 2 and 3. The heat value seems to bear a certain relation to the fuel-bed temperature. It is found that if a certain temperature (about 1000 degrees) of the gas off-take is exceeded, the excessive combustion reduces the quality of the gas. With proper adjustment of vapor and air supply the

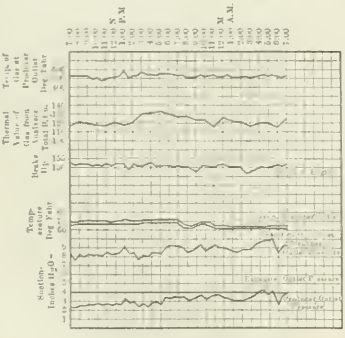

FIG. 1. LOG ON LAST DAY OF 21-HOUR RUN ON POCAHONTAS COAL

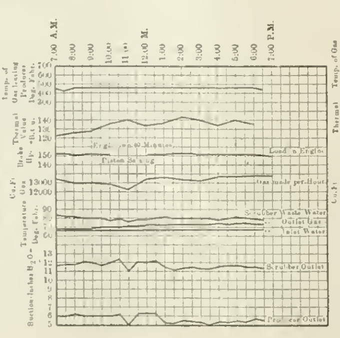

FIG. 2. LOG AT BEGINNING OF RUN OF TEXAS LIGNITE

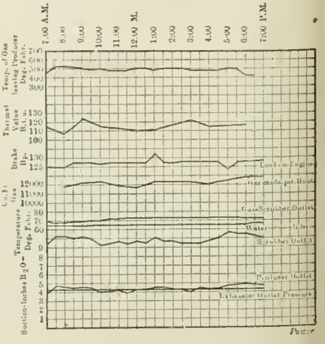

FIG. 3. LOG AT END OF 114-HOUR RUN ON TEXAS LIGNITE

temperatures may readily be kept below this point, especially with lignites.

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*From a paper read by J. R. Bibbins before the Gas Power Section of the American Society of Mechanical Engineers, December 9, 1909.

The tests of this producer, according to Mr. Bibbins, show that a higher engine compression than usual is permissible and that as much as 20 per cent. of hydrogen does not necessarily interfere with operation. The producer showed a full-load efficiency of about 70 per cent., on the basis of "low" heat value and about 77½ on the basis of "high" heat. The efficiency varied only 10 per cent. throughout its normal load range.

TABLE 4. GAS DATA

| Test. | Cu Ft. Uncorrect'd. | Cu.Ft. per Hr. 60 Deg. Fahr 30 In. Hg. | Max. for 1 Hr. | Cu.Ft. per Lb. Fuel. | Cu.Ft. per B.H.P.-Hr. | B.t.u.* per Cu Ft † Total. | B.t.u. Effective. |
|---|---|---|---|---|---|---|---|
| A | 238,900 | 7,215 | 8,500 | 47.7 | 102 | 113.4 | |
| B | 3,873,000 | 12,400 | 16,700 | 63.8 | 101.4 | 118.2 | |
| C | 1,812,200 | 16,210 | 23,300 | 89.3 | 102.1 | 113.8 | |
| D | 2,071,500 | 15,660 | 21,500 | 88.2 | 101.9 | 110.7 | |
| E | 2,797,170† | 16,600 | 17,853 | 90.2 | | 111 | |
| H | | 17,815 | 21,511 | (9 hours) | | 111.4 | |
| K | | | | | | 119 | 109.7 |
| L | | | | | | 120.6 | 112.2 |
| M | 891,300 | 11,933 | | 51.3 | 93.1 | 118.7 | 107.8 |
| N | 569,300 | 13,092 | 15,500 | 48.05 | 86.75 | 129.7 | 118.75 |

*Total heat values. $H_2O$ determination not made during some tests.
†Corrected to 30 in. Hg. and 60 deg. F.

TABLE 5. TYPICAL GAS ANALYSES.

| Test. | Fuel. | $H_2$ | CO | $CH_4$ | $CO_2$ | $N_2$ |
|---|---|---|---|---|---|---|
| A | South American lignite | 17.4 | 10.4 | 2.4 | 12.1 | 56.6 |
| B | Colorado lignite | 17.6 | 11.6 | 2.6 | 13.2 | 54.4 |
| C | Pittsburgh | 14.1 | 15.2 | 1.8 | 9.6 | 58.9 |

After the first year's period of tests, this plant was dismantled for examination. The gasification of 182,472 pounds of fuel showed no perceptible effect upon the condition of the producer, the walls being practically intact. This is due to the complete absence of clinkers and high temperatures. Experience plainly shows the latter to be the cause of clinker troubles. The fuel bed normally grades from small ash at the bottom through pure coke to green coal at the top. With proper handling, clinkers may be entirely avoided. For example, Table 7 shows a screen test of coal and ash at the Western Chemical Works, Denver, where two of these producers are in use.

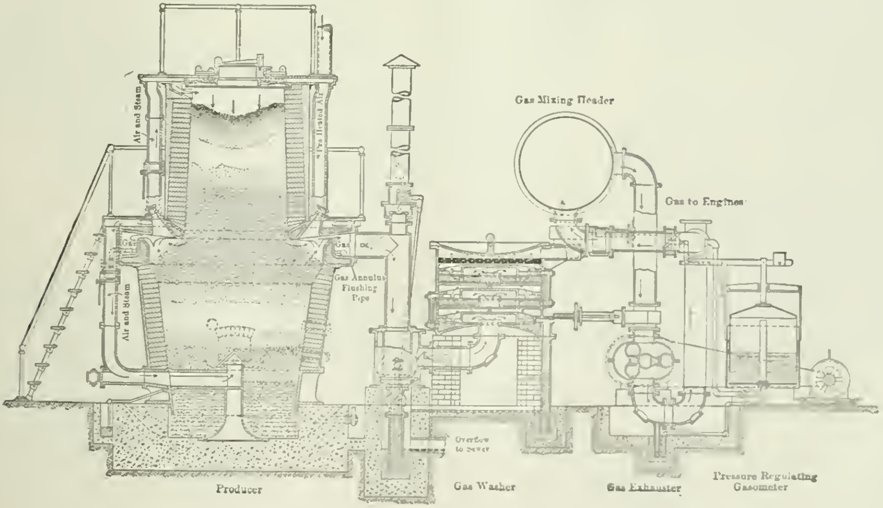


FIG. 4. SECTIONAL ELEVATION THROUGH PRODUCER PLANT

An examination of a long gas main and the engine valves, after the year's run, showed no deposits of tar either near or distant from the producer, indicating the complete fixation of the volatiles. All condensibles are removed in a static washer, the cells of which seem to clear themselves automatically of the deposit. For example, the pressure drop or resistance through a month's run increased slightly more than ½ inch. The principal skill in handling this producer is required in studying the characteristics of various kinds of fuels. Each must be handled differently for best results. With friable fuels the "let well enough alone" rule is particularly applicable, as the resistance of the bed may be greatly increased by too much poking.

## DISCUSSION

In the discussion which followed the reading of Mr. Bibbins' paper, Prof. R. H. Fernald said that the government tests, of which he has had charge, have demonstrated the practicability of gasifying almost any variety and grade of recognized fuels without any change in the design of the producer, but it is questionable whether such practice would yield the best efficiency in all cases. He thought that it would be better to design producers to handle a limited range of fuels, changing the design for widely different fuels. Fuels varying widely in composition require different treatment in the producer to avoid clinkers and get the best efficiency. Regarding the question of tar in the gas, Mr. Fernald said that his experience with a producer of different design from the Westinghouse apparatus was that tar-free gas could be produced from the majority of coals, but it was impossible with some varieties, and he rather questioned the feasibility of getting tar-free gas from all grades of fuel in any one type of producer. In conclusion, he expressed the conviction that, considering the fuel resources of the country, in order to keep the price of power developed from fuel down to a consistent figure grades of fuel which warrant transportation must be used with the greatest practical economy, the very large percentage of low grade coal now left in or at the mines must be utilized, and advantage must be taken of the large deposits of peat and lignite found in many sections of this country.

W. H. Chapman expressed the opinion that continuous agitation of the fuel bed is necessary to prevent the formation of clinkers. He also thought that the balanced draft required by the double-zone producer was a serious disadvantage and cited an instance of shutdown caused by abnormal departure from the proper draft balance.

H. F. Smith said that he had found no difficulty in producing tar-free gas continuously from widely different grades of bituminous coal so long as the producer had skilful attention, but it was impossible to do so in the ordinary power plant or factory because the requisite grade of intelligence was not to be found in the class of attendant commonly put in charge of a producer. He had therefore concluded that in order to meet commercial conditions it was necessary to provide means for taking care of the tar between the producer and the engine.

TABLE 6. CHARACTERISTICS OF LIGNITE GAS.
Western Chemical Co., Denver.

| | Heat Value (Total). | | | | Impurities | | | |
|---|---|---|---|---|---|---|---|---|
| Date | No of Determinations. | Max | Min | Average. | No. of Determinations. | Max. | Min. | Average. |
| 4-8-09 | 3 | 129.6 | 112.1 | 123.0 | 4 | 0.0290 | 0.01567 | 0.0213 |
| 4-9-09 | 4 | 121.5 | 113.7 | 118.3 | . | ...... | ....... | ..... |
| 4-10-09 | 4 | 123.9 | 106.1 | 131.1 | . | ...... | ....... | ..... |
| 4-11-09 | . | . | ... . | | | ...... | ....... | ..... |
| 4-12-09 | 1 | ..... | ... .. | 122.0 | 7 | 0.0617 | 0.0144 | 0.0284 |
| 4-13-09 | 2 | 115.4 | 111.0 | 113.2 | 6 | 0.0667 | 0.0081 | 0.0231 |
| 4-14-09 | 3 | 124.0 | 121.0 | 122.0 | 7 | 0.0264 | 0.0115 | 0.0184 |
| 4-15-09 | 2 | 117.3 | 113.7 | 115.5 | 3 | 0.0204 | 0.0051 | 0.0114 |
| 4-16-09 | 3 | 128.0 | 114.7 | 119.5 | 4 | 0.0198 | 0.0048 | 0.0124 |
| 4-17-09 | 1 | . . . | ... .. | 133.3 | 3 | 0.0260 | 0.0209 | 0.0247 |
| 4-19-09 | 4 | 128.6 | 108.5 | 121.2 | 2 | 0.0194 | 0.0058 | 0.0126 |
| 4-20-09 | 4 | 128.0 | 108.5 | 117.8 | 3 | 0.0046 | 0.0018 | 0.0033 |
| 4-21-09 | 3 | 117.8 | 110.0 | 114.7 | 3 | 0.0095 | 0.0051 | 0.0051 |
| 4-22-09 | 3 | 130.0 | 111.0 | 121.0 | 2 | 0.0288 | 0.0113 | 0.02005 |
| 4-23-09 | 3 | 129.0 | 123.4 | 126.0 | 3 | 0.0048 | 0.0018 | 0.0033 |
| 4-24-09 | 2 | 126.0 | 106.4 | 115.7 | 3 | 0.0061 | 0.0036 | 0.0053 |
| 4-26-09 | 1 | .. .. | . . | 125.0 | . | ...... | ..... | ..... |
| 4-27-09 | 1 | ..... | . | 120.4 | 3 | 0.0429 | 0.0040 | 0.0179 |
| 4-28-09 | 3 | 141.6 | 127.0 | 133.2 | 3 | 0.0089 | 0.0026 | 0.0056 |
| 4-29-09 | 2 | 131.0 | 136.0 | 128.5 | 3 | 0.0099 | 0.0059 | 0.0073 |
| 4-30-09 | . | . . | . | ..... | 3 | 0.0172 | 0.0066 | 0.0123 |
| 5-1-09 | . | ..... | . | ..... | 3 | 0.0356 | 0.0216 | 0.0304 |
| 5-2-09 | . | .... | | .... | 2 | 0.0587 | 0.0340 | 0.0463 |
| 5-3-09 | . | . | | ... . | 3 | 0.0328 | 0.0067 | 0.0205 |
| 5-4-09 | . | . | | .... . | 3 | 0.2325 | 0.0735 | 0.1381 |
| Average. | | | | 121.2 | | | | 0.02227 |

TABLE 7. SCREEN TESTS—FUEL AND ASH—NORTHERN COLORADO LIGNITE.
Western Chemical Co., Denver.

| | Coal. | Ash. |
|---|---|---|
| Over ¼ inch | 58 per cent. | 23.5 per cent. |
| Over ⅛ inch | 23½ per cent. | 33.0 per cent. |
| Through ⅛ inch | 18½ per cent. | 43.5 per cent. |
| | 100 per cent. | 100 per cent. |

Samples represent about one bushel of material quartered down taken from stock pile.

# Adaptability of Chain Grate Stokers to Fluctuating Loads

By T. A. Marsh

A common argument against automatic stokers, particularly chain grates, is that they are impractical in plants where there are sudden demands for steam, for the reason that it is generally supposed that a sudden peak cannot be readily picked up with stoker firing. However, if the boiler capacity is ample, the draft suitable and readily controlled, there is no question as to the ability of chain grates to handle the most sudden peaks that occur in power stations.

The writer has had extensive experience in determining the most suitable method of handling boiler loads and has been fortunate enough to have the opportunity to conduct a test under a condition of fluctuating load which in some measure presents the possibilities of chain-grate firing.

The test referred to was made on two 264-horsepower Babcock & Wilcox water-tube boilers, each served by Green chain grates, having an area of 58.5 square feet. The ratio of grate surface to heating surface was 1:45. The draft obtainable in the furnace when the grate was uniformly covered with a 6-inch fuel bed was 0.35 inch, and was readily controlled by means of a damper rod having positive adjustment. With these conditions, and with a fuel known as Pittsburg screenings, a 24-hour evaporative test was made, carrying the usual station load.

The test was commenced at five o'clock in the evening, and since a large part of the load was power furnished to factories and lights used in office buildings, the load dropped off steadily until 11 p.m., when a minimum of 107 boiler horsepower was reached. This condition continued until 3 a.m., from which time until 6 a.m. the horsepower increased to 640, being six times the capacity carried at three o'clock.

This very extremely fluctuating load was carried with a combined efficiency (item 73, A. S. M. E. code) of 65 per cent. for the entire test. The performance of the boiler varied from the minimum of 80 per cent. under rating to 39 per cent. over rating, and this was done without the boilers popping off, or the steam pressure dropping more than 15 pounds below the popping-off point. The accompanying chart is a graphical representation of the boiler horsepower developed, and by reference thereto the extreme suddenness of the steam demand will be realized.

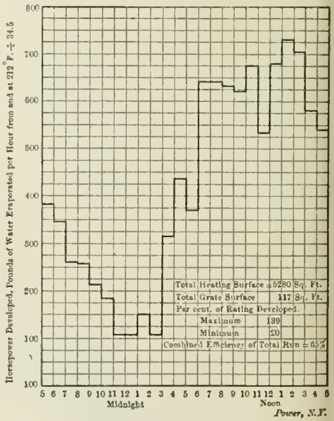


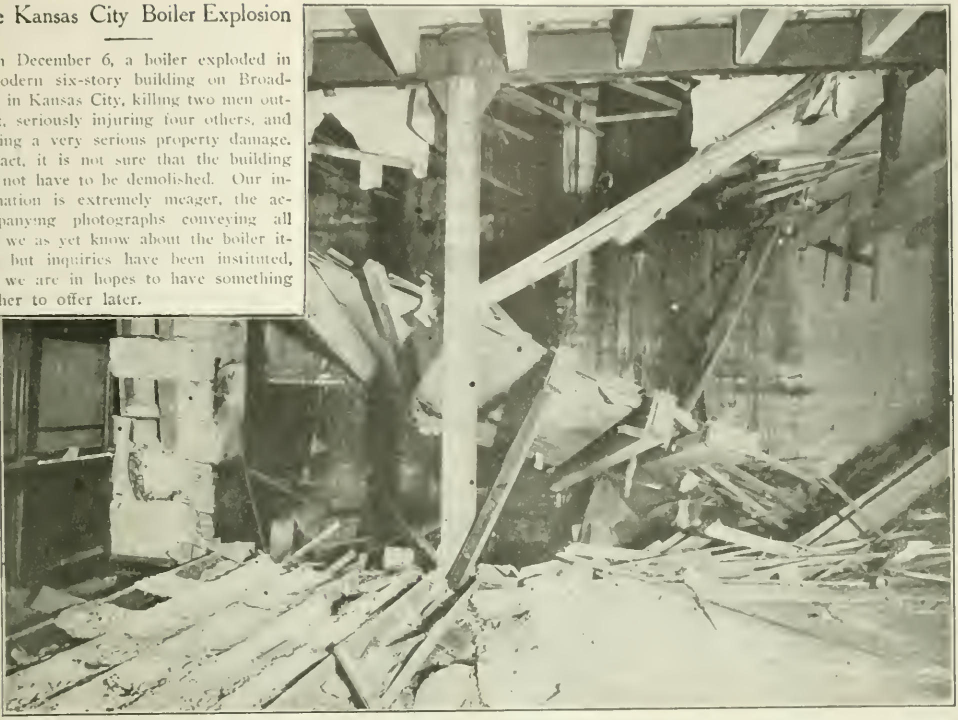
DIAGRAM OF A CHAIN GRATE WITH FLUCTUATING LOAD

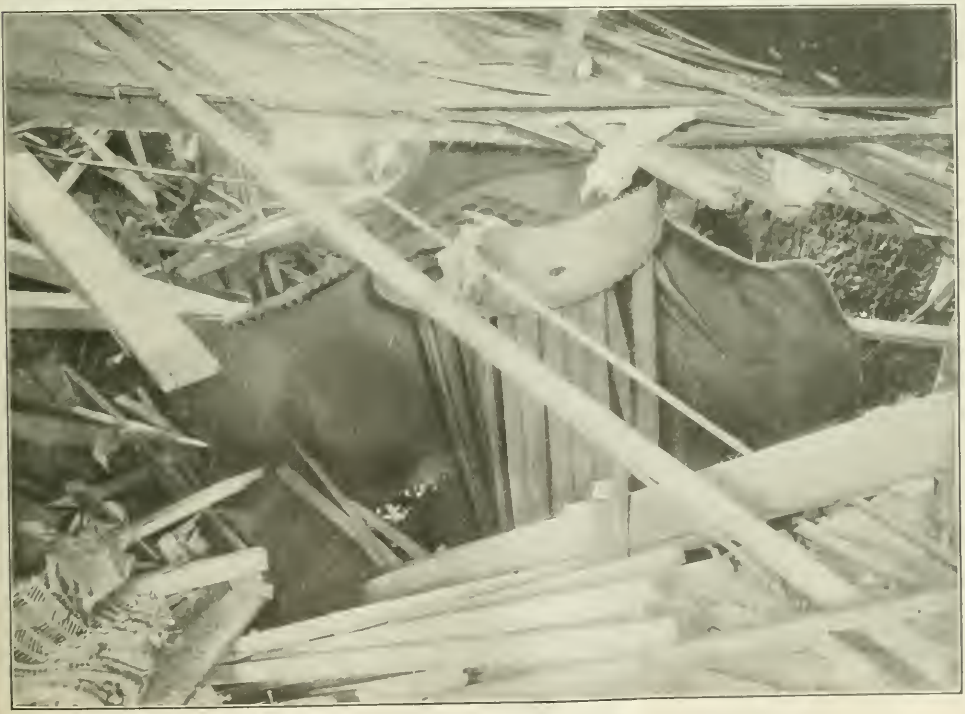
This performance is not phenomenal, except perhaps as regards economy, as there are doubtless many chain-grate installations having live-steam loads, such as are encountered in breweries, sugar refineries and starch factories, that are called upon to carry still more extreme peaks, and this is accomplished very readily by keeping sufficient grate surface covered with ignited fuel, but with the damper closed to such a point that practically no combustion (and necessarily no steam generation) occurs. Then, as steam is required, the damper is gradually opened, and the demand thus met.

With boiler settings having the usual ratios, and with draft as ordinarily found, it is possible to raise a boiler from its banked condition of "no rating" to its full-rated horsepower in an interval of from 30 to 45 minutes.

# The Kansas City Boiler Explosion

On December 6, a boiler exploded in a modern six-story building on Broadway, in Kansas City, killing two men outright, seriously injuring four others, and causing a very serious property damage. In fact, it is not sure that the building will not have to be demolished. Our information is extremely meager, the accompanying photographs conveying all that we as yet know about the boiler itself, but inquiries have been instituted, and we are in hopes to have something further to offer later.





# An Elaborate Blowoff Tank

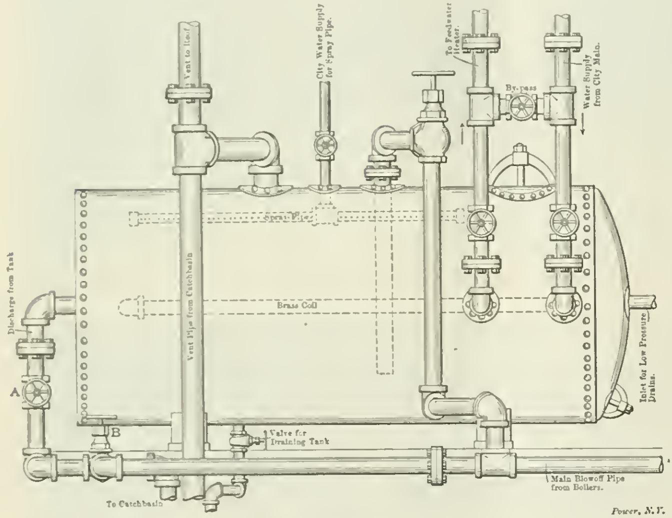
By A. J. Dixon

The elaborately equipped blowoff tank illustrated in the accompanying sketch may be regarded as the acme of refinement in apparatus of the kind. This tank is 9 feet long by 4 feet in diameter, has concave and convex heads, and is used in connection with a plant of five boilers in a public building.

The water blown from the boilers is conveyed to the tank by a 3-inch main blowoff pipe which enters through the top of the shell at a point about 4 feet distant from the convex head, and extends downward inside the tank to within 10 inches of the bottom of the shell. The water issues from the tank through an opening in the center of the concave head, and is discharged into the sewer catchbasin by a 3-inch pipe. This arrangement of the inlet and outlet orifices insures the tank remaining half full of water after each blowdown, and this water, which becomes cool in the interim, is all that is supposed to pass into the catchbasin at the next blowdown, the idea involved being the displacement of the cool water already in the tank by the hot water blown in from the boilers. It would appear, however, that the advantage of a comparatively cool discharge into the sewer would come much nearer to being realized if the inlet pipe were to terminate in the connection to the top part of the shell, instead of dropping inside, and the outlet pipe were likewise to connect with the shell on top, but with a continuation inward, so as to bring the outlet orifice about 6 inches from the bottom of the shell.

In order that the vapor with which the upper part of the tank must necessarily be filled, when blowing down under full boiler pressure, may be condensed quickly, a $1\frac{1}{2}$ inch pipe, supplied with cold water from the city main, and perforated to create a spray, is suspended longitudinally about 6 inches from the top of the shell. As a further precaution against the accumulation of steam, a 4-inch bent pipe communicating with both the tank and catchbasin, rises to the roof of the building and affords a means of escape for any vapor remaining uncondensed.

The water of condensation drained from engine and steam-pump cylinders, exhaust mains, and similar apparatus under low pressure, flows by gravity to a small receiving tank, whence it is discharged into the blowoff tank by a $2\frac{1}{2}$x$3\frac{1}{2}$x2-inch steam pump, the inlet being a few inches above the center of the convex head.


Vent to Roof
City Water Supply for Spray Pipe.
To Feedwater Heater.
By-pass
Water Supply from City Main.
Spray Pipe
Brass Coil
Discharge from Tank
Vent Pipe from Catchbasin
A
B
Valve for Draining Tank
Inlet for Low Pressure Drains.
Main Blowoff Pipe from Boilers.
To Catchbasin
Power, N.Y.

AN ELABORATE BLOWOFF TANK

A bypass for emptying the boilers directly into the catchbasin, should occasion arise for cutting the tank out of service, is also provided. Referring to the sketch, it is seen that by closing the angle valve in the branch from the blowoff main to the tank, and also the valve *A* in the discharge pipe from the tank to the catchbasin, the tank may be isolated from the blowoff system; then by opening the valve *B*, direct communication is established between the blowoff main and the catchbasin.

The special feature of this blowoff outfit, however, which confers upon it a unique place among similar devices, is that the tank is designed to enact the function of a feed-water heater, provision being made in its construction for absorption of the heat available from the high temperature of the contents of the tank during the brief intervals of blowing down, and likewise of the comparatively inconsequential quantity of heat supplied by the low-pressure drains.

This detail in the working of the apparatus is obtained by connecting the $2\frac{1}{2}$-inch line of pipe which supplies the water for boiler feed to a coil of brass pipe of corresponding size, suspended in the horizontal plane through the axis of the shell, the point of connection being in the side of the tank and a few inches from the convex head, the water emerging from the coil again and passing to the regular feed-water heater through a $2\frac{1}{2}$-inch pipe connected adjacent to the inlet pipe. The details of construction are all shown in the sketch.

# The St. Louis Boiler Ordinance

The present boiler ordinance of the city of St. Louis, leaves the stipulation of pressure entirely to the boiler inspector. Some time ago a new inspector attempted to enforce a chronologically graduated factor of safety, and because it was not correct there went up a howl from the steam users. The inspector, Mr. Tyrrell, resigned his office and the mayor appointed a new man, but the council refused to confirm him so that there is at the present time Mr. Reid trying to get into the office and cannot and Mr. Tyrrell trying to get out of the office and cannot. And now comes Councilman Schulz with an ordinance to do away with the office of Smoke Inspector and to combine the office with that of the Boiler Inspector, to raise the salary of the consolidated office to $3000 per year and to put it under the control of the Board of Public Improvement. This plan at the time of our latest advices was still under advisement.

The Great Northern Railroad Company has almost completed a power plant at Chiwaukum, in the Tumwater cañon, where it will develop 10,000 horsepower with which to operate trains through the Cascade tunnel. There are yet great undeveloped power possibilities along the river, probably more than can be utilized for many years to come.

There still remain opportunities to develop power along the lower Colville river, some of which are now in use. Large power installations have also been made along important streams in other parts of the State, particularly west of the Cascades.

West of Puget sound, where the Olympic mountains, with snow-capped peaks and heavy precipitation (100 inches a year), feed many small streams and rivers mostly within the national forests, some of the streams fall several thousand feet in their rush to the ocean, affording many opportunities for power development.

# Design of Engine to Produce Uniform Torque

By George Fenno

To everyone familiar with the shape and meaning of a steam-engine indicator diagram, it is evident that the thrust given to the piston, by the steam, varies considerably throughout the stroke. During admission, the pressure is maximum; after cutoff, the pressure gradually falls and finally becomes negative at the end of the stroke, because the steam at the other side of the piston is being compressed. If the engine has only one cylinder, it is evident that this varying force on the piston produces a fluctuating turning force at the crank pin. At the beginning of the stroke the force urging the piston forward is high, but the force tending to turn the crank, or the tangential force, is extremely low, as the crank is only slightly off center and most of the thrust given by the piston is expended in pushing directly against the bearings. These changes in tangential effort tend to vary the speed of rotation for different positions of the crank pin.

In one-cylinder engines the only way to prevent the variations in speed from becoming excessive is to use a heavy flywheel, which stores energy when the thrust is high and gives it out when the thrust is low. The fact that the turning moment varies with the change of steam pressure in the cylinder, and at the same time with the angle that the connecting rod makes with the line of centers, renders it a complicated problem to foresee what the resultant tangential effort will be for any particular engine.

In the tandem-compound both pistons are on the same rod, and move together. A little thought will show that as both pistons are always moving in the same direction, there will be an enormous thrust delivered at the beginning of the stroke when both are receiving maximum steam pressure. After the point of cutoff, the steam expands in both cylinders, the thrust gradually falls off until it reaches zero and then becomes negative due to high compression necessary with the high speed commonly used in connection with small-sized units.

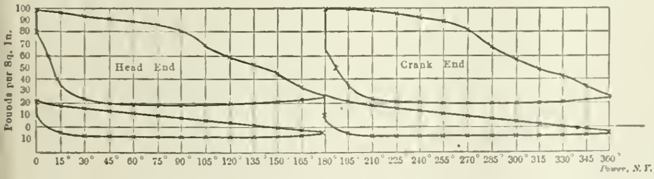
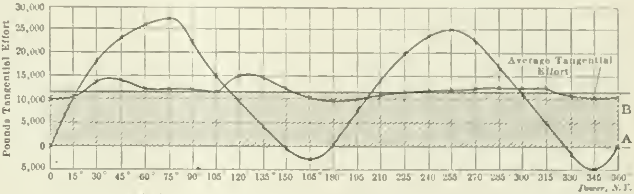


FIG. 1. DIAGRAMS FROM WHICH CRANK EFFORT CURVES WERE CALCULATED

In the angle-type engine, the low-pressure cylinder is placed vertically on the same bedplate with the high pressure and at 90 degrees to it. In this case it will be seen that the maximum thrust, due to the admission of steam to the low pressure cylinder, does not occur until after the high-pressure piston has completed half stroke, and the pressure is rapidly falling off Then maximum pressure occurs in the low-pressure cylinder and after steam is again admitted to the other side of the high-pressure piston, and so on.

The four indicator diagrams in Fig. 1 are from a compound engine and the same diagrams were used in calculating both curves of Fig. 2.



*A* for tandem and *B* for angle compound engine

FIG. 2. CRANK EFFORT DIAGRAM

The positions of the diagrams in Fig. 1 represent the events as they occur in a tandem engine. Curve *A*, Fig. 2, was plotted from the diagrams in this position. The ordinates for each diagram were taken for every 15 degrees passed through by the crank and multiplied by the corresponding piston areas. The sum of these two gives actual pounds thrust on the piston. This was then corrected for angularity of connecting rod, so that of the total thrust, only that portion was plotted which tends to push the pin in a circular path.

With the tandem engine, the tangential force delivered to the crank pin at first rises very rapidly, then quickly falls to zero and when the crank has turned through an angle of approximately 150 degrees or is very nearly at the end of one stroke, the force becomes negative This is due to the fact that the steam pressure is rapidly becoming lower while the steam on the other side of both pistons is being compressed, hence, at this point, instead of the pistons tending to drive the pin forward they become a drag and have to be carried to the end of the stroke by the inertia stored in the flywheel.

Curve *B* shows the crank effort from an angle compound engine. Here the low-pressure diagrams are moved forward 90 degrees and the tangential efforts were calculated separately for each cylinder for every 15 degrees and then added together The remarkable thing about this curve is its extreme flatness which shows how small the variation in turning moment is in this engine.

In these curves the modifying effects of friction, and inertia of reciprocating parts have been neglected, in order not to complicate the problem, but had the effects of inertia been taken into consideration, the results would have shown up still more favorably to the angle-compound engine, as the masses moving in the same direction are smaller and the fact that they are separated 90 degrees allows of perfect balancing, which is impossible with either the tandem or cross-compound construction.

The line of average tangential effort was located in the force diagram by means of a planimeter and was found to be the same for both engines, showing that the total amount of energy delivered by both is the same. This line is at the top of the shaded area and represents the *continuous* pressure necessary to carry a given load; now when this necessary crank-pin pressure is exceeded in one part of a revolution there must be a corresponding deficiency in another part. From curve *A* it is seen that the turning pressure on the crank pin of a tandem engine, rises greatly above the average amount twice in every revolution and falls not only to zero but becomes negative due to the compression at the end of the stroke. The only practical way to try and smooth out the turning moment delivered by one of these engines is to use a heavy flywheel which takes the excess energy represented by the area of one peak of the curve above the line of average pressure and carries it over to fill in the deficiency represented by the valley in the next portion of the curve.

---

A gasolene engine having a compression pressure of 70 pounds that otherwise is well suited to the economical use of denatured alcohol as gasolene, will, when using the alcohol, have an available horsepower about 10 per cent. greater than when using gasolene.

POWER
AND THE ENGINEER

DEVOTED TO THE GENERATION AND
TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.
355 Dearborn Street, Chicago.
6 Bouverie Street London, E. C.

Correspondence suitable for the columns of Power solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address "Powpub," N. Y.
Business Telegraph Code.

*CIRCULATION STATEMENT*

*During 1908 we printed and circulated 1,830,000 copies of* POWER.

*Our circulation for November, 1909, was (weekly and monthly) 162,000.*

| | |
|---|---|
| *December* 7 | 40,000 |
| *December* 14 | 30,000 |
| *December* 21 | 30,000 |
| *December* 28 | 30,000 |

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## Steam Driven Auxiliaries

As evidenced by discussions at the recent meetings of the American Society of Mechanical Engineers, considerable interest attaches to the use of small steam turbines, particularly for power-station auxiliaries. While such use is to be commended in many cases, there are limitations which will not escape the attention of careful power plant designers.

It is ordinarily assumed that inasmuch as the heat of the exhaust from steam-driven auxiliaries is returned to the boiler through the feed-water heater, the economy of the auxiliaries is not a prime factor. While from the standpoint of economy, the use of turbine-driven auxiliaries will be sanctioned in our mammoth power stations, the same reasoning will limit them in many stations of smaller size; in large plants the amount of exhaust steam may be well within the capacity of the feed-water heater, but in the smaller stations, based on economies now reported, and under prevailing conditions, there will likely be at all loads an appreciable waste of the auxiliary exhaust steam.

If for purpose of this argument, 200 degrees Fahrenheit be set as a maximum temperature practically obtainable in feed-water heaters when exhausting at atmospheric pressure, the amount of heat which can be economically utilized in the feed-water heater will be measured by the difference between 200 degrees and the hotwell temperature. In our mammoth central stations where cold water is available and high vacuum is maintained, the air-pump discharge or hotwell pump temperature is as low as 100 degrees Fahrenheit, and frequently considerably less. In many small plants either with engines or turbines, such high vacuums are not maintained, resulting in a considerably higher temperature of feed water entering the heater. Hence, we have in large stations the advantage of a greater economy of auxiliary apparatus and a considerable range of temperature rise in the feed-water heater; in the smaller plants we have not only the greater relative steam consumption of auxiliaries but also a decreased range of possible temperature rise in the feed-water heater.

In inland plants, where the absence of ocean or river water necessitates the use of cooling towers, the additional head imposed on the circulating pump greatly increases the power required, and consequently the steam consumption of auxiliaries makes the economy of auxiliaries of increasing importance. In small plants operating with cooling towers, there could easily result a steam consumption of auxiliaries greater than the decreased steam consumption of the prime mover due to the vacuum attained; again, in cooling tower plants, the vacuum is usually at a minimum, the temperature of feed water entering the feed-water heater consequently a maximum, and the possible rise of temperature within the heater a minimum, all these factors necessitating the greatest economy of auxiliaries.

With constant speed auxiliaries, particularly driving centrifugal circulating pumps, it is necessary to provide a speed suitable for the maximum head requirements; and plants subject to variation in temperature of circulating water through the seasons of the year, and to possible variation in head due to this quantity of water, and also due to possible clogging of condensers by silt or marine growth, it is necessary that the maximum speed be determined with great care. When the actual head on the circulator is less than this maximum, there will usually be a waste of power nearly proportional to the difference between the working head and the maximum head for which the pump is designed. It is therefore necessary to carefully investigate the type of governor provided, in the case of a turbine-driven circulator, to make certain that ample speed and power variation can be obtained to provide for these extremes.

The foregoing remarks will apply particularly to the operation of plants at rated capacity. For the very large plants in which a large number of units are provided, and operate at or near rated capacity, no considerations of fractional load running are necessary; but in plants of smaller capacity, and with a limited number of units, where the units are in operation at fractional load the greater portion of the time, and frequently at very light load, the economy of auxiliaries at fractional loads becomes of increasing importance. This consideration doubtless receives due attention from power-plant designers, but has been almost entirely neglected in literature bearing on this question. It is not far from correct to state in a general way, that, other conditions being constant, a wide variation in load on the prime mover will require practically a constant hourly steam consumption of auxiliaries. If, for example, the auxiliary steam consumption is ten per cent. of the total feed at rated load, then, on this basis, it will be about twenty per cent. or less at half load, and about forty per cent. or less at quarter load, depending on variation in economy of the prime mover; while it may be possible to economically utilize all of the exhaust steam from auxiliaries at rated load, the margin of safety will decrease at the lighter loads, the auxiliaries becoming more wasteful as the load on the unit is reduced. It naturally follows that with units subject to wide variation in load, it is necessary that the economy of the auxiliaries be particularly good in order not to waste the exhaust steam at the lighter loads, and it is also true that these considerations have greatest force when relating to small plants and to those subject to excess head on the circulating pump, particularly those having cooling-tower installations.

For such plants there is a certain critical load, below which it would be more economical to operate noncondensing than to attempt to operate condensing. Whether or not such condition of operation is permissible, will depend on the character and supply of feed water and other practical considerations.

## Incompetents at the Throttle

In every walk of life, whether a profession, trade or business, there are incompetent men, and some are so ridiculously unfit for the duties they are supposed to perform, that it is often wondered how the choice was made and why they are allowed to remain and take the place of men better adapted for the work. Most of us know of ministers who ought to be swinging an axe, lawyers who would be more of a success as window washers and doctors who would be more in their element out on the farm husking popcorn. Some of us also know that there are many engineers equally incompetent and altogether unfit to operate the simplest kind of a plant.

For such a condition there are many reasons, and chief of these is the attitude of the employer who thinks that anything that can open the throttle and make the wheels go around is an engineer. The following instance will serve as illustration of everyday occurrences in power-plant life:

A factory of large size had a competent engineer who felt after four years' service that he was entitled to recognition, and justly so. The management could not see it that way and were soon busy in filling a vacancy in the engine room. Instead of looking around the city for a competent man or selecting an engineer with good recommendations from those who offered their services, the firm went into the shop and brought out a woodworker as the engineer to be. Why? Because he was a good saw filer and besides putting all the saws in shape, could start 'er an' stop 'er and thus save a man. A short time afterward a new Corliss was installed, and the same engine, which has now been running for five years, sounds like a stone crusher. Why doesn't the company put in a better man? Principally because the present incumbent is cheap. The dignity and prestige which the position affords a man chosen from the masses does not cost the company anything and is a syrup so sweet to the employee that it completely removes the bad taste of lower pay. Besides the company does not see the leak in the coal pile so readily as it does the fact that the man is willing to work cheaply—thus the company pays the freight.

When the management are blamed for the poor showing made in the plant and the damage and delays usually resulting from unskilful hands, they think it preposterous and through their smoked glasses cannot see the light. The small inducement they offer for a man to work from 6.15 in the morning to perhaps 6.30 at night is no attraction to the competent engineer—the man who would save them a dozen times over the additional wage they would be obliged to, and should, pay him.

In a nutshell the above is the case against the employer, but perhaps a shade of blame falls on the engineer's side. There are men who are paid the price and are intelligent and ingenious enough to deliver the goods, but they are lazy, and when an engineer is unfortunate enough to possess this characteristic, like the balky mule, there is not much hope of getting it out of him.

Then there is another cause for low wages, and this is the man who is Jack of all trades. He is anything. Advertise for a molder, and he is one; for a plumber, and he has a "lead-pipe cinch;" or for a carpenter, and he is it. Yes, he is an engineer; he cannot be shown anything about an engine, and he gets the job, not because he is competent (he has not been examined as to his ability), but because he is willing to work cheaply.

What will remedy these conditions and secure proper compensation for competent engineers? Suppose all members of the craft did organize and establish a scale of prices, what would be the result? Many of the employers would have nothing of them, and Bill Corntassel would leave his old threshing outfit and get the job. This in all probability would continue, until about thirty per cent. of the places had been filled. The dissatisfied ones would feel the ground slipping from beneath their feet and would make a stampede for the remainder of the jobs, at the old price, that would make the charge of San Juan hill look like a Sunday afternoon walk.

In the foregoing it is not intended to infer that all engineers are ignorant or shiftless, or that all employers are as short sighted as it would appear from the preceding incident. Far from it. But at the same time conditions in many of the States are far from what they should be. Uniform license laws throughout the country, with modifications in the several States and municipalities as required by local conditions, is the very thing that is needed. Strict laws that would be absolutely fool proof and graft proof would be necessary. Proper enforcement would protect the engineer from the competition of incompetent men and tend to secure him a reasonable compensation for his work. It would benefit the employer even more and insure him the services of a man whose knowledge of engineering had been tested. It would be necessary for the employee to prove that he is competent (and not take his say so) to run any given plant and at the same time insure the safety of his limb and property in its vicinity. Efficient operation, a scarcity of mishaps and delays would repay the employer, better wages would be due the engineer, and aside from all this the public would be assured of the safety it has a right to demand.

Some States and a large number of cities have already passed good license laws, but most of these are not uniform and some differ so widely as to seriously handicap not only the engineer, but manufacturers of power plant equipment and supplies as well. Uniform laws are what is needed, and every engineer and every user of power should lend his support to the movement for their enactment.

## The Fottinger Gear

In a recent number a general review was given of various devices for extending the field for the marine steam turbine, and to them should be added a hydraulic reducing and reversing gear invented by Dr. Fottinger. The essential feature of this device is the combination of a centrifugal pump on the turbine shaft and a water turbine on the propeller shaft, with a closed circuit for the water so that it passes round and round and is changed only to prevent overheating. The turbine shaft is immediately ahead of the propeller shaft and in line with it, so that the pump delivers directly into the turbine; the turbine is a two-stage machine with one set of stationary guides between the stages. A reduction in the ratio of four and a half to one is readily obtained, so that both turbine and propeller may have desirable speeds.

Reverse action of the propeller is obtained by a duplicate gear of pump and turbine on the same shafts, and just ahead of the forward motion gear. In this gear the pump delivers water to stationary guides which reverses the flow and directs the water into a single-stage turbine. In any case, the inactive turbine runs empty and reversal is obtained by transferring the water from one set to the other, which can be done in from ten to twenty seconds.

A set capable of transmitting 500 horsepower was built by the Vulcan Company at Stetlin, and tested in the shop and in a specially built tug-boat. In the shop the gear was driven by an electric motor and loaded with a friction brake, loads being carried up to nearly two hundred horsepower. The efficiency remained nearly constant at 83 per cent. in the shop test and this has been accepted as the probable efficiency for all conditions. The seventeen per cent. loss of efficiency is due almost entirely to fluid friction and remains in the water, so that a portion can be saved by passing the feed water through the gear from the hotwell to the boiler.

# Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

## 350-Horsepower Silent Chain Drive

By [illegible] Hattersly

The Link Belt Company has recently constructed at its Philadelphia plant three large silent-chain drives which are to transmit power for a wiredrawing bench at the plant of a large steel company.

Each drive is to transmit 350 horsepower at 10-foot centers, and, as shown in Fig. 1, consists of a wide-faced pinion connected to two large flanged wheels by two strands of 2-inch pitch Renold silent chain, each strand having a width of 12 inches. The pinions are to be mounted on the armature shafts of motors making 300 revolutions per minute, giving a driven speed of the gears of 65 revolutions per minute. These pinions were made from forged steel, and are about $16\frac{1}{2}$ inches in diameter, have 26 teeth, with a face of 27 inches, and with a hub

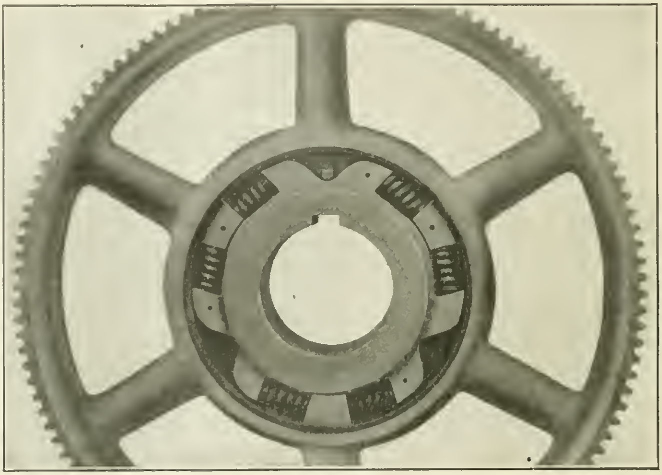

FIG. 2. GEAR HUB WITH SPRING-COMPENSATING DEVICE

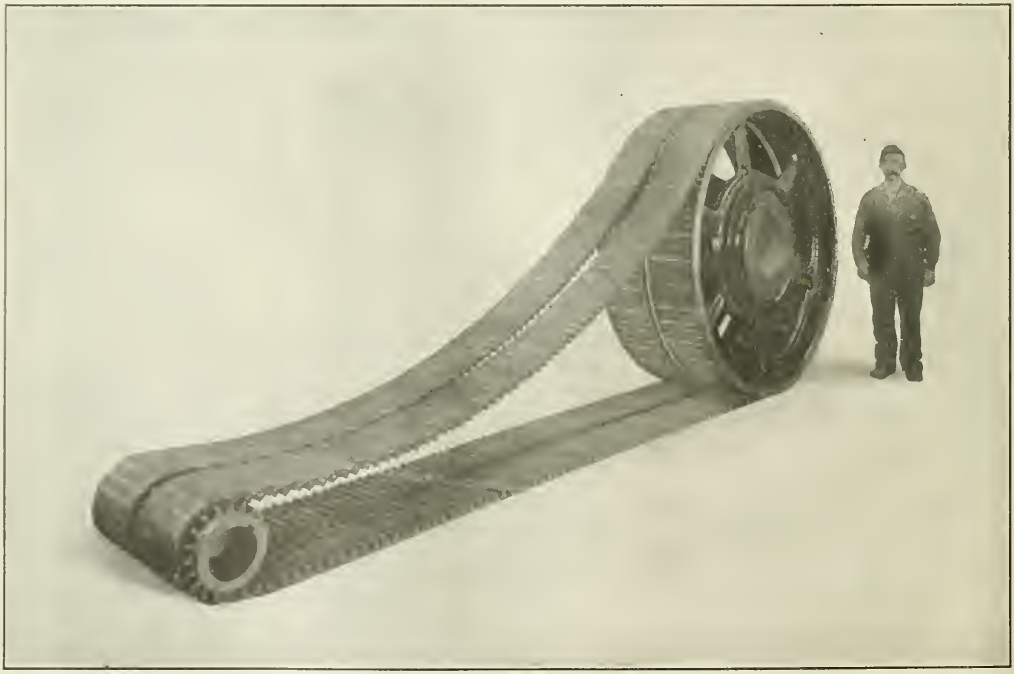

FIG. 1. 350-HORSEPOWER SILENT CHAIN DRIVE

one side 2 inches wide by $14\frac{5}{8}$ inches diameter. The bore is 10 inches, the total width through the bore 20 inches, the weight 850 pounds each.

The two wheels for each drive are mounted side by side. These wheels are made of cast iron, are about $76\frac{1}{2}$ inches in diameter, have 120 teeth, with a face of $13\frac{1}{2}$ inches, and each weighs 4200 pounds. Each wheel is provided with steel flanges and a special hub arranged with a spring-compensating device, as shown in Fig. 2. The object of this device is to provide an equalizing factor between the power shaft and the teeth of the wheel, so that any unevenness in the rotation of the power element and consequent shock will be absorbed by this device, permitting the power to be transmitted more evenly. Also if the device to which power is applied operates unevenly, then the equalizing device will absorb this shock and prevent it from being carried to the driving mechanism.

By absorbing shock this device also increases the life of the drive by preventing undue vibration which in time might tend to unduly wear the chain and the teeth of the wheels.

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## Bevis' and Gibson's Air Pump

In the design of pump illustrated herewith, the joint invention of R. R. Bevis, of Vyner road, Birkenhead (England) and J. H. Gibson, the pump bucket is provided with valves through which the water is forced on the descent of the bucket as it nears its lower position, the water being led from the lower part of the condenser to the lower part of the pump barrel through a foot valve. The air is led by a pipe from the upper part of the condenser, through air ports or inlets in the pump barrel which are above the bucket, when the latter is in its lower position. When the pump bucket descends, any air that may have been drawn through the inlets into the barrel by the suction produced by the previous ascent of the bucket, will, under normal working, be so attenuated that it will be forced back into the condenser, its pressure being insufficient to force it through the bucket valves. As the down stroke of the bucket is being completed, the water below it is forced up through the bucket valves; at the same time the air inlets are uncovered, and as there is at this point a vacuum above the bucket, the air passes into the barrel above the bucket through the inlets.

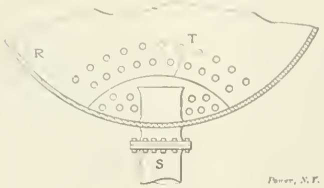


FIG. 2. SHOWING DEFLECTOR

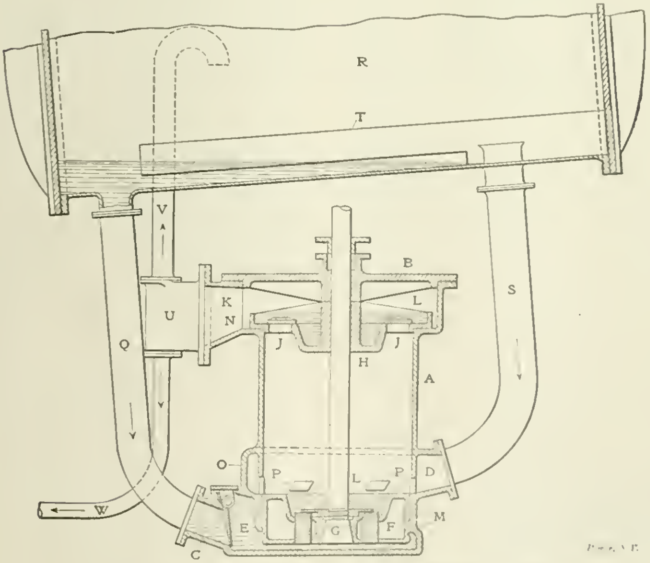


FIG. 1. SECTIONAL VIEW OF BEVIS' AND GIBSON'S AIR PUMP

The quantity of water per stroke passing into the bottom of the barrel is, in properly proportioned pumps of this type, very small, and it follows that, in practical working, the water passes to the space above the bucket through the bucket valves after the bucket passes the air inlets, whereas the air passes to the space through the air inlets, the two are thus practically kept separate until they meet above the bucket the condensed water is therefore not aerated or frothed to the same extent as usually obtains in air pumps and the upper side of the bucket, which becomes a so-called "dry" air pump, is cooled, flooded, and lubricated by the water. The condensed water is thus dealt with by the pump in this arrangement after the ordinary manner, whereas the air passes into the space above the bucket without having to pass through the water or the foot or bucket valves; in respect to the air, the pump acts after the manner of the single-valve laboratory type of air pump.

Referring to Fig. 1, *A* is the pump barrel, closed above by the cover *B* and provided with the inlet branch *C* for water and the inlet branch *D* for air and vapor. So far as the water pumping action is concerned, the construction conforms with that of an ordinary air pump. That is, there is a foot valve *E* opening toward the bottom of the pump barrel; a bucket *F* with through passages covered by bucket valves *G* opening upwardly; and a delivery valve casting *H* with through passages covered by delivery valves *J* also opening upwardly toward the air and water-outlet branch *K*. The delivery and bucket valves are shown of the usual thin metallic-disk type with guards *L* to limit their lift, and the foot valve *E* is shown as a flap valve, but any of the suitable forms of valve common to apparatus of this class may be used. The top of the bucket is dished, and the bucket valves located at the bottom of the dishing so as to insure that they shall always be sealed. In place of fitting packing round the pump bucket, a number of circumferential grooves *M* are provided, in which water may lodge and act as a seal. The head-valve casting *H* follows the contour of the top of the bucket so as to minimize clearance, and the delivery valves are arranged at the highest part so as to avoid any pockets in which air or vapor might be trapped. At V is a lip which retains sufficient water to seal the delivery valves. The air-inlet branch *D* extends as a belt *O* round the pump barrel and communicates with the interior thereof through the ports *P* located just above the lowest position of the bucket. The water-inlet branch *C* is connected by the pipe *Q* to the lowest part of the condenser *R* so as to withdraw water only, and the air inlet branch *D* is connected by the pipe *S* to a point in the condenser above the water level so as to withdraw air and uncondensed vapor only. At *T*, Fig. 2, is a deflector over the air pipe *S* to prevent water from dropping into the latter and to prevent uncondensed vapor from short-returning to M. The condensed air and water under bucket H delivers into the hot well from which the air and the water are separated and discharged, the former escaping upwardly through the air pipe V and the latter passing downwards by the pipe W to the feed pump.

The arrangement possesses the following advantages in addition to those already mentioned. No harm can result from the momentary flooding of the pump nor can the condenser be subjected to undue pressure, as there is always free communication with the atmosphere through the bucket valves. The foot and bucket valves need only be large enough to deal with the water; no work is wasted in the down stroke in compressing air or vapor in the pump barrel, and as the air has not to force its way through the water or the foot and bucket valves, as in an air pump of the ordinary valved bucket type, a better vacuum can be attained.—*The Mechanical Engineer.*

## New Direct-Acting Pumping Engine

The pump and pumping engine herewith illustrated is designed to simplify this class of hydraulic apparatus, by applying the pressure from the engine cylinder directly to the water to be pumped.

In Fig. 1 the pump is illustrated in its elementary form. It is composed of an air chamber *A*, vertical water cylinder *B*, intake check valve *C* and discharge check valve *D*, together with the delivery pipes *E* and *F*. The air chamber (which is alternately compression and vacuum) is made concentric with the pipe *B* by an extension downward into the chamber *A* of the tube *G*.

Assuming that water has been poured into the top of the pipe *B* until it has, by passing through the valve *D*, reached the level *W W*, its gravity has compressed the air contained in the recess *H* surrounding the tube *G* somewhat so it will hold the water, as shown at *X X*. The valve *D* is unnecessary for the operation of the pump except when pumping against heads. It will deliver water in quantity as high as the pipe *B* is carried without this valve.

If the finger is inserted at the point *I* so as momentarily to lift the clapper of the valve from its seat, the valve will be heard to click when the finger is removed, followed immediately by a second click, having apparently opened itself, and if the hand is wet and held over *I* before the second click can occur a considerable suction will be felt. Simultaneous with this action water will rise above the line *W W* in both pipes, overflowing at the top of *R*, and in greater quantity at *S*.

The efficiency of the pump, both for suction and delivery, increases in a direct ratio to the hight of the column of water in the pipe *B* and the pressure exerted at *R*. The air chamber must also be reasonably proportioned to both to obtain the best results.

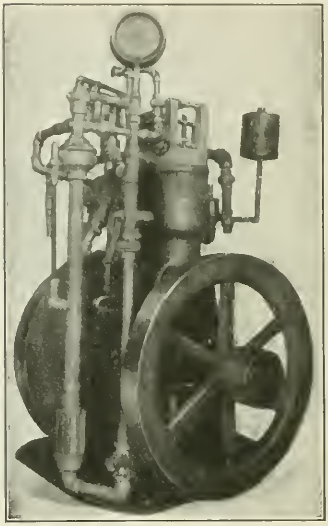


FIG. 3. PUMP ATTACHED TO A GAS ENGINE

The interiors of the piping *B* and the pump are shown in the sectional view, Fig. 2. The pressure from the engine cylinder is delivered to the top of the pump through the pipe *M*, by a valve in the cylinder head, operated by the same device that opens the exhaust valve of the engine. This opening from the cylinder has an area equal to about 1/28 the area of the bottom of the tube *G* in the pump. The purpose of this is to slow down and prevent shock to the column of water in the pipe *P*.

The fluid in the pipe *L* is a water piston, which may be seen in the gage glass on the pipe *P*, as it fluctuates up and down synchronously with the explosions in the engine cylinder. The pressure is applied through the pipe *M*, or released through the pipe *L*, by the opening of valve *K* by the eccentric operating the engine exhaust valve, after it has turned two cycles, giving the hot gas ample time to expand fully and use all the power that is in it to drive down the water piston in the pipe *P*, or water cylinder.

By comparing Fig. 2 with Fig. 3 the location of the different parts can be

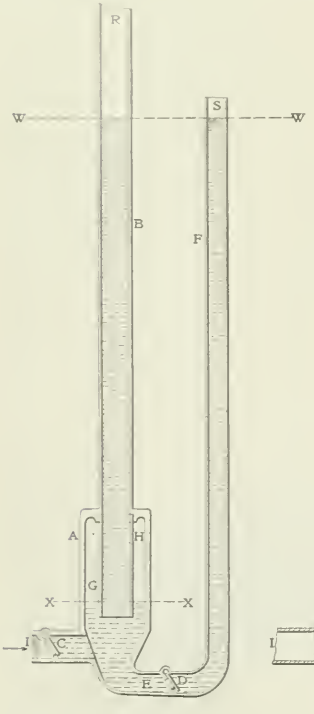


FIG. 1. ELEMENTARY FORM OF PUMP

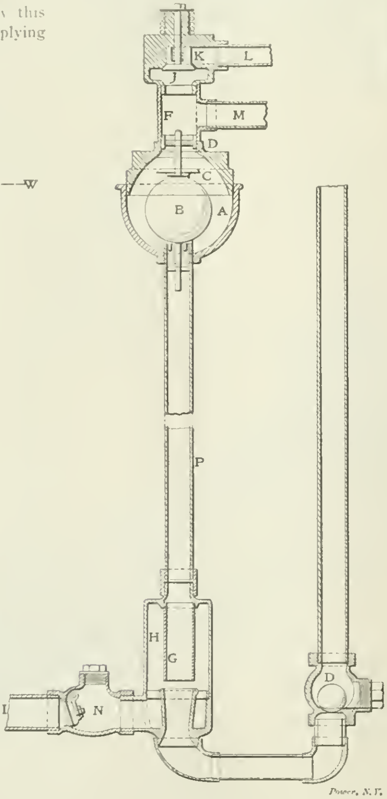


FIG. 2. SECTIONAL VIEW OF PUMP AND PIPES

readily seen, and the part they take in the operation of the unit.

In Fig. 2 the top of the pipe *P*, or water cylinder, is shown crowned with a float chamber *A* which, however, has nothing to do with the operation of the pump at low pressures, but when pumping against heads the suction so far exceeds the delivery as to require some means of cutting it off, and also, should the valve *D* leak, to prevent water from gaining access to the engine cylinder. The construction throughout is such that there are no conditions under which water can reach the engine cylinder, it is claimed, and should these pumps be operated by steam from a boiler direct, by exhaust pressure, or by taking the power directly from the cylinder of internal-combustion engines, none of the pressure fluid goes with the water being pumped. The pressure fluid does not come in contact with the water being pumped, but only with the upper end of the column of air in the water cylinder.

In pressure pumping against heads, as the resistance of the valve *D* increases the water will rise up in the water cylinder and when it enters the chamber *A* lift the float *B*, causing the valve *C* to seat at *D*. Thereafter no matter what the head is, the vacuum in chamber *H* cannot act to throw the water up until it has fallen sufficiently in the water cylinder to cause the float to draw the valve from its seat.

The valve, of course, unseats at every pressure impulse, and instantly closes. The extent to which the water cylinder will press the float upward can be governed by the design of the air chamber so as to render it incapable of throwing the column of water up with such force as to interfere with the power delivered from the engine cylinder too much. The pipe *M* is provided with a globe valve close to the cylinder, which may be seen in Fig. 3, just above the name plate on the engine cylinder.

The valve which delivers the pressure to this pipe is of the poppet type, being held closed by a strong spring. In operation the pipe *M* gets hot, and any water that should pass *C D* is promptly blown out by the steam.

The pressure is applied to the pump shortly after the piston of the engine begins its downward stroke, and is, therefore, destitute of the shock that would occur if this application were made immediately after the spark had fired the charge.

The poppet valve closes shortly before the piston reaches the bottom of its travel, and before the main exhaust valve of the engine opens, the hot and expanding gases being held to the work while the engine is exhausting, and released just before the suction stroke begins, thus completing the two cycles.

All of the power derived from the explosion is applied to the pump, except the small amount required to keep the engine in motion, this being expended in drawing in the charge, compressing it and operating the hammer sparking device.

The valve *K* opens at every revolution of the engine in low pressure pumping, so that should there be any valve leakage during compression of the explosive charge it cannot interfere with the rising column of water in the water cylinder.

Under certain circumstances in high-pressure pumping this valve *K* remains closed for two cycles, being controlled by the pressure governor which operates on a branch from the main delivery pipe, and is so adjusted as to nullify small differences due to the sinking and rising of the water supply, varying strength of the explosions, etc. It also always closes during the engine suction stroke when the unit is pumping against high heads.

In starting to pump from a well or where the source of supply is far below the pump there must be some means for drawing the water up so the valve *N* can hold it until it reaches the end of the tube *G* in the pump. To accomplish this the pipe *L* is connected directly to the engine cylinder; a globe valve is fitted to a short nipple in the cylinder head so that this pipe may be closed should occasion demand. In starting, this valve is open while the globe valve leading to the pump on the pressure pipe is closed. Water may now be raised from below the pump, and as soon as it appears in the gage glass on the water cylinder the valve is closed, or may be left open, as thereafter no suction is exerted by the cylinder, it being cut out by the suction governor, all of the suction power being within the pump itself, and derived from the repeated blows administered from the engine cylinder.

The pressure governor may be seen in Fig. 3 just back of the float chamber, and behind the pressure pipe *M*, and is so arranged that should the float fail to work it is still impossible for water to reach the cylinder through the auxiliary suction pipe, as the governor will keep the valve *K* closed.

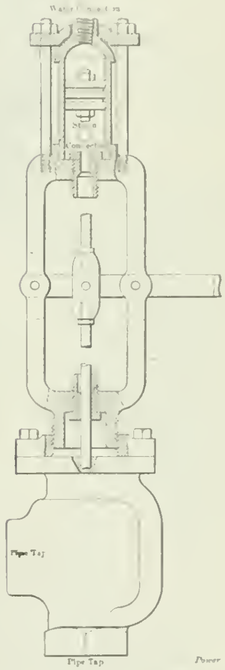
In order to use as completely as possible all of the energy developed by the fuel, a turbine is employed which takes the place of one of the engine flywheels, and utilizes the remainder of the power as it comes from the engine-exhaust valve. This turbine has shown an efficiency of about 20 per cent., it is said, when used independently of the pump, and besides its function of converting the remainder of the heat into power, it completely silences the noise of the exhaust.

The supplementary exhaust from the pump is carried by a pipe into the expansion chamber of the turbine, as shown in Fig. 3, and delivers more or less steam derived from the pump into direct contact with the lighter exhaust gases as they issue from the engine cylinder, increasing their velocity before striking the turbine.

After the unit is started the suction of the cylinder for its charge is not interfered with, and the compression and firing at all times take place under common conditions. This pumping device is the invention of George J. Murdock, 33 Wallace place, Newark, N. J.

## The Heisley Pump Governor

The accompanying engravings show a simple feed-water regulator, which is the subject of a recent patent. It is mounted upon a balanced valve such as is used with a Waters governor. In the upper cylinder is a ground-bronze piston with two water grooves. The space at the top of this piston is connected to the pump discharge so that the pressure against which the pump is working acts upon the top of the piston while the steam pressure acts upon its under side. When the pump runs too fast, increasing the pressure unduly, that pressure on top of the valve pushes it toward its seat, restricting the steam supply and slowing down the pump. On the other hand, any diminution in the water pressure below the point at which they are set to balance allows the steam pressure to force the valve open wider. The weighted lever



*Power*

FIG. 1. HEISLEY GOVERNOR IN PART SECTION

[illegible] t the [illegible] that the water will [illegible] other [illegible] water [illegible] It is [illegible] the Reeke Engineering Company, 812 Washington street, Philadelphia, Penn.

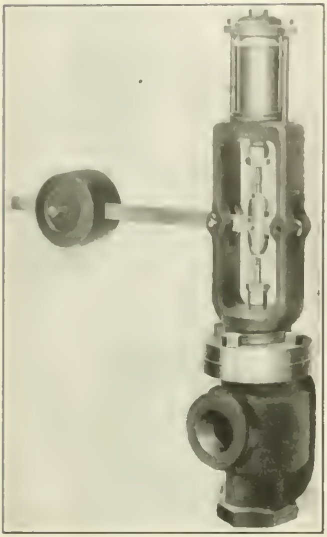


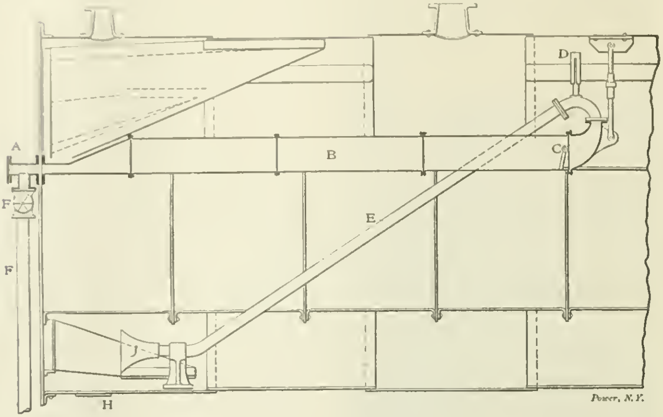
FIG. 2. HEISLEY PUMP GOVERNOR

## Ginders Scale Eliminator

In the Ginders scale eliminator the feed water enters through the connection *A*, in which a small proportion of reagent has previously been added. It then passes into the chamber *B*, where under the influence of the heat and pressure carbonic-acid gas is liberated and the scale-forming salts in solution are said to be precipitated upon the bottom of the chamber. The water passes out of the chamber through a slot in the top of the diaphragm *C* and thence through the descending feed pipe *E* and bell mouth *J* to the neighborhood of the boiler blowoff *H*. The office of the bell mouth *J* is to reduce the final velocity of the feed water and permit deposits of refractory sulphates in still water over the boiler blowoff; the quantity remaining at this stage is exceedingly small, it is claimed.

At the end of the day's run, or at other convenient time, the boiler is blown down through *H*, the feed shut off at *A* and the cock *F* of the reverse-flow connection opened. Water at high velocity then enters at bell mouth *J*, ascends the pipe *E* and, taking the outer curve of the trunk, lifts the check valves in the diaphragm *C* and so scours out the bottom of chamber *B*, carrying away the deposited mud through the cock and pipe *F* to the drain.

A gas and steam vent is provided at highest point of the curved trunk, as at *D* and suitably stayed from the boiler top.



GINDERS SCALE ELIMINATOR

The chamber *B* is made in convenient lengths to pass through a manhole and is proportioned to the evaporative capacity of the boiler, so that the quantity of feed water will allow sufficient time to complete the softening process. The illustration shows the device as applied to an English type of steam boiler. It is manufactured by E. M. Ginders, 101 Osborne road, Essex, England.

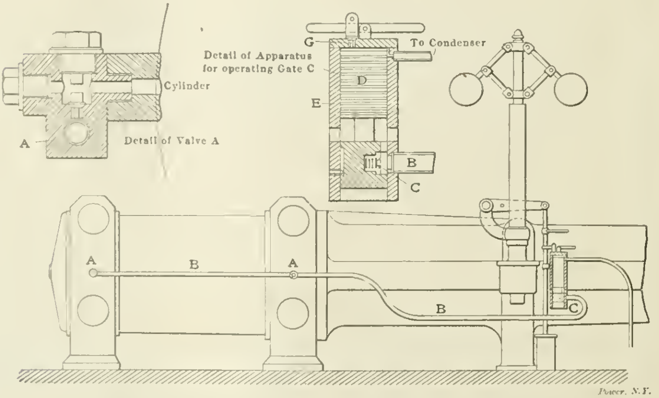
## Bollinckx Safety Device for Condensing Engines

A safety device for condensing engines, to prevent damage due to water coming back into the cylinder from the condenser is illustrated and described herewith. At each end of the cylinder a valve *A* is placed, which allows the air to enter the cylinder to break the vacuum, but which prevents the steam from escaping.

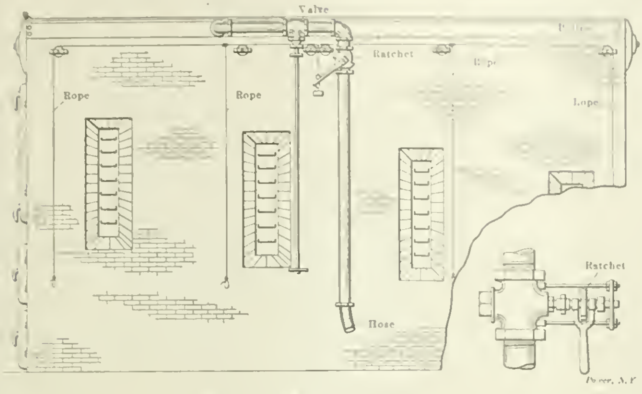
The valve inlet is connected to the tube *B*, on the end of which is placed a check *C*, which prevents the air from entering. It is necessary to provide means for opening the gate *C* at the desired moment to allow the air to enter the tube and cylinder in order to break the vacuum. This is accomplished by a piston *D*, which remains raised by the vacuum, and which falls as soon as air is introduced into the cylinder *E*, in which it works.

For the purpose of admitting air, a small valve *G* is raised, by means of the governor, when it is at such a high point that steam is not admitted to the cylinder, due to the valve not hooking up. This valve is also raised when for any cause the governor stops or falls to its lowest position, thus preventing the entrance of steam into the cylinder. This arrangement is especially advantageous for single-cylinder engines.

In the instance of compound engines a



THE BOLLINCKX SAFETY DEVICE ATTACHED TO AN ENGINE valve is placed upon the receiver, and so regulated that when the pressure falls at least half an atmosphere it rises and allows the air to pass into the cylinder, which breaks the vacuum. This device is manufactured by H. Bollinckx, Brussels.



ARRANGEMENT OF TUBE-BLOWING DEVICE

## Tube Blowing Device

When blowing the tube of a Babcock & Wilcox, or other type of water-tube boiler, it is customary to assign two men to do the work, one to handle the blower, the other to turn on and shut off the steam.

A simple yet effective device for eliminating the services of one man is illustrated and described in the following: This device is in use in the three boiler rooms of the Marion plant of the Public Service Corporation of New Jersey. It is said to be patented, and is the get-up of a former employee. The device consists of a plug valve similar to the one shown enlarged. Tightly fitted to the valve stem is a ratchet attachment, the pawl, being hung on a pin passing through the base of the fork of the lever, which is fitted loosely to the valve stem. The ratchet is designed with four teeth so that with four pulls on the lever, the valve plug is turned one complete revolution.

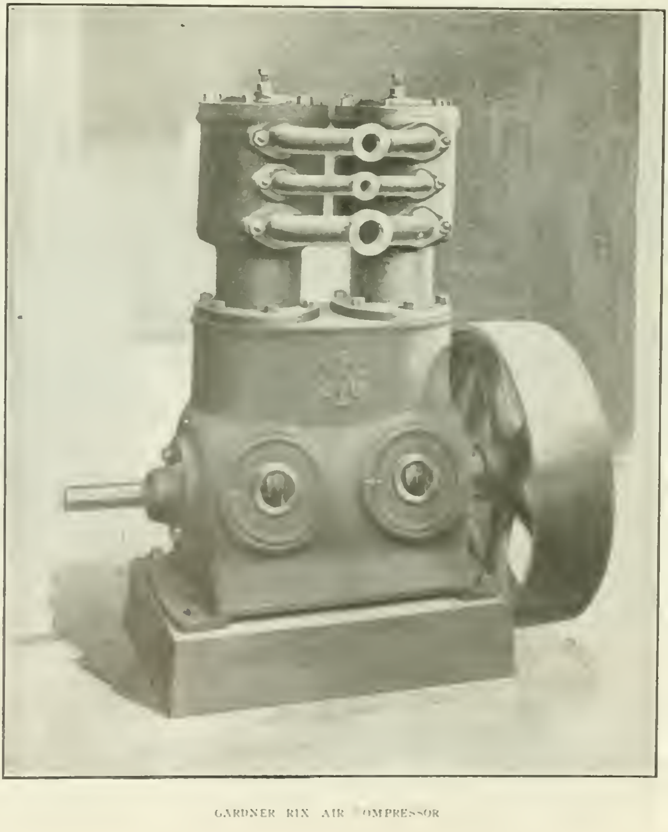
The general arrangement of the device is shown in the cut, where it is attached to the steam pipe supplying the tube blower. It will be seen that at each opening to the tube in the boiler setting, a cord is hung which passes up and over pulleys, being secured to the main cord passing over the pulley just above the ratchet lever and attached to the same. When the operator starts to blow the tube of a boiler, he first opens the valve on the steam pipe by means of the extension rod. The tube blower in this instant is then inserted through an opening opposite the tubes to be blown and the nearest cord is pulled, which lifts the ratchet lever and revolves the valve plug one-quarter turn, opening a passage to the valve through which the steam flows. When the tubes for that section have been blown clean, the cord is again pulled, turning the valve plug another turn, thus shutting off the supply of steam. The blower can be taken to the next cleaning space, when the cord is pulled, which again opens the valve, when the next pull on the cord closes it. This operation is repeated at the remaining cleaning places.

## Gardner Rix Air Compressor

The Gardner-Rix vertical high-speed air compressor, known as type "H," is illustrated and described herewith. Some of the special features commendable in this type of compressor are as follows:

Air is admitted through an annular port in the air cylinder located at the lower end of the piston travel. The smaller sizes have no inlet valve, but larger sizes have inlet valves in the air piston. The air piston is of the trunk pattern, equipped with spring rings, and is single-acting, compressing the air on the upward stroke only. The discharge valve is a flat casting and seats on the top end of the cylinder. The air piston completely fills the cylinder on each upward stroke, so that there is no clearance and the highest volumetric efficiency is attained, it is claimed.

The frame and crankcase are fitted with



GARDNER RIX AIR COMPRESSOR

nvenient handhole plates on opposite les for access to the connecting rod xes, in which are fitted glass bull's es so that the operator may look into e interior and observe the oil level and e oil splash. The lower part of the ankcase is filled with oil to such a height at the agitator on the crank disk dips to the oil at every revolution, plashing to every part of the crankcase and lubri-ating every part of the machine so oroughly that grease cups and lubri-tors are dispensed with.

The design shown is of the duplex type l," which is practically two single cyl-der machines mounted side by side on a ommon crank base and coupled to one ouble stroke crank shaft. This machine n be belt-driven or direct-connected to n electric motor, or a gasolene or steam ngine. It is built by the Gardner Gov-rnor Company, Quincy, Ill.

## The Heseltine Peat Process

By Norman B. Beasley

According to Prof. Charles A. Davis, eat expert of the United States Geo-gical Survey, Philip Heseltine, of etroit, Mich., has devised a process hich makes peat a commercial fuel. rofessor Davis's indorsement was given ter he had made several trips to the leseltine plant, in Bancroft, Mich., and here viewed the workings of the system. few years ago Philip Heseltine realized hat the only means that would be prac-cal for converting peat into fuel in this ountry would be a machine simple in onstruction, inexpensive to build, durable, light in weight, easy to manipulate and to move, to be operated with little power and with any kind of power, free from wheels, countershafts and gears, and one that could be mechanically set to deal with the majority of the different kinds and grades of peat as found in peat beds in America, also that the process must be one that could be carried out by three or four men.

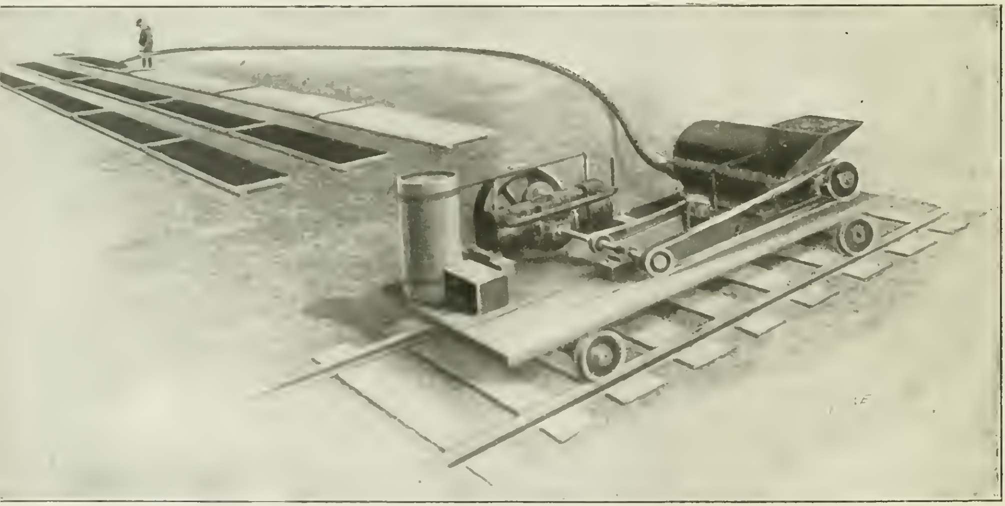
With the Heseltine process the handling and rehandling of the molds on the dry bed or dry racks, commonly considered indispensable, is said to be eliminated; in fact, the process differs in almost every respect from any other process that has even been tried or is now in use in that it thoroughly disintegrates every tissue and cellular structure of virgin peat, freeing the colloidal substances, which are forced into a solution together with crude chemicals, preventing a precipitate, and leaving all the fuel substances unchanged.

Briefly the process is this: The peat is dug by a mechanical digger and delivered to a mechanical feeder, which, in turn, automatically supplies the machine; the machine delivers through a flexible tube to the drying bed. The machine completes in a single operation the transformation of peat from its original state to a semi-liquid mass. It is then spread to a thickness of 3½ inches on the drying bed. A mechanical marker marks it into blocks 3½ inches wide and it is left in the bed seven days. At the end of this period it is lifted and dumped into crates 10 feet long, 18 inches wide and 40 inches high, where it is left seven days more; it is then in fit shape for shipment. In ordinary weather, such as is common to the northern States of the United States, this total period of fourteen days is sufficient to prepare the peat. When ready for shipment, the fuel carries 20 per cent. of moisture and in this state makes an excellent fuel, especially for gas producers. It is then in perfect form for shipment and it can be taken any distance without fear of crumbling or breaking.

Only five or six men are required to operate the plant, whereas the European process requires from 13 to 20.

The dry bed is divided into sections each 4x8 feet and is 3 inches deep. In the dry bed is one of the important features of the equipment. At the end of every seven days a conveyer picks up the peat fuel and deposits it in crates. In inclement weather the drying beds are covered with canvas; they are also protected from moisture at night in a like manner.

The machine is simple in design and easy to operate; one having a capacity of 50 tons of finished fuel per day of 10 hours weighs only 1260 pounds, and the necessary machinery to make a complete operating unit, including power, digger, trucks, frame, water tank, etc., aggregates 4000 pounds.



EQUIPMENT FOR WORKING THE HESELTINE PEAT PROCESS

The New Zealand government has recently subsidized to the extent of $75,000 a large hydroelectric mining scheme on the west coast of the South island. A plant has been installed at a cost of $250,000.

The department of mining engineering of the University of Illinois has recently issued a circular descriptive of the course in mining engineering lately established at the university. This circular can be obtained by applying to the registrar of the university, Urbana, Illinois.

## Boston Meeting of the Mechanical Engineers

On Friday evening, December 17, the engineers of Boston and vicinity assembled at the call of the committee appointed by the local members of the American Society of Mechanical Engineers, to discuss the effect of superheated steam on cast iron and steel. Papers were submitted by Prof. Ira M. Hollis, of Harvard University; Prof. Edward F. Miller, of the Massachusetts Institute of Technology, and Arthur S. Mann, of Schenectady, N. Y. The papers were discussed by the engineers of large construction and operating companies, who have had experience with fittings of different kinds when used with superheated steam, by piping specialists, by the representatives of superheater manufacturers, and in fact, from all points of view. The entire symposium will be presented in an early issue.

The January meeting will be held on Friday evening, January 21, and will take the form of a reception, perhaps a complimentary dinner to the new president of the American Society of Mechanical Engineers, George Westinghouse, and the other officers. Special efforts will be made to make the date a red-letter day in the engineering history of New England. The coöperation of the Boston Society of Civil Engineers and the local members of the American Institute of Electrical Engineers will be enlisted, and the presidents of these societies will be prominently identified with the proceedings.

## Society Notes

On Tuesday evening, December 14, P. H. McCarthy of the Federal Furnace League, delivered a lecture on "Heating and Ventilating by the Warm Air Furnace," before the Modern Science Club of Brooklyn. There were several prominent heating and ventilating engineers present and a lively discussion followed the lecture.

The fifteenth annual smoker of Stevenson Association No. 44, N. A. S. E., was held in their rooms, 2126 Broadway, New York City, Saturday evening, December 18. Several hundred members and their friends enjoyed an interesting program lasting several hours. Refreshments were served at intervals and pipes and tobacco provided for everybody.

The spacious meeting rooms of Brooklyn Association No. 41, N. A. S. E., of Brooklyn, N. Y., were comfortably filled by members and friends on Wednesday evening, December 15, to enjoy the annual smoker of this prosperous organization. In the audience were many visitors from sister associations, among them being National President W. J. Reynolds and Past National Secretary "Bill" Cronley, both of whom made brief and appropriate addresses. The "Bunch" furnished the entertainment. Refreshments were served at intervals.

Phoenix Association No. 24, N. A. S. E., of New York City, held its annual invitation smoker on the evening of December 14. After a short regular meeting of the association at the rooms in the German Masonic Temple building, on East Fifteenth street, the assemblage was invited to the lecture room, where all arrangements had been completed for a happy time. The "Bunch" furnished the entertainment. The attendance was large as is always the case at the Phoenix social gatherings. Up to midnight there was always "something doing," and good things to eat and drink were constantly in evidence.

Hutchinson Association, No. 9, N. A. S. E., of Hutchinson, Kan., held a gala night on Tuesday, December 14, to celebrate its first meeting in the new hall in the Coliseum hotel. The rooms are admirably adapted for the purposes of the association. A vote of thanks was tendered to F. A. Manda, the proprietor of the hotel, who donates the use of the hall every Wednesday evening when the meetings of the organization will be held. A series of lectures interesting to engineers will be given during the season. Many of the prominent engineers of the city were present to enjoy the festivities of the house warming.

On Tuesday evening, December 21, George A. Orrok delivered an illustrated lecture before the Modern Science Club, of Brooklyn, on the subject of surface condensers. The subject was first treated historically, and many of the views of long since obsolete condensing systems were discussed with intense interest by those present. Closing the illustrated portion of the talk with views of several recent installations of large size, Mr. Orrok called attention to the increasing amount of heat transmission that is being accomplished in modern surface condensers as a result of a wider knowledge on the part of the designer and improvement in mechanical construction. In the earlier days of surface condensers the transference of 100 B.t.u. per hour per square foot for each degree of temperature difference was considered good practice, while now a transfer of 750 B.t.u. per hour under the same conditions of temperature difference is not uncommon, and that a transfer of 1200 B.t.u. per hour had been accomplished in some instances. He expected that in the very near future every surface-condenser builder would guarantee a transfer of 1000 B.t.u. per hour per square foot of cooling surface for each degree of temperature difference. The lecture was followed by a lively discussion of the various details of condenser construction, management and upkeep.

## Engineering Societies

### AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., Jesse M. Smith, New York, N. Y.; sec., Calvin W. Rice, Engineering building; 29 West 39th St., New York. Monthly meetings in New York City. Spring meeting at Atlantic City about June 1; exact date later.

### NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Wm. C. L. Eglin, Philadelphia, Pa.; sec. and treas., John F. Gilchrist, 139 Adams St., Chicago, Ill. Association headquarters, 29 W. Thirty-ninth St., New York.

### ENGINEERS' CLUB OF PHILADELPHIA

Pres., W. P. Dallett; sec., W. P. Taylor, 1317 Spruce St. Regular meetings 1st and 3d Saturdays.

### AMERICAN SOCIETY OF NAVAL ENGINEERS

Navy Dept., Washington, D. C. Pres., Rear Admiral John K. Barton (retired) U. S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N.

### AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, Cleveland, O.

### WESTERN SOCIETY OF ENGINEERS

Pres., Andrews Allen; sec., J. H. Warder, 1737 Monadnock Block, Chicago, Ill.

### ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., George T. Barnsley; sec., E. K. Hiles, 803 Fulton building, Pittsburg, Pa. Meetings 1st and 3d Tuesdays.

### AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., Louis A. Ferguson; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly, excepting July and August.

### ENGINE BUILDERS' ASSOCIATION OF THE UNITED STATES

Pres., A. L. Merriam, Oswego, N. Y.; sec., C. H. Sembower, Reading, Pa.

### UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, W. S. Cadwell, Chicago, Ill.; sec., Thomas H. Jones, 244 Eighth street, N. E., Washington, D. C. Next convention, Buffalo, N. Y., August, 1910.

### NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., William J. Reynolds, Hoboken, N. J.; sec., F. W. Raven, 525 Manhattan building, Chicago, Ill. Next convention, Rochester, N. Y., September, 1910.

### AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next convention, Philadelphia, Pa., June, 1910.

### OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; sec. and treas., Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio.

### MASTER STEAM BOILER MAKERS' ASSOCIATION

Pres., J. H. Smyth; sec., Geo. M. Clark, 1337 N. Maplewood Ave., Chicago, Ill.

### INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., Robert A. McKee, Peoria, Ill. Next convention, Denver, Colo., September, 1910.

### NATIONAL DISTRICT HEATING ASSOCIATION

Pres., A. C. Rogers, Toledo, O.; sec. and treas., D. L. Gaskill, Greenville, O.

### NATIONAL MARINE ENGINEERS' BENEFICIAL ASSOCIATION.

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting, Washington, D. C., January 17-21, 1910.

## Business Items

The [illegible] Company has removed its [illegible] to 1011 State Mutual building, [illegible] Congress street, Boston, Mass.

The [illegible] Wire Manufacturing Company, [illegible] Water street, New York, report 116 recent sales, [illegible] blowers.

The Fitchburg Steam Engine Company, Fitchburg, Mass., will install two 800 and two [illegible] Fitchburg direct-connected engines in the new building of the New York Public Library.

The Goulds Manufacturing Company have been informed by the directors of the Alaska-Yukon exposition that their exhibit has been awarded metals. This award was the only one made on pumps of their make and is, therefore, the highest award at this exposition for triplex power pumps.

The San Francisco office of Allis-Chalmers Company has been moved from 599 Mission street to the Byron Jackson building, 160 Second street, in order to accommodate its increased selling force. The territory is in charge of R. B. Elder, who has been engaged in engineering on the Pacific coast for the past fourteen years.

The Lunkenheimer Company, of Cincinnati, Ohio, manufacturers of high-grade engineering specialties, tendered their employees and families a Thanksgiving dance in one of their new factory buildings, on Wednesday evening, November 24. About 3000 people attended. An elaborate luncheon was served and every one present thoroughly enjoyed themselves and vote dthe dance a great success.

The Reeves Pulley Company has recently moved its Chicago office into new and larger quarters at the northeast corner of Clinton and Monroe streets. This office is under the management of E. C. Winterowd, who was forced by the rapidly increasing demand for its power transmission, to enlarge its stock and increase its facilities. In the new location additional space was secured for this purpose, and they are now equipped to not only care for emergency calls, but execute all orders with the utmost promptness. In addition to a large stock of the Reeves wood split pulleys, they carry one of the largest and most complete stocks of power transmission in the Middle West.

A very interesting booklet entitled, "Problem of Woolen and Worsted Mill Lubrication Solved," has just been issued by the Keystone Lubricating Company, Department B, Philadelphia, Penn. The booklet is approved by the Lowell Textile School. It contains much very useful information for those having the lubrication of textile machinery under their charge. The text is illustrated with various types of textile manufacturing machinery showing just what parts should be lubricated and what kind of lubricant to use. Engineers in textile mills will do well to secure a copy of this booklet which we understand will be sent free on application.

## New Equipment

The Landstone (Minn.) Creamery Company will erect a new plant.

The Crystal Ice and Light Company, Paragould, Ark., will enlarge its plant.

The Tri-City Plate Ice Company, Davenport, Iowa, will erect an addition to its plant.

Godfrey & Sons Company, Milwaukee, Wis., will establish a creamery at Tomahawk, Wis.

The Corn Belt Packing Company's plant at Fort Dodge, Iowa, was burned. It will be rebuilt.

The Massillon (Ohio) Electric and Gas Company is planning to rebuild its plant on a larger scale.

The city of Cottage Grove, Ore., is having plans prepared for a water-works system to cost $100,000.

A. Endrich & Son, Frankford, Philadelphia, Penn., are building a three-story addition to their brewery.

The Denver (Colo.) Gas and Electric Company is contemplating the erection of a new power plant.

The California Ice and Storage Company, Oakland, Cal., will erect a six-story cold-storage building.

The Model Mills Company, Philadelphia, Penn., is putting up a five-story building at Ontario and I streets.

The Melbourne Lumber Company, Philadelphia, Penn., will make extensive alterations in its engine room.

Sealed bids will be received by Henry Halverson, city clerk, Dodgeville, Wis., until 7:30 p.m., January 4, 1910, for the furnishing and erection of either a cypress-wood or steel tank 22 feet in diameter by 24 feet high. Plans and specifications on file at the city clerk's office, Dodgeville, and at the office of W. G. Kirchoffer, engineer, 31 Vroman building, Madison, Wis.

## New Catalogs

Baker Valve Company, Minneapolis, Minn. Pamphlet. Balanced piston valve. Illustrated, 2 pages, 4x9 inches.

Monarch Machine Works, 711 Green avenue, Altoona, Penn. Booklet. Riggin blowoff valve. Illustrated, 3½x6 inches.

Waterbury Farrel Foundry and Machine Company, Waterbury, Conn. Catalog. Rivet, bolt and nut machinery, drop presses, foot and screw presses, hydraulic machinery, etc. Illustrated, 206 pages, 6x9 inches.

Crosby Steam Gage and Valve Company is sending out an unusually attractive loose-leaf folder describing a few of the many recording instruments of its manufacture. Each individual leaf is devoted to the illustration of one instrument, is printed only on one side, and the eleven pages making up the folder are inclosed in a cover of neat design.

## Help Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

AGENTS WANTED to sell Buckeye lubricating compound on a commission basis. Buckeye Compound Co., Pittsburg, Penn.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

WANTED—Mechanical and electrical foreman, experienced in electric and steam power, heat, light and general millwright work; capable of having complete charge of power plant and all machinery with a large manufacturing company. Box 95, POWER.

## Situations Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

WANTED—Position as gas producer erector, by machinist who has operated a direct current plant. Address "B. T. U.," POWER.

WANTED—Position as chief or operating engineer; have experience and ability in taking charge of electric or steam plants. Box 98, POWER.

SITUATION WANTED by a gas engineer experienced on two and four cycle gas engines, also on suction and pressure producers and can furnish first-class references. Address "C. W. 86," care POWER.

WANTED—Position as master mechanic for mining company using electric haulage; good stationary engineer and electrician, pump man; understand high speed and Corliss engines, air compressors; good draftsman; Pacific slope preferred. Box 94, POWER.

CHIEF ENGINEER, 40, now with large power plant, having 27 men under my charge, desires change January 1, 1910; splendid engineering experience; fully competent to take full charge; best of references, and am willing to go anywhere. Address Box 97, POWER.

## Miscellaneous

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

PATENTS secured. C. L. Parker, Solicitor of Patents, 4 McGill Bldg., Washington, D. C.

ESTABLISHED New York concern handling well known steam specialties, desire active partner with capital to enlarge; unquestionable honor required. Box 96, POWER.

ANY FIRM or engineer in charge of a steam plant that is troubled with scale in the boilers can get absolutely free, the best indicator and reducing wheel made, with velvet-lined mahogany case. For particulars, address Great Lakes Chemical Works, Manitowoc, Wis.

The annual meeting of the stockholders of the Hill Publishing Company, for the election of directors for the ensuing year and for the transaction of such other business as may properly come before the meeting, will be held at the office of the company, in the Hallenbeck building, 497-505 Pearl street, Borough of Manhattan, New York City, N. Y., on Tuesday, January 25, 1910, at 12 o'clock noon.

Dated, New York City, December 6, 1909.
Robert McKean, Secretary.

## For Sale

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

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